An 8-year-old has been persistently argumentative and angry with adults at home and school for 8 months. He often defies rules and deliberately annoys others, but does not violate others' basic rights. Which diagnosis fits the criteria?

A. Conduct disorder
B. Oppositional defiant disorder
C. Intermittent explosive disorder
D. Bipolar I disorder
E. Disruptive mood dysregulation disorder

Original table 42.1 | Nelson printed p. 278 | PDF p. 323

Table 42.1 DSM-5 Diagnostic Criteria for Oppositional Defiant Disorder

A. A pattern of angry/irritable mood, argumentative/defiant behavior, or vindictiveness lasting at least 6 mo as evidenced by at least four symptoms from any of the following categories, and exhibited during interaction with at least one individual who is not a sibling:

ANGRY/IRRITABLE MOOD
1. Often loses temper.
2. Is often touchy or easily annoyed.
3. Is often angry and resentful.

ARGUMENTATIVE/DEFIANT BEHAVIOR
4. Often argues with authority figures or, for children and adolescents, with adults.
5. Often actively defies or refuses to comply with requests from authority figures or with rules.
6. Often deliberately annoys others.
7. Often blames others for his or her mistakes or misbehavior.

VINDICTIVENESS
8. Has been spiteful or vindictive at least twice within the past 6 mo.

Note: The persistence and frequency of these behaviors should be used to distinguish a behavior that is within normal limits from a behavior that is symptomatic. For children younger than 5 yr, the behavior should occur on most days for a period of at least 6 mo unless otherwise noted (Criterion A8). For individuals 5 yr or older, the behavior should occur at least once per week for at least 6 mo, unless otherwise noted (Criterion A8). Although these frequency criteria provide guidance on a minimal level of frequency to define symptoms, other factors should be considered, such as whether the frequency and intensity of the behaviors are outside a range that is normative for the individual's developmental level, gender, and culture.

B. The disturbance in behavior is associated with distress in the individual or others in his or her immediate social context (e.g., family, peer group, work colleagues), or it impacts negatively on social, educational, occupational, or other important areas of functioning.

C. The behaviors do not occur exclusively during the course of a psychotic, substance use, depressive, or bipolar disorder. Also, the criteria are not met for disruptive mood dysregulation disorder.

From the *Diagnostic and Statistical Manual of Mental Disorders,* 5th ed. pp. 462–463. Copyright 2013. American Psychiatric Association.

A 15-year-old has recurrent impulsive aggressive outbursts grossly disproportionate to minor provocations. The attacks are not premeditated and occur without an external reward. Which diagnosis best fits?

A. Intermittent explosive disorder
B. Conduct disorder
C. Tourette disorder
D. Cyclothymia
E. Social anxiety disorder

Original table 42.2 | Nelson printed p. 278 | PDF p. 323

Table 42.2 DSM-5 Diagnostic Criteria for Intermittent Explosive Disorder

A. Recurrent behavioral outbursts representing a failure to control aggressive impulses as manifested by either of the following:
   1. Verbal aggression (e.g., temper tantrums, tirades, verbal arguments or fights) or physical aggression toward property, animals, or other individuals, occurring twice weekly, on average, for a period of 3 mo. The physical aggression does not result in damage or destruction of property and does not result in physical injury to animals or other individuals.
   2. Three behavioral outbursts involving damage or destruction of property and/or physical assault involving physical injury against animals or other individuals occurring with a 12 mo period.

B. The magnitude of aggressiveness expressed during the recurrent outbursts is grossly out of proportion to the provocation or to any precipitating psychosocial stressors.

C. The recurrent aggressive outbursts are not premeditated (i.e., they are impulsive and/or anger-based) and are not committed to achieve some tangible objective (e.g., money, power, intimidation).

D. The recurrent aggressive outbursts cause either marked distress in the individual or impairment in occupational or interpersonal functioning, or as associated with financial or legal consequences.

E. Chronologic age is at least 6 yr (or equivalent developmental level).

F. The recurrent aggressive outbursts are not better explained by another mental disorder (e.g., major depressive disorder, bipolar disorder, disruptive mood dysregulation disorder, a psychotic disorder, antisocial personality disorder, borderline personality disorder) and are not attributable to another medical condition (e.g., head trauma, Alzheimer disease) or to the physiologic effects of a substance (e.g., a drug of abuse, a medication). For children ages 6-18 yr, aggressive behavior that occurs as part of an adjustment disorder should not be considered for this diagnosis.

Note: This diagnosis can be made in addition to the diagnosis of attention-deficit/hyperactivity disorder, conduct disorder, oppositional defiant disorder, or autism spectrum disorder when recurrent impulsive aggressive outbursts are in excess of those usually seen in these disorders and warrant clinical attention.

From the *Diagnostic and Statistical Manual of Mental Disorders,* 5th ed. p. 466. Copyright 2013. American Psychiatric Association.

A 14-year-old repeatedly steals while confronting victims, threatens classmates, and has been cruel to animals over the past year. Which diagnosis is most consistent?

A. Oppositional defiant disorder
B. Intermittent explosive disorder
C. Conduct disorder
D. Panic disorder
E. Specific phobia

Original table 42.3 | Nelson printed p. 279 | PDF p. 324

Table 42.3 DSM-5 Diagnostic Criteria for Conduct Disorder

A. A repetitive and persistent pattern of behavior in which the basic rights of others or major age-appropriate societal norms or rules are violated, as manifested by the presence of at least 3 of the following 15 criteria in the past 12 mo from any of the following categories, with at least one criterion present in the past 6 mo:

AGGRESSION TO PEOPLE AND ANIMALS
1. Often bullies, threatens, or intimidates others.
2. Often initiates physical fights.
3. Has used a weapon that can cause serious physical harm to others (e.g., a bat, brick, broken bottle, knife, gun).
4. Has been physically cruel to people.
5. Has been physically cruel to animals.
6. Has stolen while confronting a victim (e.g., mugging, purse snatching, extortion, armed robbery).
7. Has forced someone into sexual activity.

DESTRUCTION OF PROPERTY
8. Has deliberately engaged in fire setting with the intention of causing serious damage.
9. Has deliberately destroyed others' property (other than by fire setting).

DECEITFULNESS OR THEFT
10. Has broken into someone else's house, building, or car.
11. Often lies to obtain good or favors or to avoid obligations (i.e., "cons" others).
12. Has stolen items of nontrivial value without confronting a victim (e.g., shoplifting, but without breaking and entering; forgery).

SERIOUS VIOLATIONS OF RULES
13. Often stays out at night despite parental prohibitions, beginning before age 13 yr.
14. Has run away from home overnight at least twice while living in the parental or parental surrogate home, or once without returning for a lengthy period.
15. Is often truant from school, beginning before age 13 yr.

B. The disturbance in behavior causes clinically significant impairment in social, academic, or occupational functioning.

C. If the individual is age 18 yr or older, criteria are not met for antisocial personality disorder.

From the *Diagnostic and Statistical Manual of Mental Disorders,* 5th ed. pp. 469–471. Copyright 2013. American Psychiatric Association.

A 16-year-old develops delusions and disorganized speech for 9 days after an otherwise healthy baseline, then fully returns to usual functioning. Medical and substance causes are excluded. Which psychotic disorder is most consistent?

A. Schizophrenia
B. Schizophreniform disorder
C. Brief psychotic disorder
D. Delirium
E. Persistent delusional disorder

Original table 47.1 | Nelson printed p. 285 | PDF p. 331

Table 47.1 DSM-5 Diagnostic Criteria for Brief Psychotic Disorder

A. Presence of one (or more) of the following symptoms. At least one of these must be (1), (2), or (3):
   1. Delusions
   2. Hallucinations
   3. Disorganized speech (e.g., frequent derailment or incoherence)
   4. Grossly disorganized or catatonic behavior

Note: Do not include a symptom if it is a culturally sanctioned response.

B. Duration of an episode of the disturbance is at least 1 day but less than 1 mo, with eventual full return to premorbid level of functioning.

C. The disturbance is not better explained by major depressive or bipolar disorder with psychotic features or another psychotic disorder such as schizophrenia or catatonia, and is not attributable to the physiologic effects of a substance (e.g., a drug of abuse, a medication) or another medical condition.

Specify if:

With marked stressor(s) (brief reactive psychosis): If symptoms occur in response to events that, singly or together, would be markedly stressful to almost anyone in similar circumstances in the individual's culture.

Without marked stressor(s): If the symptoms do not occur in response to events that, singly or together, would be markedly stressful to almost anyone in similar circumstances in the individual's culture.

With postpartum onset: If onset is during pregnancy or within 4 wk postpartum.

From the *Diagnostic and Statistical Manual of Mental Disorders,* 5th ed. p 94. Copyright

An adolescent has delusions, auditory hallucinations, and disorganized speech for 10 weeks with no substance exposure or mood syndrome. Which duration-defined diagnosis currently fits?

A. Brief psychotic disorder
B. Schizophreniform disorder
C. Schizophrenia
D. Delirium
E. Acute stress disorder

Original table 47.2 | Nelson printed p. 286 | PDF p. 332

Table 47.2 DSM-5 Diagnostic Criteria for Schizophreniform Disorder

A. Two (or more) of the following, each present for a significant portion of time during a 1 mo period (or less if successfully treated). At least one of these must be (1), (2), or (3):
   1. Delusions
   2. Hallucinations
   3. Disorganized speech (e.g., frequent derailment or incoherence)
   4. Grossly disorganized or catatonic behavior
   5. Negative symptoms (i.e., diminished emotional expression or avolition)

B. An episode of the disorder lasts at least 1 mo but less than 6 mo. When the diagnosis must be made without waiting for recovery, it should qualified as "provisional."

C. Schizoaffective disorder and depressive or bipolar disorder with psychotic features have been ruled out because either (1) no major depressive or manic episodes have occurred concurrently with the active-phase symptoms or (2) if mood episodes have occurred during active-phase symptoms, they have been present for a minority of the total duration of the active and residual periods of the illness.

D. The disturbance is not attributable to the physiologic effects of a substance (e.g., a drug of abuse, a medication) or another medical condition.

Specify if:

With good prognostic features: This specifier requires the presence of at least two of the following features: onset of prominent psychotic symptoms within 4 wk of the first noticeable change in usual behavior or functioning; confusion or perplexity; good premorbid social and occupational functioning; and absence of blunted or flat affect.

Without good prognostic features: This specifier is applied if two or more of the previous features have not been present.

From the *Diagnostic and Statistical Manual of Mental Disorders,* 5th ed. pp 96–97. Copyright 2013. American Psychiatric Association.

A 17-year-old has hallucinations, disorganized speech, and declining school and social function for 8 months, including at least a month of prominent active symptoms. Medical and substance causes are excluded. Which diagnosis best fits?

A. Brief psychotic disorder
B. Schizophreniform disorder
C. Schizophrenia
D. Panic disorder
E. Adjustment disorder

Original table 47.3 | Nelson printed p. 286 | PDF p. 332

Table 47.3 DSM-5 Diagnostic Criteria for Schizophrenia

A. Two (or more) of the following, each present for a significant portion of time during a 1 mo period (or less if successfully treated). At least one of these must be (1), (2), or (3):
   1. Delusions
   2. Hallucinations
   3. Disorganized speech (e.g., frequent derailment or incoherence)
   4. Grossly disorganized or catatonic behavior
   5. Negative symptoms (i.e., diminished emotional expression or avolition)

B. For a significant portion of the time since the onset of the disturbance, level of functioning in one or more major areas, such as work, interpersonal relations, or self-care, is markedly below the level achieved before the onset (or when the onset is in childhood or adolescence, there is failure to achieve expected level of interpersonal, academic, or occupational functioning).

C. Continuous signs of the disturbance persist for at least 6 mo. This 6 mo period must include at least 1 mo of symptoms (or less if successfully treated) that meet Criterion A (i.e., active-phase symptoms) and may include periods of prodromal or residual symptoms. During these prodromal or residual periods, the signs of the disturbance may be manifested by only negative symptoms or by two or more symptoms listed in Criterion A present in an attenuated form (e.g., odd beliefs, unusual perceptual experiences).

D. Schizoaffective disorder and depressive or bipolar disorder with psychotic features have been ruled out because either (1) no major depressive or manic episodes have occurred concurrently with the active-phase symptoms or (2) if mood episodes have occurred during active-phase symptoms, they have been present for a minority of the total duration of the active and residual periods of the illness.

E. The disturbance is not attributable to the physiologic effects of a substance (e.g., a drug of abuse, a medication) or another medical condition.

F. If there is a history of autism spectrum disorder or a communication disorder of childhood onset, the additional diagnosis of schizophrenia is made only if prominent delusions or hallucinations, in addition to the other required symptoms of schizophrenia, are also present for at least a month (or less if successfully treated).

From the *Diagnostic and Statistical Manual of Mental Disorders,* 5th ed. pp 99–100. Copyright 2013. American Psychiatric Association.

A previously well adolescent develops rapidly progressive psychosis and new seizures. Which listed secondary etiology should be specifically investigated?

A. Autoimmune encephalitis
B. Isolated academic stress
C. Habitual snoring
D. Developmental dyslexia
E. Primary nocturnal enuresis

Original table 47.4 | Nelson printed p. 287 | PDF p. 333

Table 47.4 Possible Causes of Secondary Psychosis

	EXAMPLES	INVESTIGATIONS
Trauma	Traumatic head injury	CT, MRI
Autoimmune disorders	Systemic lupus erythematosus, NMDA receptor encephalitis and others	Autoantibody titers
Cytogenetic/congenital disorders	Velocardiofacial syndrome, agenesis of corpus callosum	Karyotyping, MRI
Toxic/substance-induced disorders	PCP, MDMA, LSD, cannabis, alcohol, cocaine, synthetic cannabinoids (bath salts) Lead, mercury or arsenic poisoning, ginseng, St. John's Wort, ma huang	Careful medication history; urine screen for drugs, heavy metal screen; trial off the offending agent
Iatrogenic disorders	Antimalarials, steroids, isoniazid	Careful medication history; trial off the offending agent
Cerebrovascular disorders	Stroke, subdural hematomas	CT, MRI
Space-occupying disorders	Cerebral tumors	CT, MRI
Metabolic disorders	Pheochromocytoma, metachromatic leukodystrophy, Wilson disease, adult Tay-Sachs disease, acute intermittent porphyria	Urinary catecholamines; arylsulfatase-A levels, copper and ceruloplasmin levels
Dietary disorders	Pellagra, B_{12} deficiency; thiamine deficiency	B_{12}, folate, thiamine levels
Sepsis/infectious disorders	Neurosyphilis, toxoplasmosis, HIV disease, encephalitis	RPR to rule out syphilis; HIV antibody titers; glucose, protein in CSF
Unknown cause/degenerative/demyelinating disorders	Lewy body dementia, Parkinson disease, Huntington disease, multiple sclerosis, Friedreich ataxia	MRI, CT, EEG, evoked potentials
Seizure disorders	Partial complex seizures, temporal lobe epilepsy	EEG, including sleep deprivation; telemetric EEG as indicated
Endocrine disorders	Hyperthyroidism, hypothyroidism, hyperparathyroidism	Serum calcium, thyroid/parathyroid hormone levels

CSF, Cerebrospinal fluid; EEG, electroencephalography; LSD, lysergic acid diethylamide; MDMA, 3,4-methylenedioxy-*N*-methylamphetamine; NMDA, *N*-methyl-D-aspartate; PCP, phencyclidine; RPR, rapid plasma reagin.
Modified from Keshavan MS, Kaneko Y. Secondary psychoses: An update. *World Psychiatry*. 2013;12(1):4–15:Table 1, p 5.

An adolescent with first-episode psychosis also has fluctuating consciousness, abnormal movements, and a recent febrile illness. Which interpretation best follows the red-flag table?

A. Typical uncomplicated primary psychosis
B. Features concerning for a secondary medical etiology
C. Diagnostic evidence of conduct disorder
D. Findings that exclude encephalitis
E. Evidence of isolated social anxiety

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Table 47.5 Red Flags and Features Suggesting Secondary Etiologies of Psychosis

ATYPICAL FEATURES
- Normal before event
- Very early (≤13 yr) age of onset
- Acute or subacute onset (days, ≤1 mo)
- Catatonia
- Dyskinesias
- Isolated misidentification delusion (Capgras syndrome)
- Depressed level of consciousness; disorientation; somnolence
- Cognitive and recent memory decline
- Poor orientation
- Intractability despite adequate therapy
- Rapidly progressive and/or fluctuating (polymorphic) symptoms
- Multimodal hallucinations: visual, auditory, olfactory, gustatory
- Poor response to antipsychotics

HISTORY
- Infectious prodrome (fever)
- New or worsening headache; change in headache pattern
- Paresthesias
- Past, current substance misuse
- Recent onset incontinence
- Anorexia/weight loss
- Risk factors for cerebrovascular disease or central nervous system infections
- Malignancy
- Immunocompromised status
- Head trauma
- Seizures
- Hepatobiliary disorders
- Systemic lupus erythematosus/other autoimmune diseases
- Biologic relatives with similar medical complaints
- Aphasia, mutism, dysarthria

PHYSICAL EXAMINATION
- Autonomic hyperactivity: tachycardia, hypertension, mydriasis, sleep disturbance
- Incoordination, or gait difficulty; nystagmus
- Toxidrome
- Abnormal neurologic exam: upper and lower motor neuron focal findings
- Movement disorder
- Neuroendocrine changes

DIAGNOSTIC ABNORMALITIES
- Abnormal electroencephalogram (extreme delta brush, diffuse slowing)
- Abnormal cerebrospinal fluid (pleocytosis: greater than 5 lymphocytes)
- Positive urine toxicology
- Screening laboratory tests including *N*-methyl-D-aspartate receptor and other antibodies
- Abnormal neuroimaging studies (unilateral or bilateral hippocampal/medial temporal lobe hyperdensities: limbic encephalitis)
- Hyponatremia

Modified from Kliegman RM, Toth H, Bordini BJ, Basel D, eds. *Nelson Pediatric Symptom-Based Diagnosis*. 2nd ed. Elsevier, 2023: Table 31.9, p 526

A previously healthy teen develops psychosis over 3 weeks together with new seizures and abnormal movements. Which additional diagnostic category is raised by the proposed criteria?

A. Possible autoimmune psychosis
B. Persistent tic disorder
C. Uncomplicated adjustment disorder
D. Somatic symptom disorder
E. Specific learning disorder

Original table 47.6 | Nelson printed p. 288 | PDF p. 334

Table 47.6 Proposed Diagnostic Criteria for Autoimmune Psychosis

For a diagnosis of possible autoimmune psychosis:

The patient must have current psychotic symptoms of abrupt onset (rapid progression of <3 months) with at least one of the following:

- Currently or recently diagnosed with a tumor
- Movement disorder (catatonia or dyskinesia)
- Adverse response to antipsychotics, raising suspicion of neuroleptic malignant syndrome (rigidity, hyperthermia, or raised creatine kinase)
- Severe or disproportionate cognitive dysfunction
- A decreased level of consciousness
- The occurrence of seizures that are not explained by a previously known seizure disorder
- A clinically significant autonomic dysfunction (abnormal or unexpectedly fluctuant blood pressure, temperature, or heart rate)

If a patient has possible autoimmune psychosis, they should be investigated as per section 5 ("Consensus multimodal approach to the systematic investigation of patients with suspected autoimmune psychosis"), including electroencephalography, MRI, serum autoantibodies, and CSF analysis (including CSF autoantibodies). The results should lead to a diagnosis of non-autoimmune psychosis or probable/definite autoimmune psychosis.

For a diagnosis of probable autoimmune psychosis:

The patient must have current psychotic symptoms of abrupt onset (rapid progression of <3 mo) with at least one of the seven clinical criteria listed previously for possible autoimmune psychosis and at least one of the following:

- CSF pleocytosis of >5 white blood cells/μL
- Bilateral brain abnormalities on T2 weighted fluid-attenuated inversion recovery MRI highly restricted to the medial temporal lobes

Or two of the following:

- Electroencephalogram encephalopathic changes (i.e., spikes, spike-wave activity, or rhythmic slowing [intermittent rhythmic delta or theta activity] focal changes, or extreme delta brush
- CSF oligoclonal bands or increased IgG index
- The presence of a serum antineuronal antibody detected by cell-based assay

After exclusion of alternative diagnoses.

For a diagnosis of definite autoimmune psychosis:

The patient must meet the criteria for probable autoimmune psychosis with IgG class antineuronal antibodies in CSF.

Note that these criteria do not exclude a diagnosis being made in a patient with an acute onset (<3 mo) of psychosis, even if that patient has had a previous psychotic, other psychiatric, or encephalopathic episode that resolved.

From Pollak TA, Lennox BR, Müller S, et al. Autoimmune psychosis: an international consensus on an approach to the diagnosis and management of psychosis of suspected autoimmune origin [published correction appears in *Lancet Psychiatry*, 2019

An adolescent develops hallucinations soon after starting a medication known to cause psychotic symptoms. Symptoms are absent during periods without exposure, and there is no delirium. Which diagnosis best fits the table?

A. Schizophrenia
B. Brief psychotic disorder
C. Substance/medication-induced psychotic disorder
D. Catatonia
E. Major depressive disorder

Original table 47.7 | Nelson printed p. 291 | PDF p. 337

Table 47.7 DSM-5 Diagnostic Criteria for Substance/Medication Induced Psychotic Disorder

A. Presence of one or both of the following symptoms:
   1. Delusions
   2. Hallucinations
B. There is evidence from the history, physical examination, or laboratory findings of both (1) and (2):
   1. The symptoms of Criterion A developed during or soon after substance intoxication or withdrawal or after exposure to a medication.
   2. The involved substance/medication is capable of producing the symptoms in Criterion A.
C. The disturbance is not better explained by a psychotic disorder that is not substance/medication induced.
D. The disturbance does not occur exclusively during the course of a delirium.
E. The disturbance causes clinically significant distress or impairment in social, occupational, or other important areas of functioning.

Specify if:

With onset during intoxication: If the criteria are met for intoxication with the substance and the symptoms develop during intoxication.

With onset during withdrawal: If the criteria are met for withdrawal from the substance and the symptoms develop during, or shortly after, withdrawal.

From the *Diagnostic and Statistical Manual of Mental Disorders*, 5th ed. pp 110–115. Copyright 2013. American Psychiatric Association. .

A child develops persistent hallucinations during an established neurologic illness. Evaluation shows the hallucinations are a direct pathophysiologic consequence of the disease, and attention remains intact. Which diagnosis best fits?

A. Psychotic disorder due to another medical condition
B. Substance-induced psychotic disorder
C. Delirium
D. Brief psychotic disorder
E. Oppositional defiant disorder

Original table 47.8 | Nelson printed p. 291 | PDF p. 337

Table 47.8 DSM-5 Diagnostic Criteria for Psychotic Disorder Due to Another Medical Condition

A. Prominent hallucinations or delusions.
B. There is evidence from the history, physical examination, or laboratory findings that the disturbance is the direct pathophysiologic consequence of another medical condition.
C. The disturbance is not better explained by another mental disorder.
D. The disturbance does not occur exclusively during the course of a delirium.
E. The disturbance causes clinically significant distress or impairment in social, occupational, or other important areas of functioning.

Specify whether:

With delusions: If delusions are the predominant symptom.

With hallucinations: If hallucinations are the predominant symptom.

From the *Diagnostic and Statistical Manual of Mental Disorders,* 5th ed. pp 115–116. Copyright 2013. American Psychiatric Association. .

An adolescent abruptly remains motionless with a fixed gaze, gives almost no verbal responses, and holds an imposed posture. Which syndrome is described by these combined signs?

A. Hyperkinetic tic disorder
B. Catatonia
C. Panic attack
D. Selective mutism alone
E. Attention-deficit/hyperactivity disorder

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Table 47.9 Catatonia

Excitement: Extreme hyperactivity; constant motor unrest, which is apparently nonpurposeful
Immobility/stupor: Extreme hypoactivity, immobility; minimally responsive to stimuli
Mutism: Verbally unresponsive or minimally responsive
Staring: Fixed gaze, little or no visual scanning of environment, decreased blinking
Posturing/catalepsy: Maintains posture(s), including mundane (e.g., sitting or standing for hours without reacting)
Grimacing: Maintenance of odd facial expressions
Echopraxia/echolalia: Mimics of examiner's movements/speech
Stereotypy: Repetitive, non–goal-directed motor activity (e.g., finger play; repeatedly touching, patting, or rubbing self)
Mannerisms: Odd, purposeful movements (hopping or walking tiptoe, saluting passersby, exaggerated caricatures of mundane movements)
Verbigeration: Repetition of phrases or sentences
Rigidity: Maintenance of a rigid posture despite efforts to be moved
Negativism: Apparently motiveless resistance to instructions or to attempts to move/examine the patient; contrary behavior does the opposite of the instruction
Waxy flexibility: During reposturing of the patient, offers initial resistance before allowing themselves to be repositioned (similar to that of bending a warm candle)
Withdrawal: Refusal to eat, drink, or make eye contact
Impulsivity: Suddenly engaging in inappropriate behavior (e.g., runs down the hallway, starts screaming, or takes off clothes) without provocation; afterward, cannot explain
Automatic obedience: Exaggerated cooperation with examiner's request, or repeated movements that are requested once
Passive obedience *(mitgehen)*: Raising arm in response to light pressure of finger, despite instructions to the contrary
Negativism *(gegenhalten)*: Resistance to passive movement that is proportional to strength of the stimulus; response seems automatic rather than willful
Ambitendency: Appears stuck in indecisive, hesitant motor movements
Grasp reflex: Striking the patient's open palm with two extended fingers of the examiner's hand results in automatic closure of the patient's hand
Perseveration: Repeatedly returns to the same topic or persists with the same movements
Combativeness: Belligerence or aggression, usually in an undirected manner, without explanation
Autonomic abnormality: Abnormality of body temperature (fever), blood pressure, pulse rate, respiratory rate, inappropriate sweating

From Dhossche DM, Wachtel LE. Catatonia is hidden in plain sight among different pediatric disorders: A review article. *Pediatr Neurol*. 2010;43:307–315.

A child with suspected catatonia has new seizures and cognitive change. Which listed category of associated conditions warrants active consideration?

A. Neurologic illness including autoimmune encephalitis
B. Uncomplicated myopia
C. Primary dental caries
D. Seasonal allergic rhinitis alone
E. Lactose intolerance

Original table 47.10 | Nelson printed p. 292 | PDF p. 338

Table 47.10 Conditions Associated with Catatonia

Psychotic Disorders
- Paranoid schizophrenia, catatonic schizophrenia, psychosis, autism, Prader-Willi syndrome, intellectual impairment

Mood Disorders
- Bipolar disorder: manic or mixed episodes

Major Depressive Disorder

Medical Conditions
- Hyper-hypothyroidism, euthyroid autoimmune thyroiditis, Addison disease, infections, electrolyte imbalances, pathogenic variants in *SCN2A* gene, systemic lupus erythematosus

Neurologic Conditions
- Epilepsy, strokes, traumatic brain injury, multiple sclerosis, infectious and autoimmune encephalitis, acute disseminated encephalomyelitis, neuromyelitis optica spectrum

Drugs
- Withdrawal: benzodiazepines, L-dopa, gabapentin
- Overdose: LSD, PCP, cocaine, MDMA (Ecstasy), disulfiram, levetiracetam

LSD, Lysergic acid; MDMA, 3,4-methylenedioxy-*N*-methylamphetamine; PCP, phencyclidine.

A hospitalized teenager with a medical illness has stupor, mutism, and waxy flexibility, in the absence of delirium. Which statement best matches the listed catatonia criteria?

A. One motor sign is sufficient
B. Three or more characteristic signs support catatonia due to a medical condition
C. A hallucination is required
D. Symptoms must begin before age 10 years
E. A confirmed mood disorder is required

Original table 47.11 | Nelson printed p. 292 | PDF p. 338

Table 47.11 DSM-5 Criteria for Catatonia Due to Another Medical Condition

A. The clinical picture is dominated by three (or more) of the following symptoms:
   1. Stupor (i.e., no psychomotor activity; not actively relating to environment).
   2. Catalepsy (i.e., passive induction of a posture held against gravity).
   3. Waxy flexibility (i.e., slight, even resistance to positioning by examiner).
   4. Mutism (i.e., no, or very little, verbal response [*Note:* not applicable if there is an established aphasia]).
   5. Negativism (i.e., opposing or not responding to instructions or external stimuli).
   6. Posturing (i.e., spontaneous and active maintenance of a posture against gravity).
   7. Mannerism (i.e., odd, circumstantial caricature of normal actions).
   8. Stereotypy (i.e., repetitive, abnormally frequent, non–goal-directed movements).
   9. Agitation, not influenced by external stimuli.
   10. Grimacing.
   11. Echolalia (i.e., mimicking another's speech).
   12. Echopraxia (i.e., mimicking another's movements).

B. There is evidence from the history, physical examination, or laboratory findings that the disturbance is the direct pathophysiologic consequence of another medical condition.

C. The disturbance is not better explained by another mental disorder (e.g., a manic episode).

D. The disturbance does not occur exclusively during the course of a delirium.

E. The disturbance causes clinically significant distress or impairment in social, occupational, or other areas of functioning.

Coding note: Include the name of the medical condition in the name of the mental disorder (e.g., F06.1 catatonic disorder due to hepatic encephalopathy). The other medical condition should be coded and listed separately immediately before the catatonic disorder due to the medical condition (e.g., K71.90 hepatic encephalopathy; F06.1 catatonic disorder due to hepatic encephalopathy)

Adapted from Weder ND, Muralee S, Penland H, Tampi RR. Catatonia: A review. *Ann Clin Psychiatry*. 2008;20(2):97–107:Table 2.

A resident uses the Bush-Francis Catatonia Screening Instrument in a child with suspected catatonia. When uncertain whether a finding was present during the examination, how should that item be scored according to the table?

A. Score it as definitely present
B. Score it zero
C. Double the score of a related item
D. Omit the entire assessment
E. Assign the maximum possible score

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Table 47.12 Standard Examination of Catatonia

The method described here is used to complete the 23-item Bush-Francis Catatonia Rating Scale (BFCRS) and the 14-item Bush-Francis Catatonia Screening Instrument (BFCSI). Item definitions on the two scales are the same. The BFCSI measures only the presence or absence of the first 14 signs.

Ratings are based solely on observed behaviors during the examination, with the exception of completing the items for "withdrawal" and "autonomic abnormality," which may be based on directly observed behavior or chart documentation.

As a general rule, only items that are clearly present should be rated. If the examiner is uncertain as to the presence of an item, rate the item as "0."

PROCEDURE

1. Observe the patient while trying to engage in a conversation.
2. The examiner should scratch his or her head in an exaggerated manner.
3. The arm should be examined for cogwheeling. Attempt to reposture and instruct the patient to "keep your arm loose." Move the arm with alternating lighter and heavier force.
4. Ask the patient to extend his or her arm. Place one finger beneath his or her hand and try to raise it slowly after stating, "Do not let me raise your arm."
5. Extend the hand stating, "Do not shake my hand."
6. Reach into your pocket and state, "Stick out your tongue. I want to stick a pin in it."
7. Check for grasp reflex.
8. Check the chart for reports from the previous 24-hour period. Check for oral intake, vital signs, and any incidents.
9. Observe the patient indirectly, at least for a brief period each day, regarding the following:
   - Activity level
   - Abnormal movements
   - Abnormal speech
   - Echopraxia
   - Rigidity
   - Negativism
   - Waxy flexibility
   - Gegenhalten
   - Mitgehen
   - Ambitendency
   - Automatic obedience
   - Grasp reflex

Gegenhalten, Resistance to movements that is equal and opposite to the pressure exerted by examiner; *mitgehen*, extreme mitmachen where even slightest pressure moves limb; mitmachen, passive movement of extremity despite instruction not to move

A hospitalized 12-year-old develops acute fluctuating confusion over 2 days, cannot sustain attention, and has new disorientation. Which syndrome meets the table's core clinical features?

A. Primary schizophrenia
B. Delirium
C. Persistent depressive disorder
D. Specific learning disorder
E. Selective mutism

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Table 48.1 DSM-5 Diagnostic Criteria for Delirium

A. A disturbance in attention (i.e., reduced ability to direct, focus, sustain, and shift attention) and awareness (reduced orientation to the environment).
B. The disturbance develops over a short period of time (usually hours to a few days), represents a change from baseline attention and awareness, and tends to fluctuate in severity during the course of a day.
C. An additional disturbance in cognition (e.g., memory deficit, disorientation, language, visuospatial ability, or perception).
D. The disturbances in Criteria A and C are not explained by another preexisting, established, or evolving neurocognitive disorder and do not occur in the context of a severely reduced level of arousal, such as coma.
E. There is evidence from the history, physical examination, or laboratory findings that the disturbance is a direct physiologic consequence of another medical condition, substance intoxication or withdrawal (i.e., due to a drug of abuse or to a medication), or exposure to a toxin, or is due to multiple etiologies.

From the *Diagnostic and Statistical Manual of Mental Disorders,* 5th ed. p. 596. Copyright 2013. American Psychiatric Association.

A child in the ICU becomes quiet, withdrawn, slow to respond, and intermittently confused after a previously alert baseline. Which delirium motor subtype best fits?

A. Hyperactive delirium
B. Hypoactive delirium
C. Catatonia by definition
D. Compulsion
E. Provisional tic disorder

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Table 48.2 DSM-5 Delirium Subtypes

Hyperactive delirium	**Increased psychomotor activity and mood lability** • Confusion • Psychosis • Disorientation • Agitation • Hypervigilance • Hyper-alertness • Combativeness • Loud, pressured speech • Behavioral dysregulation • Pulling at lines/catheters
Hypoactive delirium	**Decreased psychomotor activity** • Sluggishness • Lethargy • Stupor • Confusion • Apathy
Mixed delirium	**Normal level of psychomotor activity** • Poor attention • Decreased awareness • Rapid fluctuation of activity level

Adapted from Meagher D, Moran M, Raju B, et al. A new data-based motor subtype schema for delirium. *J Neuropsychiatry Clin Neurosci*. 2008;20(2):185–193:Fig 1.

A mechanically ventilated child develops fluctuating inattention while receiving prolonged sedation. Which potentially reversible contributor appears in the delirium mnemonic table?

A. Medication/sedation exposure
B. Primary dyslexia
C. Normal tooth eruption
D. Familial tall stature
E. Speech articulation delay

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Table 48.3 Etiologies of Pediatric Delirium (CRITICAL CARE mnemonic)

Cardiovascular	Anemia, shock, vasculitis, hypertensive encephalopathy
Respiratory	Respiratory insufficiency, respiratory failure, pneumothorax
Infection	Sepsis, encephalitis, urinary tract infection, meningitis, fever, pneumonia, tracheitis, cellulitis, surgical site infection, COVID-19
Toxins	Polypharmacy, heavy metals, drug:drug interactions
Inflammatory process	Autoimmune and rheumatologic disease
CNS pathology	Stroke, seizure, head trauma, intracranial bleed, tumor, anoxic brain injury
Abuse, withdrawal, sedation	Alcohol, benzodiazepines, opioids, barbiturates, prolonged/excessive sedation
Liver	Liver insufficiency, hepatic failure, hyperammonemia
Catheters, central line infections	Invasive device or procedure complications
Alimentation	Electrolyte imbalance, nutritional deficiencies, dehydration
Renal	Renal insufficiency or failure
Endocrinopathies	Glycemic disturbance, thyroid disease, parathyroid disease, adrenal disease

Adapted from Malas N, Brahmbhatt K, McDermott C, Smith A, Ortiz-Aguayo R, Turkel S. Pediatric delirium: Evaluation, management, and special considerations. *Curr Psychiatry Rep.* 2017;19(9):65.

A 13-year-old has new visual hallucinations, severe inattention, and a waxing and waning course over hours. Which diagnosis is favored over primary psychosis in the comparison table?

A. Delirium
B. Schizophrenia
C. Specific phobia
D. Persistent depressive disorder
E. Oppositional defiant disorder

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Table 48.4 Differential Diagnosis of Delirium

CLINICAL FEATURE	DELIRIUM	PSYCHOSIS	DEPRESSION	CATATONIA
Course	Acute onset, hours, days or more	Insidious onset over many months, prodrome	Insidious onset, at least 2 wk, often over months	Onset variable
Attention	Markedly impaired attention and arousal	Normal to mild impairment	Mild impairment	Variable difficulty with attention and arousal
Fluctuation	Characterized by a waxing and waning course; disturbed day/night cycle	Absent	Absent	Less likely to fluctuate, motor signs may show more fluctuation
Perception	Misperceptions; hallucinations (visual, fleeting); paramnesia	Hallucinations, auditory with personal reference	May have mood-congruent hallucinations	May have hallucinations, especially if secondary to primary psychosis
Speech and language	Abnormal clarity, speed and coherence; disjointed and dysarthric; misnaming; characteristic dysgraphia	Disorganized with bizarre theme	Decreased amount of speech	Mutism; echolalia
Other cognition	Disorientation to time, place; recent memory and visuospatial abnormalities	Disorientation to person; concrete interpretations	Mental slowing; indecisiveness; memory retrieval difficulty	Global disorientation
Behavior	Lethargy; nonsystematized delusions; emotional lability	Systematized delusions; paranoia; bizarre behavior	Depressed mood; anhedonia; lack of energy; sleep and appetite disturbance	Stupor; catalepsy; negativism; posturing; stereotypy; agitation not influenced by external stimuli; grimacing; echopraxia
Electroencephalogram	Diffuse slowing; low voltage fast activity; specific patterns	Normal	Normal	Normal, focal abnormalities or generalized slowing

A disoriented ICU patient sleeps poorly during the day and becomes more agitated overnight. Which nonpharmacologic intervention is listed?

A. Keep the room brightly illuminated overnight
B. Provide a visible clock and orienting calendar while maintaining daytime light cues
C. Rotate different unfamiliar caregivers at every contact
D. Remove prescribed hearing aids
E. Increase overnight noise to maintain alertness

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Table 48.5 Nonpharmacologic Management of Delirium

Environmental modifications	• Maintain lighting consistent with the time of day • Minimize noise • Familiar objects • Visible clock, calendar
Sensory modifications	• Have appropriate sensory aides available (glasses, hearing aids) • Soft, calming music • Minimize lines, catheters, restraints • Maintain comfortable position and body alignment
Caregiver interventions	• Frequent reorientation • Fewer care team providers/different faces • Cluster cares to minimize interruptions • Promote normal sleep/wake schedule • Presence of familiar caregivers

A student can start homework but repeatedly forgets the second and third steps of multistep directions. Which executive-function domain in the table is most affected?

A. Inhibitory control
B. Working memory
C. Cognitive shifting
D. Self-monitoring
E. Response initiation

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Table 49.1 Symptom Expression of Executive Dysfunction

EXECUTIVE FUNCTION DEFICIT	SYMPTOM EXPRESSION
Inhibitory control	Impulsivity/poor behavioral regulation Interrupts "Blurts things out"
Shifting	Problems with transitioning from one task/activity to another Unable to adjust to unexpected change Repeats unsuccessful problem-solving approaches
Initiation	Difficulty independently beginning tasks/activities Lacks initiative Difficulty developing ideas or making decisions
Working memory	Challenges following multistep instruction (e.g., only completes one of three steps) Forgetfulness
Organization and planning	Fails to plan ahead Work is often disorganized Procrastinates and does not complete tasks "Messy" child
Self-monitoring	Fails to recognize errors and check work Does not appreciate impact of actions on others Poor self-awareness
Emotional control	Experiences behavioral and emotional outbursts (e.g., tantrums) Easily upset/frustrated Frequent mood changes

A child has persistent difficulty reading unfamiliar words and manipulating individual speech sounds. Which neurodevelopmental domain in the academic-disorder table is most relevant?

A. Phonologic language processing
B. Gross motor endurance
C. Olfactory recognition
D. Cardiac conduction
E. Color perception

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Table 49.2 Neurodevelopmental Dysfunction Underlying Academic Disorders*

ACADEMIC DISORDER	POTENTIAL UNDERLYING NEURODEVELOPMENTAL DYSFUNCTION
Reading	Language • Phonologic processing • Verbal fluency • Syntactic and semantic skills Memory • Working memory Sequencing Visual-spatial Attention
Written expression, spelling	Language • Phonologic processing • Syntactic and semantic skills Graphomotor Visual-spatial Memory • Working memory Sequencing Attention
Mathematics	Visual-spatial Memory • Working memory Language Sequencing Graphomotor Attention

*Isolated neurodevelopmental dysfunction can lead to a specific academic disorder, but more often there is a combination of factors underlying weak academic performance.

A child repeatedly forgets a three-step classroom instruction. Which real-world intervention in the table best targets the suspected executive-function deficit?

A. Repeat concise instructions and provide a concrete visual reference
B. Give longer verbal instructions without cues
C. Punish each missed step
D. Require immediate unsupervised multitasking
E. Remove all classroom structure

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Table 49.3 Executive Function Categories: Presenting Symptoms, Suggested Dysfunction, and Potential Interventions

SYMPTOM/PRESENTING COMPLAINT	SUSPECTED AREA OF DYSFUNCTION	POSSIBLE "REAL-WORLD" INTERVENTIONS
Acts before thinking Interrupts Poor behavioral and/or emotional control	Inhibitory control	Increase structure in environment to set limits for inhibition problems. Make behavior and work expectations clear and explicit; review with child. Post rules in view; point to them when child breaks rule. Teach response-delay techniques (e.g., counting to 10 before acting).
Cannot follow multistep instructions Forgetful	Working memory	Repeat instructions as needed. Keep instructions clear and concise. Provide concrete references.
Struggles starting assignments/ tasks Lacks initiative/motivation Has trouble developing ideas/ strategies	Initiation	Increase structure of tasks. Establish and rely on routine. Break tasks into smaller, manageable steps. Place child with partner or group for modeling and cueing from peers.
Does not plan ahead Uses trial-and-error approach	Planning	Practice with tasks with only a few steps first. Teach simple flow charting as a planning tool. Practice with planning tasks (e.g., mazes). Ask child to verbalize plan before beginning work. Ask child to verbalize second plan if first does not work. Ask child to verbalize possible consequences of actions before beginning. Review incidents of poor planning/anticipation with child.
Work/belongings is/are "messy" Random/haphazard problem solving Procrastinates/does not complete tasks	Organization	Increase organization of classroom and activities to serve as model, and help child grasp structure of new information. Present framework of new information to be learned at the outset, and review again at the end of a lesson. Begin with tasks with only a few steps and increase gradually.
Gets "stuck" Trouble transitioning Does not adapt to change	Flexibility/shifting	Increase routine to the day. Make schedule clear and public. Forewarn of any changes in schedule. Give "2-minute warning" of time to change. Make changes from one task to the next or one topic to the next, clear and explicit. Shifting may be a problem of inhibiting, so apply strategies for inhibition problems.

A 9-year-old has persistent inattention and impulsivity at home and school for 9 months with clear academic impairment. Which additional feature of the listed ADHD criteria must be established?

A. Symptoms began before age 12 years
B. Only one symptom is required
C. Symptoms occur exclusively during psychosis
D. Symptoms must first emerge after age 15
E. A normal academic record is required

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Table 50.1 DSM-5 Diagnostic Criteria for ADHD

A. A persistent pattern of inattention and/or hyperactivity/impulsivity that interferes with functioning or development, as characterized by (1) and/or (2):

1. **Inattention:** Six (or more) of the following symptoms of inattention have persisted for ≥6 mo to a degree that is inconsistent with development level and that negatively affects directly on social and academic/occupational activities:
   a. Often fails to give close attention to details or makes careless mistakes in schoolwork, at work, or during other activities (e.g., overlooks or misses details, work is inaccurate).
   b. Often has difficulty sustaining attention in tasks or play activities.
   c. Often does not seem to listen when spoken to directly.
   d. Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not the result of oppositional behavior or failure to understand instructions).
   e. Often has difficulty organizing tasks and activities.
   f. Often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (e.g., schoolwork, homework).
   g. Often loses things necessary for tasks or activities (e.g., toys, school assignments, pencils, books, tools).
   h. Is often easily distracted by extraneous stimuli.
   i. Is often forgetful in daily activities.
2. **Hyperactivity/impulsivity:** Six (or more) of the following symptoms of inattention have persisted for ≥6 mo to a degree that is inconsistent with development level and that negatively affects directly on social and academic/occupational activities.
   a. Often fidgets with hands or feet or squirms in seat.
   b. Often leaves seat in classroom or in other situations in which remaining seated is expected.
   c. Often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, may be limited to subjective feelings of restlessness).
   d. Often has difficulty playing or engaging in leisure activities quietly.
   e. Is often "on the go" or often acts as if "driven by a motor."
   f. Often talks excessively. Impulsivity.
   g. Often blurts out answers before questions have been completed.
   h. Often has difficulty awaiting turn.
   i. Often interrupts or intrudes on others (e.g., butts into conversations or games).

B. Several inattentive or hyperactive/impulsive symptoms were present before 12 yr of age.

C. Several inattentive or hyperactive/impulsive symptoms are present in two or more settings (e.g., at school [or work] or at home) and are documented independently.

D. There is clear evidence of clinically significant impairment in social, academic, or occupational functioning.

E. Symptoms do not occur exclusively during the course of schizophrenia, or another psychotic disorder, and are not better accounted for by another mental disorder (e.g., mood disorder, anxiety disorder, dissociative disorder, personality disorder, substance intoxication or withdrawal).

CODE BASED ON TYPE

314.01 Attention-deficit/hyperactivity disorder, combined presentation: if both Criteria A1 and A2 are met for the past 6 mo.

314.00 Attention-deficit/hyperactivity disorder, predominantly inattentive presentation: if Criterion A1 is met but Criterion A2 is not met for the past 6 mo.

314.01 Attention-deficit/hyperactivity disorder, predominantly hyperactive-impulsive presentation: if Criterion A2 is met but Criterion A1 is not met for the past 6 mo.

Specify if:

Mild: Few, if any, symptoms in excess of those required to make the diagnosis are present, and if the symptoms result in no more than minor impairments in social and occupational functioning.

Moderate: Symptoms or functional impairment between "mild" and "severe" are present.

Severe: Many symptoms in excess of those required to make the diagnosis, or several symptoms that are particularly severe, are present, or the symptoms result in marked impairment in social or occupational functioning.

From American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed, Text Revision, Washington, DC: American Psychiatric Association; 2000, and *Fifth Edition* (Copyright 2013 American Psychiatric Association.)

An adolescent has clinically significant inattentive symptoms without the minimum hyperactive/impulsive symptoms. Which comparison in the table explains why DSM-5 ADHD may still be diagnosed whereas older ICD-10 hyperkinetic disorder criteria might not be met?

A. DSM-5 permits either inattentive or hyperactive/impulsive symptom domains
B. DSM-5 always requires symptoms in only one classroom
C. ICD-10 excludes all inattention
D. DSM-5 requires a coexisting tic disorder
E. ICD-10 has no symptom requirements

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Table 50.2 Differences Between U.S. and European Criteria for ADHD or HKD

DSM-5 ADHD	ICD-10 HKD	ICD-11 ADHD*
SYMPTOMS		
Either or both of the following: • At least 6 of 9 inattentive symptoms • At least 6 of 9 hyperactive or impulsive symptoms	*All of the following:* • At least 6 of 8 inattentive symptoms • At least 3 of 5 hyperactive symptoms • At least 1 of 4 impulsive symptoms	*No minimum numbers of symptoms but must have:* • Persistent pattern (≥6 mo) of inattention and/or hyperactivity-impulsivity that has a direct negative impact on academic, occupational, or social functioning
PERVASIVENESS		
Some impairment from symptoms is present in one or more settings	Criteria are met for one or more settings	Symptoms must be evident across multiple situations or settings but are likely to vary according to the structure and demands of the setting

*ICD-11 went into effect on January 1, 2022.
ADHD, Attention-deficit/hyperactivity disorder; HKD, hyperkinetic disorder; DSM-5, Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition; ICD-10, International Classification of Diseases, Tenth Edition.
Modified from Biederman J, Faraone S. Attention-deficit hyperactivity disorder. *Lancet*. 2005;366:237–248.

A school-aged child is referred for inattentiveness and restless behavior but also snores loudly every night and has daytime sleepiness. Which listed ADHD mimic should be assessed?

A. Obstructive sleep apnea
B. Familial tall stature
C. Uncomplicated eczema
D. Dental eruption
E. Primary color blindness

Original table 50.3 | Nelson printed p. 313 | PDF p. 360

Table 50.3 Differential Diagnosis of Attention-Deficit/Hyperactivity Disorder (ADHD)

GENERAL

CATEGORY	SPECIFIC CONDITIONS, CAUSES
Developmental	Low developmental level/cognitive abilities Very high cognitive abilities Specific learning disabilities in reading, mathematics, or written expression Communication or language disorder Autism spectrum disorder Fetal alcohol syndrome
Psychiatric	Anxiety/depression Oppositional defiant disorder/conduct disorder Bipolar disorder/disruptive mood dysregulation disorder Substance use disorder Posttraumatic stress disorder/adjustment disorder
Medical	Sleep disorder, obstructive sleep apnea Hearing or vision impairment Specific medications, such as some antiepileptics or high-dose steroids Thyroid disorders Tic disorders Posttraumatic head injury or encephalitis Genetic conditions, such as fragile X, Klinefelter syndrome, Turner syndrome, tuberous sclerosis, and neurofibromatosis
Psychosocial	Response to abuse, neglect Response to distress in home, inappropriate expectations or parenting practices Response to inappropriate classroom setting

A child repeatedly scores below the 20th percentile on math progress monitoring and the teacher reports inability to advance to the next math concept. Which interpretation best follows the table?

A. Findings raise concern for a mathematics learning disability and justify evaluation
B. A family history is required before any evaluation
C. The pattern proves a global intellectual disability
D. Academic progress should be checked only in adulthood
E. Concern is excluded because the child attends school

Original table 52.2 | Nelson printed p. 321 | PDF p. 368

Table 52.2 Risk Factors for a Specific Learning Disability Involving Mathematics

The child is at or below the 20th percentile in any math area, as reflected by standardized testing or ongoing measures of progress monitoring.
The teacher expresses concerns about the child's ability to "take the next step" in math.
There is a positive family history for math learning disability (this alone will not initiate an intervention).
Parents think they have to "reteach" math concepts to their child.

A 10-year-old continues to make severe grammar and paragraph-organization errors after 7 months of targeted instruction; individually administered tests show achievement well below age expectations. Which diagnosis best fits?

A. Specific learning disorder with impairment in written expression
B. Oppositional defiant disorder
C. Specific phobia
D. Tourette disorder
E. Transient developmental variation

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Table 52.3 DSM-5 Diagnostic Criteria for Specific Learning Disability with Impairment in Written Expression

A. Difficulties learning and using academic skills that have persisted for at least 6 months, despite the provision of interventions that target those difficulties.
   Difficulties with written expression (e.g., makes multiple grammatical or punctuation errors within sentences; employs poor paragraph organization; written expression of ideas lacks clarity).
B. The affected academic skills are substantially and quantifiably below those expected for the individual's chronologic age and cause significant interference with academic or occupational performance or with activities of daily living, as confirmed by individually administered standardized achievement measures and comprehensive clinical assessment. For individuals age 17 years and older, a documented history of impairing learning difficulties may be substituted for the standardized assessment.
C. The learning difficulties begin during school-age years but may not become fully manifest until the demands for those affected academic skills exceed the individual's limited capacities (e.g., as in timed tests, reading or writing lengthy complex reports for a tight deadline, excessively heavy academic loads).
D. The learning difficulties are not better accounted for by intellectual disabilities, uncorrected visual or auditory acuity, other mental or neurologic disorders, psychosocial adversity, lack of proficiency in the language of academic instruction, or inadequate educational instruction.

315.2 (F81.81) With impairment in written expression:
Spelling accuracy
Grammar and punctuation accuracy
Clarity or organization of written expression

Specify current severity:
Mild: Some difficulties learning skills in one or two academic domains, but of mild enough severity that the individual may be able to compensate or function well when provided with appropriate accommodations or support services, especially during the school years.
Moderate: Marked difficulties learning skills in one or more academic domains, so that the individual is unlikely to become proficient without some intervals of intensive and specialized teaching during the school years. Some accommodations or supportive services at least part of the day at school, in the workplace, or at home may be needed to complete activities accurately and efficiently.
Severe: Severe difficulties learning skills, affecting several academic domains, so that the individual is unlikely to learn those skills without ongoing intensive individualized and specialized teaching for most of the school years. Even with an array of appropriate accommodations or services at home, at school, or in the workplace, the individual may not be able to complete all activities efficiently.

From the *Diagnostic and Statistical Manual of Mental Disorders,* 5th ed. Washington, DC: American Psychiatric Association; 2013:66–67.

A child understands instructions and uses grammatically normal sentences but consistently misproduces speech sounds, making words hard to understand. Which domain is most directly impaired?

A. Speech production
B. Receptive language
C. Pragmatic language
D. Working memory
E. Written language

Original table 53.1 | Nelson printed p. 325 | PDF p. 372

Table 53.1 Definitions of Basic Terms in Communication, Language, and Speech

TERM	DEFINITION	EXAMPLES
Communication	• Broad umbrella term that encompasses understanding and producing language, speech, nonverbal communicative gestures, and written language	• Humans share ideas using verbal or signed speech and language • Nonverbal communicative gestures include nodding one's head up and down to convey "yes" in some cultures
Language	• Verbal, signed, written, or other systems that use arbitrary but conventional, rule-governed symbols to communicate about objects, events, and ideas in the past, present, and future	• Verbal symbols include words (e.g., *apple* in English or *manzana* in Spanish, both of which represent a red, tasty fruit) • Signed symbols include the word *apple* in American Sign Language, produced by the twist of the knuckle of the index finger on the cheek
Speech	• Perception of the meaningful units of sounds that comprise verbal language and production of these sounds by coordinating the mouth, tongue, airflow, and vibration of the vocal folds	• Speech sounds or phonemes make a difference in meaning (e.g., *b, p, a, i,* and *t* affect the meaning of *bat, bit, pat,* and *pit*) • Speech does not include all vocal sounds, such as coughs or throat clearing • Phonemes in sign language are based on spatial, temporal features, such as hand shape
Receptive language	• Hearing and understanding verbal or sign language	• Recognizing own name • Following two-step directions
Expressive language	• Speaking using verbal or sign language	• Speaking first words or signs in a sign language • Telling stories
Phonology	• The system of relationships among speech sounds or phonemes that constitute a fundamental component of language	• Understanding *seetheredball* can be segmented into *see the red ball* • Babbling, consonant-vowel combinations that use phonemes
Lexicon	• All of the words or vocabulary of a person or a language	• The lexicon of the mathematician may vary from the lexicon of the lawyer
Morphology	• Units of meaning that can be combined to form vocabulary	• In English *dogs* is made of two morphemes, *dog* and the plural *-s; untie* is made of *un-* and *tie*
Syntax	• Grammar and word order to make sentences	• In English word order, *the dog chases the cat*, while in Hindi word order, *the cat the dog chases*
Pragmatics	• Verbal and nonverbal communication skills that govern how language and communication are used in context • Includes intonation, facial expression, and body language	• Use of eye contact and gestures to make a point forcefully • The timing and responsiveness between communication partners (e.g., engaging, responding, and maintaining reciprocal exchanges)
Nonliteral or figurative language skill	• Meaning of a word or phrase that is not literal but understood in context	• Hints (e.g., a teacher saying, "*I think I hear children talking*") • Idioms (e.g., "*Give me a hand*") • Metaphor (e.g., "*You are my sunshine*") • Hyperbole (e.g., "*That's the biggest thing I've ever seen!*")
Advanced language skills	• Ability to listen, speak, read, write, and reason using language	• Academic language • Ability to debate and deliver speeches
Literacy skills	• Skills required for reading and writing	• Reading an alphabetic language requires awareness of the sounds of language, print, and the relationship between letters and sounds • Spelling is a literacy skill
Bilingualism and multilingualism	• Ability to speak and/or sign two or more languages	• Ability to communicate verbally in Chinese and English • Ability to communicate verbally in English and to use American Sign Language • Ability to use Chinese, English, and American Sign Language
Biliteracy and multiliteracy	• Ability to read and write in two or more languages	• Ability to read and write Chinese, Spanish, and English
Phonologic processes	• Errors in speech production that affect more than a single sound and are based on violations of predictable, rule-based features	• Fronting, when a sound that should be made in the back of the mouth (cat) is made in the front of the mouth (tat) • Cluster reduction, when a consonant cluster (as in stop) is reduced to a single consonant (top)

At a well visit, a 12-month-old responds to a request such as “come here” and uses a first word. Which age band of communication development in the table is the closest match?

A. Birth to 3 months
B. 4 to 6 months
C. 7 to 12 months
D. 3 to 4 years
E. 4 to 5 years

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Table 53.2 Speech, Language, and Communication Milestones from Birth to 5 Years, Based on Typically Developing Children Acquiring a Single Verbal Language

HEARING AND UNDERSTANDING	SPEAKING
BIRTH TO 3 MO	
• Startles at loud sounds • Recognizes voices and quiets if crying • Turns head toward sounds • Watches faces • Quiets or smiles when spoken to	• Makes pleasure sounds (cooing, gooing) • Cries differently for different needs
4-6 MO	
• Moves eyes in direction of sounds • Responds to changes in tone of voice • Notices music and sounds • Recognizes familiar people and things at a distance	• Vocalizes differently to show excitement, being tired, or in pain • Makes sounds when alone and when playing • Makes babbling sounds that are speechlike and uses consonant sounds, such as *p, b,* and *m* • Reaches for toys or objects • Engages in turn-taking and protoconversations
7-12 MO	
• Listens when spoken to • Turns and looks in direction of sounds • Enjoys social games, such as peek-a-boo and pat-a-cake • Responds to own name • Recognizes words for common items, such as *cup, shoe,* and *juice* • Begins to respond to simple requests *(Come here; Want more?)* or *No* • Looks when an adult points at something	• Uses speech sounds or gestures to get and keep attention and to respond to others • Imitates different speech sounds and gestures • Babbles with long and short groups of sounds, such as *bababa upup bibi,* and mixes different syllables, such as *badadeda* • Says one or two words *(bye-bye, dada, mama)* • Points to or shows things to spontaneously share interest with familiar people • Uses gestures such as waving for *hi* and *bye* or shaking head for *no*
1-2 YR	
• Listens to simple stories, songs, and rhymes • Follows simple commands and understands simple questions *(Roll the ball; Kiss the baby; Where’s your shoe?)* • Points to things when asked or when named such as body parts and objects	• Learns to say more words every month • Uses some one- and two-word questions *(Where kitty? Go bye-bye? What’s that?)* • Combines two words in their own ways *(more cookie, no juice, mommy book)* • Uses consonant sounds such as *p, b, m, h,* and *w* in English
2-3 YR	
• Understands differences in meaning (e.g., go–stop, in–on, big–little, up–down) • Follows two-step requests *(Get the book and put it on the table.)*	• Often asks for or directs attention to objects by naming them • Has a word for almost everything • Uses prepositions like *in, on,* and *under* • Often uses two- to three-word “sentences” • Speech is mostly understood by familiar listeners • Uses consonant sounds such as *k, g, f, t, d,* and *n* in English
3-4 YR	
• Understands simple *who, what, where,* and *why* questions • Understands words for colors like *red, blue,* or *green* and shapes like *circle* or *square* • Responds when you call from another room	• Uses pronouns like *I, you, me, we,* and *they* • Uses sentences that have four or more words with more complex grammar such as negative *(I no want to)* and questions • Talks about activities outside the home • Usually understood by people outside the family
4-5 YR	
• Hears and understands most of what is said at home and in school • Pays attention to a short story and answers simple questions about it • Understands words for time like *yesterday, today,* and *tomorrow* • Understands words for order like *first, next,* and *last* • Follows longer directions such as *(Find an animal you like, draw a circle around it, and bring the paper to me)*	• Uses sentences that include details (I like to read my books) and different action words like jump or play; may still make some grammar mistakes (I gots one game and he got three games) • Tells simple stories using mostly full sentences • Communicates easily with other children and adults • Says most sounds correctly except a few that are harder to say, such as *l, s, r, v, z, ch, sh,* and *th* in English

Milestones may not apply to bilingual children, children exposed to sign languages, children learning a second language, and children with language and learning disorders
For Spanish translations and more information, including activities for families:
• American Speech-Language-Hearing Association: http://www.asha.org/public/speech/development/chart.htm

An 8-year-old has age-inappropriate difficulties understanding spoken directions and producing sentences, with academic impairment despite adequate hearing. Which diagnosis from the criteria table best fits?

A. Language disorder
B. Speech sound disorder
C. Childhood-onset fluency disorder
D. Selective mutism
E. Panic disorder

Original table 53.3 | Nelson printed p. 330 | PDF p. 377

Table 53.3 DSM-5 Diagnostic Criteria for Communication Disorders

LANGUAGE DISORDER

A. Persistent difficulties in the acquisition and use of language across modalities (i.e., spoken, written, sign language, or other) due to deficits in comprehension or production that include the following:
   1. Reduced vocabulary (word knowledge and use).
   2. Limited sentence structure (ability to put words and word endings together to form sentences based on the rules of grammar and morphology).
   3. Impairments in discourse (ability to use vocabulary and connect sentences to explain or describe a topic or series of events or have a conversation).
B. Language abilities are substantially and quantifiably below those expected for age, resulting in functional limitations in effective communication, social participation, academic achievement, or occupational performance, individually or in any combination.
C. Onset of symptoms is in the early developmental period.
D. The difficulties are not attributable to hearing or other sensory impairment, motor dysfunction, or another medical or neurologic condition and are not better explained by intellectual disability (intellectual developmental disorder) or global developmental delay.

SPEECH SOUND DISORDER

A. Persistent difficulty with speech sound production that interferes with speech intelligibility or prevents verbal communication of messages.
B. The disturbance causes limitations in effective communication that interfere with social participation, academic achievement, or occupational performance, individually or in any combination.
C. Onset of symptoms is in the early developmental period.
D. The difficulties are not attributable to congenital or acquired conditions, such as cerebral palsy, cleft palate, deafness or hearing loss, traumatic brain injury, or other medical or neurologic conditions.

SOCIAL (PRAGMATIC) COMMUNICATION DISORDER

A. Persistent difficulties in the social use of verbal and nonverbal communication as manifested by all of the following:
   1. Deficits in using communication for social purposes, such as greeting and sharing information, in a manner that is appropriate for the social context.
   2. Impairment of the ability to change communication to match context or the needs of the listener, such as speaking differently in a classroom than on a playground, talking differently to a child than to an adult, and avoiding use of overly formal language.
   3. Difficulties following rules for conversation and storytelling, such as taking turns in conversation, rephrasing when misunderstood, and knowing how to use verbal and nonverbal signals to regulate interaction.
   4. Difficulties understanding what is not explicitly stated (e.g., making inferences) and nonliteral or ambiguous meanings of language (e.g., idioms, humor, metaphors, multiple meanings that depend on the context for interpretation).
B. The deficits result in functional limitations in effective communication, social participation, social relationships, academic achievement, or occupational performance, individually or in combination.
C. The onset of the symptoms is in the early developmental period (but deficits may not become fully manifest until social communication demands exceed limited capacities).
D. The symptoms are not attributable to another medical or neurologic condition or to low abilities in the domains of word structure and grammar and are not better explained by autism spectrum disorder, intellectual disability (intellectual developmental disorder), global developmental delay, or another mental disorder.

From the *Diagnostic and Statistical Manual of Mental Disorders, 5th ed.* Washington, DC: American Psychiatric Association; 2013:42, 44, 47–48.

A child has repeated sound prolongations and blocks during speech. Which term in the terminology table is synonymous with the DSM-5 label childhood-onset fluency disorder?

A. Aphasia
B. Stuttering
C. Apraxia
D. Dysarthria
E. Selective mutism

Original table 53.4 | Nelson printed p. 333 | PDF p. 380

Table 53.4 Terminology Related to Childhood-Onset Fluency Disorder

TERM	DEFINITION
Stuttering	A speech disorder manifested through abnormal speech patterns referred to as *dysfluencies*
Childhood-onset fluency disorder	Term used in DSM-5 that is synonymous with *stuttering*
Stammering	The clinical term used in the United Kingdom rather than stuttering; stammering also used informally to describe halting speech
Cluttering	A speech disorder characterized by an excessively rapid and irregular rate of speech
Dysfluency	Speech disruptions that can occur in normal or disordered speech

A 7-year-old frequently repeats syllables, prolongs sounds, and has speech blocks that disrupt classroom participation. Which diagnosis best follows the criteria?

A. Childhood-onset fluency disorder
B. Receptive language disorder
C. Specific learning disorder in mathematics
D. Tourette disorder
E. Social anxiety disorder alone

Original table 53.5 | Nelson printed p. 333 | PDF p. 380

Table 53.5 DSM-5 Diagnostic Criteria for Childhood-Onset Fluency Disorder

A. Disturbances in the normal fluency and time patterning of speech that are inappropriate for the individual's age and language skills, persist over time, and are characterized by frequent and marked occurrences of one (or more) of the following:
   1. Sound and syllable repetitions.
   2. Sound prolongations of consonants and vowels.
   3. Broken words (e.g., pauses within a word).
   4. Audible or silent blocking (filled or unfilled pauses in speech).
   5. Circumlocutions (word substitutions to avoid problematic words).
   6. Words produced with an excess of physical tension.
   7. Monosyllabic whole-word repetitions (e.g., "I-I-I-I see him").

B. The disturbance causes anxiety about speaking or limitations in effective communication, social participation, or academic or occupational performance, individually or in any combination.

C. The onset of symptoms is in the early developmental period.
   Note: Later-onset cases are diagnosed as 307.0 [F98.5] adult-onset fluency disorder.

D. The disturbance is not attributable to a speech-motor or sensory deficit, dysfluency associated with neurologic insult (e.g., stroke, tumor, trauma), or another medical condition and is not better explained by another mental disorder.

From the *Diagnostic and Statistical Manual of Mental Disorders. 5th ed.* Washington, DC: American Psychiatric Association; 2013:45–46.

A nonverbal child with intact eye movements needs a low-technology aided way to communicate choices. Which option is listed?

A. Eye-gaze picture board
B. Unassisted speech
C. An implanted speech generator
D. Automated text-to-speech application only
E. Electroencephalography

Original table 54.1 | Nelson printed p. 337 | PDF p. 384

Table 54.1 Types of Augmentative and Alternative Communication

	LOW TECH	MID-HIGH TECH
Unaided	• Sign language • Gestures	—
Aided	• Communication boards/books • Picture exchange systems • Visual schedules • Eye-gaze picture board • Simple single-message speech output devices	• Voice output communication aids (VOCAs)/speech-generating devices (SGDs) with prestored recordings of natural speech or computer-generated speech • Specialized software on electronic tablet, smartphone • Spelling and/or symbol systems to represent language

Unaided systems: Do not require special materials or equipment; rely on user's body to covey messages.
Aided systems: Require the use of tools or equipment; can require power or no power.

A newborn passes the initial hearing screen, but parents later report poor response to sound. Which alternative approach in the table addresses the false assumption that the initial pass excludes later hearing loss?

A. Provide audiologic evaluation for new concerns
B. Dismiss concerns because screening was normal
C. Wait until the child enters school
D. Assess only vision
E. Assume the child has autism

Original table 55.1 | Nelson printed p. 340 | PDF p. 387

Table 55.1 Common False Assumption About Deaf or Hard of Hearing (D/HH) Infants and Children

FALSE ASSUMPTION	ALTERNATIVE APPROACH
Being D/HH causes language delay.	Often, the parent and deaf infant do not share a common language, creating a language barrier leading to delays. Early identification (by 1-3 mo of age) and intervention by 6 mo of age are critical for language development.
Passing newborn hearing screening tests means one does not need to be concerned about hearing.	Many factors can cause delayed-onset hearing loss. A full audiologic evaluation is indicated for any caregiver concern about hearing or for delays in language development—a "wait and see" approach is never indicated.
All behavioral symptoms or developmental delays are caused by the hearing loss.	Young neurotypical deaf children with adequate access to language through amplification and spoken language, sign language, or both should not be expected to have challenges in development, behavior, or social engagement. Referral for evaluation is essential if these symptoms are present.
Sign language is a last resort for communication for D/HH infants or children.	American Sign Language (ASL) is a full and complex language with a clear syntax and grammar structure. Learning sign language can promote language development when children cannot access spoken language during a period when this input is critical for cortical brain development.

Including access to Deaf individuals as part of healthcare teams

Clinicians should also consider the possibility of hearing loss in

A family of a deaf child wants a natural visual language with its own linguistic rules rather than a word-for-word manual version of English. Which option in the communication table matches?

A. American Sign Language
B. Cued English speech only
C. An oral-only approach
D. Finger spelling of every English word
E. An audiogram

Original table 55.2 | Nelson printed p. 341 | PDF p. 388

Table 55.2 Communication Approaches for Children Who Are Deaf and Hard of Hearing (D/HH)

COMMUNICATION MODALITY	DESCRIPTION	CITATION/ORGANIZATION
American Sign Language (ASL)	ASL is the recognized sign language of the deaf community in the United States. ASL conforms to linguistic principles and is distinct from English.	National Association of the Deaf (https://www.nad.org/about-us/position-statements/position-statement-on-american-sign-language)
Conceptually Accurate Signed English (CASE)	Using conventional ASL signs in an English word order.	https://www.cdc.gov/ncbddd/hearingloss/parentsguide/building/case.html
Manually coded English	Signing Exact English is an example of a manually coded English. It is a sign system that matches signs with the English language and includes manual representation of all components of the English language.	www.signingexactenglish.com
Fingerspelling/Rochester method	The Rochester method was intended to support English literacy and uses fingerspelling for all words.	
Cued Speech	Cued Speech is a visual communication system that uses eight handshapes in four different placements near the face in combination with the mouth movements of speech to make the sounds of spoken language look different from each other.	National Cued Speech Association (https://www.mdaap.org/pdf/CuedSpeech.pdf)
Spoken language and listening	Children learn to listen and talk with the support of hearing technology such as hearing aids, assistive listening devices (such as an FM system), or cochlear implants. Auditory-oral approaches include gestures, listening, speech/lip reading, and spoken speech. Auditory-verbal relies on listening and spoken speech.	Communication Options (https://www.agbell.org/Families/Communication-Options) Centers for Disease Control and Prevention: How People with Hearing Loss Learn Language (https://www.cdc.gov/ncbddd/hearingloss/language.html)

The parents of a child with newly identified hearing loss are weighing communication options. Which medical-home strategy best matches the table's family-centered approach?

A. Elicit family priorities and support informed decisions
B. Choose one method before discussing family goals
C. Withhold referral until school age
D. Avoid asking what the family already knows
E. Discourage collaboration with specialists

Original table 55.5 | Nelson printed p. 345 | PDF p. 392

Table 55.5 Approaches in the Medical Home to Support the Family Journey

FAMILY JOURNEY THEMES	CONSIDERATIONS AND STRATEGIES
Family-centered decision-making: Ensure families are central in decision-making	Before the visit: • Physician reflection on their own knowledge, expertise, and biases At the visit: • Listen to family concerns actively and address concerns, referring to others when outside provider expertise is necessary
Families' need for **informed** choice	Before the visit: • Recognize that each family and child are unique and decisions may vary across families • Recognize that decisions may change over the life span of the child • Recognize the passion across communication modalities, which drive potential biases in information and guidance At the visit: • Listen actively to understand the family's values and intended goals and outcomes • Collaboratively seek information from a variety of reputable sources and discuss potential biases across various "experts" in the field (see resource list) • Incorporate the family's values in an action plan together • Refer to experts as appropriate
Family-to-family support: Because having a child who is D/HH can feel isolating and professionals do not carry the same day-to-day experiences, family-to-family connection is an important component of support	Before the visit: • Recognize the importance of family-to-family support • Identify resources to link families with other families (see resources) During the visit: • Discuss the possible isolation families face • Determine interest and readiness for family networking • Share resources that they can rely on when ready to reach out
Access to D/HH adults: To support the family's recognition of what success can be and to provide children with a conceptual framework for D/HH individuals as adults	Before the visit: • Recognize families may be experiencing grief over the loss of their child's expected future and that experiences with other individuals who are D/HH may be limited or nonexistent • Identify resources to link families with Deaf adults and Deaf mentoring programs (see Table 55.3) During the visit: • Discuss family's hopes and fears • Highlight the importance of high expectations for their child • Discuss ways to promote identity, connection, and independence for their child
Child interactions and supports	Before the visit: • Recognize the variability and uniqueness of children who are D/HH in terms of capabilities, skills, and opportunities At the visit: • Engage D/HH children directly rather than rely solely on family members for interpreting communication; for children who use sign language, access to an interpreter is a right under the Americans with Disabilities Act • Recognize children's strengths and resilience • Ensure children have access to their own health information (at their developmental level) and have the opportunity for inclusion in decisions as appropriate • Advocate with children and families to have high expectations for skills, recognizing that often medical and educational settings use a deficit model (the child must be behind) to access supports

An infant with developmental delay is found to have phenylketonuria. Which early intervention is paired with this condition in the table?

A. Phenylalanine-restricted diet
B. High-protein unrestricted diet
C. Copper supplementation
D. Complete elimination of all carbohydrates
E. Corticosteroid monotherapy

Original table 56.3 | Nelson printed p. 348 | PDF p. 395

Table 56.3 Conditions in Which Early Treatment May Significantly Improve the Course of the Disease

CONDITION	TREATMENT
Galactosemia	Lactose-free diet
Fructosemia	Fructose-free diet
Phenylketonuria	Phenylalanine-free diet
Maternal phenylketonuria	Phenylalanine-free diet during pregnancy
Maple syrup urine disease	Diet restricted in branched-chain amino acids + dialysis or exchange transfusion
Hypoglycemia from any cause	Prevent hypoglycemia and/or provide glucose
Lead intoxication	Separate child from source of lead; chelation therapy
Hypothyroidism	Thyroid replacement
Recurrent otitis media	Antibiotic prophylaxis, pressure-equalizing tubes
Malnutrition	Adequate nutrition
Increased intracranial pressure (e.g., hydrocephalus, neoplasm)	Shunt ventricles or cystic structure
Congenital HIV infection	Prenatal/postnatal treatment with AZT (zidovudine)
Congenital toxoplasmosis	Prenatal treatment with spiramycin, pyrimethamine, and sulfonamide
Dopa-responsive dystonia	Responds to levodopa; may be misdiagnosed as cerebral palsy
Biotinidase deficiency	Oral biotin
Biotin-thiamine–responsive basal ganglia disease	Biotin, thiamine
Wilson disease	Copper chelation; liver transplant
Cerebral folate disorder	Folinic acid
Creatine disorders	Creatine monohydrate
Vitamin B_{12} deficiency	Vitamin B_{12}
Cerebral glucose transporter defect	Ketogenic diet
Metachromatic leukodystrophy	BMT
Niemann-Pick disease	BMT, liver transplantation, implanted amniotic epithelial cells
Adrenoleukodystrophy	BMT
Glycogen storage disease type IV	Liver transplantation
Menkes disease	Parenteral copper histidinate
Lesch-Nyhan syndrome	Allopurinol + BMT
Krabbe disease	BMT
α-Mannosidosis	ERT: velmanase alfa
Aspartylglucosaminuria	BMT
Gaucher disease type III	ERT: Ceredase; SRT: Cerdelga; PCT: Mucosolvan
Hunter syndrome (MPS II)	ERT: Elaprase
Hurler syndrome (MPS I)	ERT: Aldurazyme
Sanfilippo syndrome A (MPS IIIa)	SRT: Genistein
Sanfilippo syndrome B (MPS IIIb)	SRT: Genistein
Sanfilippo syndrome C (MPS IIIc)	SRT: Genistein
Sanfilippo syndrome D (MPS IIId)	SRT: Genistein
Sly syndrome (MPS VII)	ERT: Mepsevii
Neuronal ceroid lipofuscinosis type II	ERT: Brineura

BMT, Bone marrow transplant; ERT, enzyme replacement therapy; MPS, mucopolysaccharidosis; PCT, pharmacologic chaperone therapy; SRT, substrate reduction therapy.

A 2-year-old has marked language delay prompting evaluation for intellectual disability. Which developmental period in the table commonly first brings language delay to clinical attention?

A. Newborn period
B. Early infancy at 2-4 months
C. Toddler years at 2-3 years
D. Middle adolescence
E. Only adulthood

Original table 56.6 | Nelson printed p. 352 | PDF p. 399

Table 56.6 Common Presentations of Intellectual Disability by Age

AGE	AREA OF CONCERN
Newborn	Dysmorphic syndromes, (multiple congenital anomalies), microcephaly Major organ system dysfunction (e.g., feeding, breathing)
Early infancy (2-4 mo)	Failure to interact with the environment Concerns about vision and hearing impairments
Later infancy (6-18 mo)	Gross motor delay
Toddlers (2-3 yr)	Language delays or difficulties
Preschool (3-5 yr)	Language difficulties or delays Behavior difficulties, including play Delays in fine motor skills: cutting, coloring, drawing
School age (>5 yr)	Academic underachievement Behavior difficulties (e.g., attention, anxiety, mood, conduct)

uncertain during the early years and becomes clearer as the demands of

A child has global developmental delay of unclear cause. Which element belongs in the recommended initial assessment?

A. A three-generation family pedigree and detailed developmental history
B. A single school report without examination
C. Empirical antipsychotic treatment for all children
D. No hearing evaluation if newborn screening passed
E. Genetic testing only after adulthood

Original table 56.7 | Nelson printed p. 354 | PDF p. 401

Table 56.7 Suggested Evaluation of the Child with Intellectual Disability (ID) or Global Developmental Delay (GDD)

TEST	COMMENT
In-depth history	Includes prenatal, perinatal, and postnatal events (including seizures); developmental attainments; and three-generation pedigree in family history (focusing on neurologic or developmental abnormalities, miscarriages, consanguinity, etc.)
Physical examination	Particular attention to minor or subtle dysmorphisms; growth issues; neurocutaneous findings; eye and skull abnormalities; hepatosplenomegaly; and neurologic examination for focality Behavioral phenotype
Vision and hearing evaluation	Essential to detect and treat; can mask as developmental delay
Gene microarray analysis	A ~15% yield overall Better resolution than with karyotype; may identify up to twice as many abnormalities as karyotyping Often included in exome testing
Karyotype	No longer a first-line test Reserve use when concerned for trisomic/monosomic conditions, inversions and balanced insertions, or reciprocal translocations
Fragile X screen	Combined yield of 2%, preselection on clinical grounds can increase yield to 7.6%
Next-generation gene sequencing	Detects inherited and de novo point mutations, especially in nonsyndromic severe intellectual disability Whole exome sequencing gives an additional yield of about 30–40% Pilot studies of whole genome sequencing (WGS) reveal additional yield of about 15%
Neuroimaging	MRI preferred; positive findings increased by abnormalities of skull contour or microcephaly and macrocephaly or focal neurologic examination (30–40% if indicated, 10–14% if screening) Identification of specific etiologies is rare; most conditions that are found do not alter the treatment plan; need to weigh risk of sedation against possible yield
Thyroid (T_4, TSH)	Near 0% in settings with universal newborn screening program
Serum lead	If there are identifiable risk factors for excessive environmental lead exposure (e.g., low socioeconomic status, home built before 1950)
Metabolic testing	Yield of 0.2–4.6% based on clinical indicators and tests performed Urine organic acids, plasma amino acids, ammonia, lactate, and capillary blood gas Focused testing based on clinical findings is warranted if lack of newborn screen results or suggestive history/exam (e.g., regression, consanguinity, hepatosplenomegaly, course facies) Tandem mass spectrometry newborn screening has allowed for identification of many disorders in the perinatal period and has decreased yield in older children; other disorders have emerged, such as congenital disorders of glycosylation (yield 1.4%) and disorders of creatine synthesis and transport (yield 2.8%)
MECP2 for Rett syndrome	1.5% of females with criteria suggestive of Rett (e.g., acquired microcephaly, loss of skills) 0.5% of males
EEG	May be deferred in absence of history of seizures or significant language regression
Repeated history and physical examination	Can give time for maturation of physical and behavioral phenotype; new technology may be available for evaluation

EEG, Electroencephalogram; CGH, comparative genomic hybridization; MECP2, methyl CpG–binding protein 2; T_4, thyroxine; TSH, thyroid-stimulating hormone.
Data from Michelson DJ, Shevell MI, Sheer EH, et al. Evidence report. Genetic and metabolic testing on children with global developmental delay: Report of the Quality Standards

A child with unexplained global developmental delay is being screened for potentially treatable metabolic disorders. Which blood test appears in the first-tier TIDE protocol?

A. Plasma amino acids
B. Serum troponin alone
C. Hemoglobin electrophoresis alone
D. A rheumatoid factor alone
E. Skin prick testing

Original table 56.8 | Nelson printed p. 355 | PDF p. 402

Table 56.8 Treatable Intellectual Disability Endeavor (TIDE) Diagnostic Protocol

TIER 1: NONTARGETED METABOLIC SCREENING TO IDENTIFY 54 (60%) TREATABLE IEM	
Blood	Plasma amino acids, total homocysteine, acylcarnitine profile, copper, ceruloplasmin
Urine	Organic acids, purine and pyrimidines, creatine metabolites, oligosaccharides, glycosaminoglycans, amino acids (when indicated)
TIER 2: CURRENT PRACTICE ADHERING TO INTERNATIONAL GUIDELINES* (ONE OR MORE OF THE FOLLOWING)	
Blood	Cytogenetic testing (array CGH), thyroid studies, complete blood count, lead, metabolic testing, fragile X, targeted gene sequencing/molecular panel
Diagnostics	Brain MRI and 1H spectroscopy (where available)
Referrals	Audiology, ophthalmology
TIER 3: TARGETED WORKUP TO IDENTIFY 35 (40%) TREATABLE IEM REQUIRING SPECIFIC TESTING According to patient's symptomatology and clinician's expertise Use of digital tools (www.treatable-id.org)	
Blood	Plasma cholestanol, 7-dehydroxycholesterol:cholesterol ratio, pipecolic acid and urine α-amino adipic semialdehyde (AASA), very-long-chain fatty acids Plasma vitamin B_{12} and folate, serum lactate to pyruvate ratio, whole blood manganese
CSF	Lactate to pyruvate ratio, amino acids, neurotransmitters, CSF to plasma glucose ratio
Urine	Urine deoxypyridinoline
Other	Enzyme activities (leukocytes): arylsulfatase A, biotinidase, glucocerebrosidase, fatty aldehyde dehydrogenase CoQ measurement: fibroblasts Molecular analysis: *CA5A, NPC1, NPC2, SC4MOL, SLC18A2, SLC19A3, SLC30A10, SLC52A2, SLC52A3, PDHA1, DLAT, PDHX, SPR, TH* genes

*Low threshold for ordering tests.
IEM, Inborn errors of metabolism; CSF, cerebrospinal fluid; CGH, comparative genomic hybridization; CoQ, coenzyme Q (ubiquinone).

A child with intellectual disability develops new constipation and reflux symptoms. Which associated condition category in the table should be assessed?

A. Gastrointestinal conditions
B. Normal visual maturation
C. Dental eruption alone
D. Simple myopia
E. Seasonal pollen exposure

Original table 56.9 | Nelson printed p. 356 | PDF p. 403

Table 56.9 Conditions Associated with ID

MEDICAL/PHYSICAL CONDITIONS	DEVELOPMENTAL/ PSYCHIATRIC CONDITIONS
Cerebral palsy/severe motor impairment	Attention-deficit/hyperactivity disorder
Seizures	Emotional disorders (anxiety, mood disorders, posttraumatic stress disorder)
Endocrine abnormalities (e.g., hypothyroidism, short stature)	Obsessive-compulsive disorder
GI issues (constipation, reflux)	Behavioral disorders (self-injurious behavior, aggression, adjustment disorder, disruptive behavior)
Dysphagia	Autism spectrum disorder
Other organ system anomalies (e.g., congenital heart disease, malformations)	Eating and feeding disorders
Hearing loss	Psychotic disorders
Vision impairment (refractive error, cataracts, strabismus)	Movement disorders (tics, stereotypies,)
Dental caries	Developmental coordination disorder
Lead poisoning from associated pica	Learning disabilities (difficulties not explained by cognition alone)
Sleep disorders (OSA, behavioral sleep dysfunction)	Substance abuse
Obesity	Victimization (bullying, sexual abuse, physical abuse)

GI, Gastrointestinal; OSA, obstructive sleep apnea.

An adolescent with mild intellectual disability has learned to use public transport, complete basic job tasks, and manage simple daily routines with occasional support. Which support level in the comparison table best fits?

A. Intermittent support
B. Pervasive round-the-clock support
C. No assessment of adaptive functioning
D. Intensive medical ventilation
E. Emergency-only neurologic support

Original table 56.11 | Nelson printed p. 360 | PDF p. 407

Table 56.11 Severity of Intellectual Disability and Adult-Age Functioning

LEVEL	SUPPORT LEVEL	FUNCTIONAL AGE EQUIVALENT AS ADULT	ADULT ADAPTATION
Mild	Intermittent	9-11 yr	Reads at fourth- to fifth-grade level; simple multiplication and division; can write a simple list or letter; completes job application; basic independent job skills (arrive on time, stay at task, interact with coworkers); uses public transportation, might qualify for driver's license; keeps house, cooks using recipes; challenges with planning and money management; at risk of being manipulated by others; may need support for making decisions in healthcare, shopping, finances, and raising a family.
Moderate	Limited	6-8 yr	Sight-word reading; copies information (e.g., address from card to job application); matches written number to number of items; recognizes time on clock; communicates; some independence in self-care; housekeeping with supervision or cue cards; meal preparation, can follow picture recipe cards; job skills learned with much repetition; employment in a supported environment; use of public transportation with some supervision; successful friendships attained, but social judgment and life decisions require support.
Severe	Extensive	3-5 yr	Little understanding of written language or number, time, and money concepts; needs extensive supports for problem solving; trainable in some basic activities of daily living, but needs some level of continuous support and supervision for most activities; might communicate wants and needs with use of basic words, phrases, gestures, or with the use of augmentative and alternative communication techniques; trainable in some basic activities of daily living.
Profound	Pervasive	<3 yr	Dependent for self-care, continence, communication needs with supports required for all activities of everyday living; co-occurring physical and sensory limitations are common; may use objects in a goal-directed fashion for recreation or self-care; limited understanding of symbolic communication, but may understand some gestures and emotional cues; uses nonverbal expressions; might need complete custodial or nursing care.

Data from World Health Organization. International Statistical Classification of Diseases and Related Health Problems, 10th revision. Geneva: WHO; 2011 and American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders, 5th ed. Washington, DC: American Psychiatric Association.

A neonate has holoprosencephaly, cleft lip and palate, and scalp defects. Which chromosomal condition in the comparison table is most likely?

A. Trisomy 13
B. Trisomy 18
C. Turner syndrome
D. Klinefelter syndrome
E. Trisomy 21

Original table 57.1 | Nelson printed p. 362 | PDF p. 409

Table 57.1 Chromosomal Trisomies (13, 18) and Their Clinical Findings

TRISOMY 13	TRISOMY 18
HEAD AND FACE	
Scalp defects (e.g., cutis aplasia) Microphthalmia, corneal abnormalities Cleft lip and palate in 60–80% of cases Microcephaly Microphthalmia Sloping forehead Holoprosencephaly (arrhinencephaly) Capillary hemangiomas Deafness	Small and premature appearance Tight palpebral fissures Narrow nose and hypoplastic nasal alae Narrow bifrontal diameter Prominent occiput Micrognathia Cleft lip or palate Microcephaly
CHEST	
Congenital heart disease (e.g., VSD, PDA, ASD) in 80% of cases Thin posterior ribs (missing ribs)	Congenital heart disease (e.g., VSD, PDA, ASD) Short sternum, small nipples
EXTREMITIES	
Overlapping of fingers and toes (clinodactyly) Polydactyly Hypoplastic nails, hyperconvex nails	Limited hip abduction Clinodactyly and overlapping fingers; index over third, fifth over fourth; closed fist Rocker-bottom feet Hypoplastic nails
GENERAL	
Severe developmental delays and prenatal and postnatal growth restriction Renal abnormalities 1-year survival <10%	Severe developmental delays and prenatal and postnatal growth restriction Premature birth, polyhydramnios Inguinal or abdominal hernias 1-year survival <10%

ASD, Atrial septal defect; PDA, patent ductus arteriosus; VSD, ventricular septal defect.
From Behrman RE, Kliegman RM. *Nelson Essentials of Pediatrics,* 4th ed. Philadelphia:

A child with developmental delay and deep palmar and plantar furrows has a mosaic extra autosome. Which rare aneuploidy in the table best fits?

A. Mosaic trisomy 8
B. Full trisomy 21
C. Monosomy X
D. 47,XXY
E. Trisomy 13

Original table 57.2 | Nelson printed p. 363 | PDF p. 410

Table 57.2 Other Rare Aneuploidies and Partial Autosomal Aneuploidies

DISORDER	KARYOTYPE	CLINICAL MANIFESTATIONS
Trisomy 8	47,XX/XY,+8	Growth and mental deficiency are variable. The majority of patients are mosaics. Deep palmar and plantar furrows are characteristic. Joint contractures are present.
Trisomy 9	47,XX/XY,+9	The majority of patients are mosaics. Clinical features include craniofacial (high forehead, microphthalmia, low-set malformed ears, bulbous nose) and skeletal (joint contractures) malformations and heart defects (60%).
Trisomy 16	47,XX/XY,+16	The most commonly observed autosomal aneuploidy in spontaneous abortion; the recurrence risk is negligible.
Tetrasomy 12p	46,XX[12]/46,XX, +i(12p)[8] (mosaicism for an isochromosome 12p)	Known as Pallister-Killian syndrome Sparse anterior scalp hair (more so temporal region), eyebrows, and eyelashes; prominent forehead; chubby cheeks; long philtrum with thin upper lip and cupid-bow configuration; polydactyly; streaks of hyperpigmentation and hypopigmentation

A hypotonic newborn has upslanting palpebral fissures, a flat facial profile, and a poor Moro reflex. Which syndrome in the neonatal-features table is most consistent?

A. Trisomy 21
B. Trisomy 13
C. Fragile X premutation
D. Turner syndrome
E. Phenylketonuria

Original table 57.3 | Nelson printed p. 366 | PDF p. 413

Table 57.3 Clinical Features of Trisomy 21 in the Neonatal Period

CENTRAL NERVOUS SYSTEM	**MUSCULOSKELETAL**
Hypotonia*	Joint hyperflexibility*
Developmental delay	Short neck, redundant skin*
Poor Moro reflex*	Short metacarpals and phalanges
CRANIOFACIAL	Short fifth digit with clinodactyly*
Brachycephaly with flat occiput	Single transverse palmar creases*
Flat face*	Wide gap between first and second toes
Upward slanted palpebral fissures*	Pelvic dysplasia*
Epicanthal folds	Short sternum
Speckled irises (Brushfield spots)	Two sternal manubrium ossification centers
Three fontanels	**GASTROINTESTINAL**
Delayed fontanel closure	Duodenal atresia
Frontal sinus and midfacial hypoplasia	Annular pancreas
Mild microcephaly	Tracheoesophageal fistula
Short, hard palate	Hirschsprung disease
Small nose, flat nasal bridge	Imperforate anus
Protruding tongue, open mouth	Neonatal cholestasis
Small dysplastic ears*	**CUTANEOUS**
CARDIOVASCULAR	Cutis marmorata
Endocardial cushion defects	
Ventricular septal defect	
Atrial septal defect	
Patent ductus arteriosus	
Aberrant subclavian artery	
Pulmonary hypertension	

*Hall's criteria to aid in diagnosis.

A child with trisomy 21 has increasing difficulty with speech intelligibility despite progress in other motor skills. Which domain in the table specifically describes this problem?

A. Speech and language
B. Cardiac anatomy
C. Renal function
D. Olfaction
E. Skin pigmentation

Original table 57.6 | Nelson printed p. 370 | PDF p. 417

Table 57.6 Neurodevelopmental, Neurobehavioral, and Psychiatric Characteristics of Trisomy 21

MOTOR SKILLS	
Gross motor skills	0-24 mo: Mild delays initially which widen with age At 2 years 25% walking
Oromotor	Dysphagia 0-6 mo: 50% Self-feeding delays: 70%
Fine motor skill	Early skills delays: ~75% Bimanual skill delays: 100%
SPEECH AND LANGUAGE	
Intelligibility	Frequently unintelligible (parent report): 5-21 yr: 54–57% Motor speech impairment: Delay: 27% Articulation: 60% Apraxia: 33% Dysfluency: Stuttering: 10–45% Cluttering (abnormally rapid or irregular pace or both): 80%
Language	Receptive: Similar to mental age–matched controls Expressive: More delayed relative to mental age–matched controls Syntax: More impaired than expressive vocabulary Pragmatics: Same variety of language functions as mental age–matched peers; may be less likely to ask for clarification
SOCIAL AND EMOTIONAL DEVELOPMENT	
	High sociability Joint attention compared with mental age–matched peers Strong imitation skills Pro-social empathetic responses to others in distress Underexpression of emotional distress Less frequent and shorter social referencing Reduced ability to read facial expressions More restricted repetitive behaviors and interests Average social motivation but lower social cognition
COGNITION	
	Intellectual disability: Mild: ~25% Moderate: ~50% Severe: ~25% Decline in IQ throughout childhood (slowing in developmental progress relative to same-age peers) Strengths: Implicit memory, visual spatial sequencing, visual spatial construction, and nonverbal memory Weaknesses: Working memory capacity, explicit memory, verbal processing, auditory short-term memory, complex visual spatial skills, executive functioning
Oppositional behaviors	70%
Aggression	4–15%
Self-injurious behavior	18%
Autism spectrum disorders	15–20%
ADHD	14–40%
Anxiety disorders	10–22%
Obsessive-compulsive disorders	0.5–4.5%
Depression	5–11%
Catatonia/Down syndrome disintegrative disorder	Multiple case series and case reports

IQ, Intelligence quotient; ADHD, attention-deficit/hyperactivity disorder.

A preschooler has persistent deficits in social reciprocity and nonverbal communication plus repetitive, restricted play patterns beginning early in development. Which diagnosis fits the listed core criteria?

A. Autism spectrum disorder
B. Specific phobia
C. Provisional tic disorder
D. Isolated speech sound disorder
E. Conduct disorder

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Table 58.1 DSM-5 Diagnostic Criteria for Autism Spectrum Disorder

A. Persistent deficits in social communication and social interaction across multiple contexts, as manifested by the following, currently or by history:
   1. Deficits in social-emotional reciprocity.
   2. Deficits in nonverbal communicative behaviors used for social interaction.
   3. Deficits in developing, maintaining, and understanding relationships.

B. Restricted, repetitive patterns of behavior, interests, or activities, as manifested by at least two of the following, currently or by history:
   1. Stereotyped or repetitive motor movements, use of objects, or speech.
   2. Insistence on sameness, inflexible adherence to routines, or ritualized patterns of verbal or nonverbal behavior.
   3. Highly restricted, fixated interests that are abnormal in intensity or focus.
   4. Hyperreactivity or hyporeactivity to sensory input or unusual interest in sensory aspects of the environment.

C. Symptoms must be present in the early developmental period (may not become fully manifest until social demands exceed limited capacities, or may be masked by learned strategies in later life).

D. Symptoms cause clinically significant impairment in social, occupational, or other important areas of current functioning.

E. These disturbances are not better explained by intellectual disability (intellectual developmental disorder) or global developmental delay.

From the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*. (Copyright 2013). American Psychiatric Association, pp. 50–51.

A child with autism has motor abnormalities and unusual language development. How does the table classify these findings?

A. Associated features not required by DSM-5 core criteria
B. Mandatory evidence of a separate psychotic disorder
C. Features that exclude autism
D. Evidence of a primary hearing deficit in every case
E. Required proof of an inborn error of metabolism

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Table 58.2 Associated Features of Autism Not in DSM-5 Criteria

Atypical language development and abilities
Age <6 yr: frequently disordered and delayed in comprehension; two thirds have difficulty with expressive phonology and grammar
Age ≥6 yr: disordered pragmatics, semantics, and morphology, with relatively intact articulation and syntax (i.e., early difficulties are resolved)
Motor abnormalities: motor delay; hypotonia; catatonia; deficits in coordination, movement preparation and planning, praxis, gait, and balance

For version with full references, see American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*. Washington DC: American

A 2-year-old has lost previously used words and now rarely points to share interest. Which next step best follows the preschool warning-sign table?

A. Prompt developmental and hearing assessment for possible autism
B. Reassure that regression is expected at this age
C. Wait until age 5 for evaluation
D. Prescribe antibiotics without examination
E. Restrict interaction with peers

Original table 58.3 | Nelson printed p. 375 | PDF p. 422

Table 58.3 Signs and Symptoms of Possible Autism in Preschool Children (or Equivalent Mental Age)

Spoken Language
Language delay (in babbling or using words; e.g., using <10 words by age 2 yr).
Regression in, or loss of, use of speech.
Spoken language (if present) may include unusual features, such as vocalizations that are not speechlike; odd or flat intonation; frequent repetition of set words and phrases (echolalia); reference to self by name or "you" or "she" or "he" beyond age 3 yr.
Reduced and/or infrequent use of language for communication (e.g., use of single words, although able to speak in sentences).

Responding to Others
Absent or delayed response to name being called, despite normal hearing.
Reduced or absent responsive social smiling.
Reduced or absent responsiveness to other people's facial expressions or feelings.
Unusually negative response to the requests of others ("demand avoidance" behavior).
Rejection of cuddles initiated by parent or caregiver, although the child may initiate cuddles.

Interacting with Others
Reduced or absent awareness of personal space, or unusually intolerant of people entering their personal space.
Reduced or absent social interest in others, including children of own age—may reject others; if interested in others, child may approach others inappropriately, seeming to be aggressive or disruptive.
Reduced or absent imitation of others' actions.
Reduced or absent initiation of social play with others; plays alone.
Reduced or absent enjoyment of situations that most children like (e.g., birthday parties).
Reduced or absent sharing of enjoyment.

Eye Contact, Pointing, and Other Gestures
Reduced or absent use of gestures and facial expressions to communicate (although may place an adult's hand on objects).
Reduced and poorly integrated gestures, facial expressions, body orientation, eye contact (looking at people's eyes when speaking), and speech used in social communication.
Reduced or absent social use of eye contact (assuming adequate vision).
Reduced or absent "joint attention" (when one person alerts another to something by means of gazing, finger pointing, or other verbal or nonverbal indication for the purpose of sharing interest). This would be evident in the child from lack of:
- Gaze switching
- Following a point (looking where the other person points to—may look at hand)
- Using pointing at or showing objects to share interest

Ideas and Imagination
Reduced or absent imagination and variety of pretend play.

Unusual or Restricted Interests and/or Rigid and Repetitive Behaviors
Repetitive "stereotypic" movements such as hand flapping, body rocking while standing, spinning, and finger flicking.
Repetitive or stereotyped play (e.g., opening and closing doors).
Overfocused or unusual interests.
Excessive insistence on following own agenda.
Extremes of emotional reactivity to change or new situations; insistence on things being "the same."
Overreaction or underreaction to sensory stimuli, such as textures, sounds, or smells.
Excessive reaction to the taste, smell, texture, or appearance of food, or having extreme food fads.

Adapted from Baird G, Douglas HR, Murphy MS. Recognizing and diagnosing autism in children and young people: Summary of NICE guidance. *BMJ*. 2011;343:d6360, Box 1, p. 901.

A child with autism initiates few social interactions and has repetitive behaviors that markedly interfere with function across settings despite redirection. Which concept does the severity table emphasize?

A. Support needs in both social communication and restricted/repetitive behaviors
B. A classification based only on IQ
C. A severity level based solely on age
D. Severity determined only by speech articulation
E. No need to assess functional support

Original table 58.4 | Nelson printed p. 376 | PDF p. 423

Table 58.4 DSM-5 Severity Levels for Autism Spectrum Disorder

SEVERITY LEVEL	SOCIAL COMMUNICATION	RESTRICTED, REPETITIVE BEHAVIORS
Level 3 "Requiring very substantial support"	Severe deficits in verbal and nonverbal social communication skills cause severe impairments in functioning, very limited initiation of social interactions, and minimal response to social overtures from others. *For example,* a person with few words of intelligible speech who rarely initiates interaction and, when he or she does, makes unusual approaches to meet needs only and responds to only very direct social approaches.	Inflexibility of behavior, extreme difficulty coping with change, or other restricted/repetitive behaviors markedly interfere with functioning in all spheres. Great distress/difficulty changing focus or action.
Level 2 "Requiring substantial support"	Marked deficits in verbal and nonverbal social communication skills; social impairments apparent even with supports in place; limited initiation of social interactions; and reduced or abnormal responses to social overtures from others. *For example,* a person who speaks simple sentences, whose interaction is limited to narrow special interests, and who has markedly odd nonverbal communication.	Inflexibility of behavior, difficulty coping with change, or other restricted/repetitive behaviors appear frequently enough to be obvious to the casual observer and interfere with functioning in a variety of contexts. Distress and/or difficulty changing focus or action.
Level 1 "Requiring support"	Without supports in place, deficits in social communication cause noticeable impairments. Difficulty initiating social interactions, and clear examples of atypical or unsuccessful responses to social overtures of others. May appear to have decreased interest in social interactions. *For example,* a person who is able to speak in full sentences and engages in communication but whose to-and-fro conversation with others fails and whose attempts to make friends are odd and typically unsuccessful.	Inflexibility of behavior causes significant interference with functioning in one or more contexts. Difficulty switching between activities. Problems of organization and planning hamper independence.

From the Diagnostic and Statistical Manual of Mental Disorders, 5th ed (Copyright 2013). American Psychiatric Association, p. 52.

A child with autistic-like behavior also has seizures and developmental delay. Which listed genetic syndrome involving SHANK3 merits consideration?

A. Phelan-McDermid syndrome
B. Turner syndrome
C. Classic galactosemia
D. Hereditary angioedema
E. Congenital hypothyroidism

Original table 58.6 | Nelson printed p. 378 | PDF p. 425

Table 58.6 Syndromes with Autistic-Like Behaviors

CHROMOSOME DELETIONS	OTHER SYNDROMES
1q21	2q37 monosomy
7q11.28	Angelman
16p11.2	Bardet-Biedl
17q12	Cardiofaciocutaneous
2q23.1 (*MBD5**)	CHARGE association
12q24.3	Cohen
Cri-du-chat (5p15.2-p15.33)	Congenital rubella
22q deletion syndrome	Cornelia de Lange
Jacobsen (11q23.2)	Costello
Phelan-McDermid (*SHANK3*; 22q13)	*FOXG1* variants
Pitt-Hopkins (18q21.2)	Fragile X
	Hypomelanosis of Ito
CHROMOSOME DUPLICATIONS	Joubert
15q11.1-q13.3	Kleefstra (*EHMT1*)
7q11.23	Lujan-Fryns
18q12.2	Moebius sequence
16p11.2	Muscle-eye brain disease
1q21.1	Myotonic dystrophy
22q11.2	Neurofibromatosis
Potocki-Lupski (17p11.2)	Nonsyndromic intellectual disability due to *SYNGAP1* variants
EPILEPSY ENCEPHALOPATHIES, EPILEPSY	Noonan
Cortical dysplasia focal epilepsy	Oculoauriculovertebral spectrum (including Goldenhar)
SCN1A-related syndromes (Dravet, Lennox Gastaut, others)	Partial monosomy 1p36
Early myoclonic encephalopathies (Ohtahara: *STXBP1*, *ARX*, *SIK1*)	Partial tetrasomy 15
SCN2A-related syndromes (West, others)	Prader-Willi
SLC6A1 myotonic-atonic epilepsy	PTEN variants
HCN1-related epilepsies	Rett complex (female >> male)
CDKL5	Ring chromosome 14
SCN8A	*SETD1B* variants
PCDH19	Sex chromosome aneuploidies
SCL35A2-related disorders	Sashi-Pena (*ASXL2*)
Epilepsy-aphasia spectrum (Landau-Kleffner; *GRIN2A*; continuous spike wave during low-wave sleep)	Smith-Lemli-Opitz
	Smith-Magenis
	Sotos
Juvenile myoclonic epilepsy (*RING2*)	Timothy
	Tolchin-Le Caignec (TOLCAS)
	Trisomy 21
	Tuberous sclerosis
	WAGR
	Wiedemann-Steiner (*KMT2A*)
	Williams

*Italics denoted affected gene
Modified from Kliegman RM, Toth H, Bordini BJ, Basel D, eds. *Nelson Pediatric*

A child with autism-like behavior has a suggestive metabolic history and seizures. Which treatable metabolic disorder listed in the table warrants consideration?

A. Biotinidase deficiency
B. Isolated familial tall stature
C. Uncomplicated myopia
D. Primary dental caries
E. Habitual snoring alone

Original table 58.7 | Nelson printed p. 378 | PDF p. 425

Table 58.7 Inborn Errors of Metabolism with Autistic-Like Behavior

Adenylosuccinate lyase deficiency
Biotinidase deficiency
Cerebral creatinine deficiency
Cerebral folate deficiency
Ceroid lipofuscinosis (infantile)
Cystathionine β-synthase deficiency
Dihydropyrimidinase deficiency
Disorders of creatine transport or metabolism
Homocystinuria
Lesch-Nyhan syndrome
Methylenetetrahydrofolate reductase deficiency
Mitochondrial disorders
Mucopolysaccharidosis
Phenylketonuria (untreated)

Modified from Kliegman RM, Toth H, Bordini BJ, Basel D, eds. *Nelson Pediatric Symptom-Based Diagnosis,* 2nd ed. Philadelphia: Elsevier; 2023: Table 32.8, p. 539.

A child with autism spectrum disorder has never had genetic evaluation. Which investigation is listed for all individuals in the table?

A. Chromosomal microarray
B. PET scan of the brain
C. Routine muscle biopsy
D. A lead level in every child regardless of exposure
E. Whole-body CT

Original table 58.8 | Nelson printed p. 380 | PDF p. 427

Table 58.8 Medical and Genetic Evaluation of Children with Autism Spectrum Disorder

PHYSICAL EXAMINATION
Dysmorphic physical features
Muscle tone and reflexes
Head circumference
Wood lamp examination for tuberous sclerosis
DIAGNOSTIC TESTING
Chromosomal microarray (CMA) in all individuals
Fragile X DNA test in males
Audiology and vision evaluation
Lead test in children with pica
ADDITIONAL TARGETED GENETIC TESTING
Fragile X DNA test in females with symptoms suggestive of fragile X, family history of X-linked intellectual disability, tremor, ataxia, or premature ovarian failure
MeCP2 sequencing in females
PTEN testing if head circumference >2.5 standard deviations (SD) above the mean
MeCP2 deletion/duplication testing in males with significant developmental regression, drooling, respiratory infections, and hypotonia
Karyotype if unable to obtain CMA or if balanced translocation suspected
ADDITIONAL TARGETED DIAGNOSTIC TESTING
Electroencephalogram (EEG) in children with seizures, staring spells, or developmental regression
Brain MRI in children with dysmorphology, microcephaly, focal neurologic findings, seizures, severe hypotonia, or developmental regression
Metabolic testing in children with developmental regression, hypotonia, seizures, food intolerance, cyclic vomiting, lethargy, hearing loss, ataxia, or course facial features
Exome or genome sequencing if atypical features are present (behavioral or dysmorphic) (see Table 56.1)

Data from Schaefer GB, Mendelsohn NJ. Clinical genetics evaluation in identifying the etiology of autism spectrum disorders: 2013 guideline revisions. *Genet Med.* 2013;15(5):399–407 and Lord C, Charman T, Havdahl A, et al. The Lancet Commission on the future of care and clinical research in autism. *Lancet.* 2022;399:271–326.

A child with autism is prescribed a stimulant for significant hyperactivity. Which parameters listed in the treatment table should be monitored?

A. Height, weight, blood pressure, and heart rate
B. Only a weekly chest radiograph
C. Only serum amylase
D. Only visual acuity
E. No physical parameters

Original table 58.10 | Nelson printed p. 382 | PDF p. 429

Table 58.10 Common Pharmacologic Treatments in Autism Spectrum Disorder (ASD)

TARGET SYMPTOM	MEDICATION CLASS*	EFFECTS	SIDE EFFECTS	MONITORING
Hyperactivity and/or Inattention	Stimulants	Decreased hyperactivity, impulsivity, improved attention	Activation, irritability, emotional lability, lethargy/social withdrawal, stomach ache, reduced appetite, insomnia, increased stereotypy	Height, weight, BP, HR
	α_2-Agonists	Decreased hyperactivity, impulsivity, improved attention	Drowsiness, irritability, enuresis, decreased appetite, dry mouth, hypotension	Height, weight, BP, HR
	Selective norepinephrine reuptake inhibitor	Decreased hyperactivity, impulsivity, improved attention	Irritability, decreased appetite, fatigue, stomach ache, nausea, vomiting, racing heart rate	Height, weight, BP, HR
Anxiety	Selective serotonin reuptake inhibitors	Decreased anxiety	Activation, hyperactivity, inattention, sedation, change in appetite, insomnia, stomachache, diarrhea Citalopram: prolonged QTc interval	Weight, BP, HR
Irritability	Atypical antipsychotics (risperidone, aripiprazole)	Decreased irritability, aggression, self-injurious behavior, repetitive behavior, hyperactivity	Somnolence, weight gain, extrapyramidal movements, drooling, tremor, dizziness, vomiting, gynecomastia	Weight, BP, HR Monitor CBC, cholesterol, ALT, AST, prolactin, glucose or hemoglobin A_{1c}
Insomnia	Melatonin	Shortened sleep onset	Nightmares, enuresis	—

*Specific medication names are provided in parentheses when there is a Food and Drug Administration (FDA)–approved indication for the use of the medication to treat the symptom in children with ASD. Further information about these medications is available in Chapter 33.
BP, Blood pressure; HR, heart rate; CBC, complete blood count; ALT, alanine transaminase; AST, aspartate transaminase.

A child has an FMR1 allele with more than 200 CGG repeats and gene silencing by methylation. Which category in the table does this represent?

A. Full mutation
B. Intermediate allele
C. Normal allele
D. Autosomal trisomy
E. Mitochondrial deletion

Original table 59.2 | Nelson printed p. 384 | PDF p. 431

Table 59.2 Phenotypic and Genetic Effect of Number of CGG Repeats

VARIATION TYPE	CGG ALLELE SIZE	TYPICAL PHENOTYPE	GENETIC CONSEQUENCES
Full mutation	More than 200 repeats	Males are affected with fragile X syndrome About 50% of females are affected with fragile X syndrome	Repeat expansion and methylation typically result in partial or complete silencing of *FMR1* Females usually benefit from having two X chromosomes, because usually one of them is unaffected (i.e., no expanded CGG repeats) and X-inactivation does not silence all copies of it
Premutation	About 55-200 repeats	Patients typically have normal intellect, and some may have mild manifestations associated with fragile X syndrome Carriers may be at increased risk for fragile X–associated tremor ataxia syndrome and *FMR1*-related primary ovarian insufficiency	FMRP expression is usually not significantly impaired; however, larger mutations may have lowered expression Alleles are at risk for CGG expansion during maternal gametogenesis, and offspring are at risk for fragile X syndrome
Intermediate (gray zone)	About 45-54 repeats	Patient does not have fragile X syndrome caused by CGG repeats	A minority of intermediate/gray zone alleles may have minor instability; however, expansion of CGG repeats is unlikely, and if it occurs, it will not reach full mutation number within a single generation
Normal	About 5-44 repeats	Patient does not have fragile X syndrome caused by CGG repeats	No meiotic or mitotic instability is present; alleles are transmitted without any change in repeat number

FMR1 gene, FMRP translational regulator 1; FMRP, fragile X mental retardation protein.
From Fragile X Syndrome. *Clinical Overview. Elsevier Point of Care.* https://www.clinicalkey.com/#!/content/clinical_overview/67-s2.0-c9588237-6031-4f21-b273-34970f89cd2e. Updated June 14, 2021. Copyright Elsevier. All rights reserved; with data from Hersh JH et al. Health supervision for children with fragile X syndrome. *Pediatrics.* 2011;127(5):994–1006.

A boy with developmental delay has hypotonia, attention difficulties, and features of fragile X syndrome. Which clinical pattern in the table is associated with a full mutation?

A. Early developmental delay with behavioral and physical features
B. Normal development until adulthood in all carriers
C. An isolated congenital cataract without developmental issues
D. Acute episodic fever without cognitive symptoms
E. Only a progressive peripheral neuropathy

Original table 59.3 | Nelson printed p. 385 | PDF p. 432

Table 59.3 Clinical Features of Fragile X Syndrome and Premutation Carriers

COGNITIVE, BEHAVIORAL, AND PHYSICAL CHARACTERISTICS	AGE REPORTED
FULL MUTATION FRAGILE X SYNDROME (>200 CGG REPEATS)	
Hypotonia	Infancy
Reflux	Infancy
Poor suck	Infancy
Developmental delay/intellectual disability (96% males, 64% females)	Early childhood
Autism (46% males, 16% females)	Early childhood
Attention problems (84% males, 67% females)	Early childhood
Hyperactivity (66% males, 30% females)	Early childhood
Anxiety (70% males, 56% females)	Early childhood
Aggression (38% males, 14% females)	Early childhood
Self-injurious behaviors (41% males, 10% females)	Early childhood
Depression (12% males, 22% females)	Early childhood
Recurrent otitis media (>60%)	Early childhood
Seizures (18% males, 7% females)	Early childhood
Strabismus (20%)	Early childhood
Sleep disturbances	Early childhood
Flat feet	Early childhood
Low muscle tone	Early childhood
Hyperextensible joints	Early childhood
Large prominent ears	Early/middle childhood
Elongated face	Early/middle childhood
Large testes	Adolescence
Obesity (30%)	Adolescence
Mitral valve prolapse	Adulthood
Cognitive decline/parkinsonism (17%)	Adulthood
Perseveration	Adulthood
PREMUTATION CARRIERS (55-200 CGG REPEATS)	
Attention problems	Early childhood
Autism spectrum disorder	Early childhood
Seizures	Early childhood
Anxiety	Adolescence
Depression	Adulthood
Hypertension	Adulthood
Sleep disturbances	Adulthood
Migraine	Adulthood
Fibromyalgia	Adulthood
Hypothyroidism	Adulthood
Fragile X–associated primary ovarian insufficiency (FXPOI) (~20%)	Adulthood
Fragile X–associated tremor ataxia syndrome (FXTAS) (40% males, 16% females)	Later adulthood

Data from National Center on Birth Defects and Developmental Disabilities, Centers for Disease Control and Prevention. Data and Statistics on Fragile X Syndrome, 2021;

A dietitian compares the recommended macronutrient energy distribution for a toddler and an older child. Which nutrient in the table has a higher recommended percent-energy range at ages 1-3 years than at ages 4-18 years?

A. Fat
B. Carbohydrate
C. Omega-3 polyunsaturated fat
D. Omega-6 polyunsaturated fat
E. Water

Original table 60.2 | Nelson printed p. 388 | PDF p. 435

Table 60.2 Acceptable Macronutrient Distribution Ranges

AMDA (% OF ENERGY)		
MACRONUTRIENT	**AGE 1-3 YR**	**AGE 4-18 YR**
Fat	30-40	25-35
ω6 PUFAs (linoleic acid)	5-10	5-10
ω3 PUFAs (α-linolenic acid)	0.6-1.2	0.6-1.2
Carbohydrate	45-65	45-65
Protein	5-20	10-30

PUFAs, Polyunsaturated fatty acids.

A mother asks what distinguishes human milk beyond providing calories. Which property listed in the table contributes to protection of the infant mucosa?

A. Secretory immunoglobulin A
B. High levels of added synthetic sweeteners
C. Complete absence of immune proteins
D. A requirement for sterile preparation after every feed
E. The same composition as cow milk

Original table 61.1 | Nelson printed p. 409 | PDF p. 456

Table 61.1 Selected Beneficial Properties of Human Milk Compared with Infant Formula

FACTOR	ACTION
ANTIBACTERIAL FACTORS	
Secretory IgA	Specific antigen-targeted antiinfective action
Lactoferrin	Immunomodulation, iron chelation, antimicrobial action, antiadhesive, trophic for intestinal growth
κ-Casein	Antiadhesive, bacterial flora
Oligosaccharides	Prevention of bacterial attachment
Cytokines	Antiinflammatory, epithelial barrier function
GROWTH FACTORS	
Epidermal growth factor	Luminal surveillance, repair of intestine
Transforming growth factor (TGF)	Promotes epithelial cell growth (TGF-β) Suppresses lymphocyte function (TGF-β)
Nerve growth factor	Promotes neural growth
ENZYMES	
Platelet-activating factor (PAF)–acetylhydrolase	Blocks action of PAF
Glutathione peroxidase	Prevents lipid oxidation
Nucleotides	Enhance antibody responses, bacterial flora

Adapted from Hamosh M. Bioactive factors in human milk. *Pediatr Clin North Am.* 2001;48:69–86.

A breastfeeding parent is diagnosed with untreated active pulmonary tuberculosis. Which management category in the table is relevant while infectiousness is being addressed?

A. A temporary breastfeeding precaution with continued milk-expression planning as appropriate
B. An absolute permanent ban on any human milk for every TB exposure
C. No need to assess maternal infectiousness
D. Automatic initiation of complementary foods in the first week
E. A contraindication to infant vaccinations

Original table 61.2 | Nelson printed p. 410 | PDF p. 457

Table 61.2 Absolute and Relative Contraindications to Breastfeeding Because of Maternal Health Conditions

MATERNAL HEALTH CONDITION	DEGREE OF RISK
HIV and HTLV infection	In the United States, breastfeeding is contraindicated. In other settings, health risks of not breastfeeding must be weighed against the risk of transmitting the virus to the infant.
Tuberculosis infection	Direct breastfeeding is contraindicated until completion of approximately 2 wk of appropriate maternal therapy.
Varicella-zoster infection	Infant should not have direct contact with active lesions. Infant should receive immune globulin.
Herpes simplex infection	Breastfeeding is contraindicated with active herpetic lesions of the breast.
CMV infection	May be found in milk of mothers who are CMV seropositive. Transmission through human milk causing symptomatic illness in term infants is uncommon.
Hepatitis B infection	Infants routinely receive hepatitis B immune globulin and hepatitis B vaccine if mother is HBsAg positive. No delay in initiation of breastfeeding is required.
Hepatitis C infection	Breastfeeding is not contraindicated.
COVID-19	Maternal infection is not a contraindication for breastfeeding or feeding expressed milk.
Ebola	Confirmed maternal Ebola infection is a contraindication to breastfeeding and expressed milk.
Brucellosis	Active untreated brucellosis is a contraindication to breastfeeding and expressed milk.
Live vaccines	Smallpox and yellow fever live-virus vaccines are contraindicated for breastfeeding mothers.
Alcohol intake	Limit maternal alcohol intake to <0.5 g/kg/day (for a woman of average weight—this is the equivalent of 2 cans of beer, 2 glasses of wine, or 2 oz of liquor).
Cigarette smoking	Discourage cigarette smoking, but smoking is not a contraindication to breastfeeding.
Marijuana usage	Metabolites, including tetrahydrocannabinol, are detectable in breast milk. Marijuana usage is not recommended but is not a strict contraindication to breastfeeding.
Chemotherapy, radio-pharmaceuticals	Breastfeeding is generally contraindicated.

CMV, Cytomegalovirus; HBsAg, hepatitis B surface antigen; HIV, human

A family asks which serious intestinal complication in premature infants is among conditions for which human milk may be protective. Which is listed?

A. Necrotizing enterocolitis
B. Intestinal malrotation
C. Hirschsprung disease
D. Pyloric stenosis
E. Intussusception

Original table 61.3 | Nelson printed p. 410 | PDF p. 457

Table 61.3 Conditions for Which Human Milk May Have a Protective Effect

INFANT		MOTHER
• Diarrhea • Otitis media • Urinary tract infection • Necrotizing enterocolitis • Septicemia • Infant botulism • Insulin-dependent diabetes mellitus • Celiac disease	• Crohn disease • Lymphoma • Leukemia • Recurrent otitis media • Atopy • Hospitalizations for respiratory illness • Sudden infant death syndrome • Obesity	• Uterine atony • Breast cancer • Ovarian cancer • Cardiovascular disease • Obesity • Type 2 diabetes

A healthy term infant is exclusively breastfed at 5 months. Which feeding transition best matches the table?

A. Introduce iron-rich complementary foods at about 6 months while continuing breastfeeding
B. Replace breast milk with juice at 6 months
C. Delay complementary food until 2 years
D. Stop breastfeeding when solids begin
E. Start only water and discard iron-rich foods

Original table 61.5 | Nelson printed p. 411 | PDF p. 458

Table 61.5 Recommendations on Breastfeeding Management for Healthy Term Infants

1. Exclusive breastfeeding for about 6 months
   - Breastfeeding preferred; alternatively, expressed mother's milk or donor breast milk
   - To continue for 2 years or beyond as long as mutually desired by mother and child
   - Complementary foods rich in iron, zinc, and other micronutrients should be introduced at about 6 mo of age
2. Peripartum policies and practices that optimize breastfeeding initiation and maintenance should be compatible with the AAP and Academy of Breastfeeding Medicine Model Hospital Policy and include the following:
   - Direct skin-to-skin contact with mothers immediately after delivery until the first feeding is accomplished and encouraged throughout the postpartum period
   - Delay in routine procedures (weighing, measuring, bathing, blood tests, vaccines, and eye prophylaxis) until after the first feeding is completed
   - Delay in administration of intramuscular vitamin K until after the first feeding is completed but within 6 hr of birth
   - Ensure 8-12 feedings at the breast every 24 hr
   - Ensure formal evaluation and documentation of breastfeeding by trained caregivers (including position, latch, milk transfer, examination) at least once for each nursing shift
   - Give no supplements (water, glucose water, commercial infant formula, or other fluids) to breastfeeding newborn infants unless medically indicated using standard evidence-based guidelines for the management of hyperbilirubinemia and hypoglycemia
   - Avoid routine pacifier use in the postpartum period
   - Begin daily oral vitamin D drops (400 IU) at hospital discharge
3. All breastfeeding infants should be seen by a pediatrician within 48-72 hr after discharge from the hospital
   - Evaluate hydration and elimination patterns
   - If weight >7% below birthweight or there is additional weight loss on day 5 or later, providers should consider more frequent follow-ups and/or referral to a lactation consultant.
   - Discuss maternal/infant issues
   - Observe feeding
4. Mother and infant should sleep in proximity to each other to facilitate breastfeeding
5. Pacifier should be offered, while placing infant in back-to-sleep-position, no earlier than 3-4 weeks of age and after breastfeeding has been established

From American Academy of Pediatrics (AAP). Breast-feeding and the use of human milk. *Pediatrics*. 2012;129:e827–e841.

A mother on postpartum day 2 worries that only small volumes of milk are being expressed. Which interpretation is consistent with the milk-supply timeline?

A. Milk production normally rises during days 2-4
B. Full mature milk must be present in large volumes on day 1
C. A day-2 small volume proves lactation failure
D. Milk production should not begin until day 10
E. Breast fullness should persist after each effective feed

Original table 61.6 | Nelson printed p. 411 | PDF p. 458

Table 61.6 Patterns of Milk Supply

DAY OF LIFE	MILK SUPPLY
Day 1	Some milk (~5 mL) may be expressed.
Days 2-4	Lactogenesis; milk production increases.
Day 5	Milk present; fullness and leaking are felt.
Day 6 onward	Breasts should feel "empty" after feeding.

Adapted from Neifert MR. Clinical aspects of lactation: promoting breastfeeding success. *Clin Perinatol*. 1999;26:281–306.

A breastfed infant is starting complementary feeding at 6 months. Which food choice addresses a nutrient highlighted in the table?

A. Iron-rich meat or iron-fortified infant cereal
B. Only dilute fruit juice
C. An exclusive low-iron rice diet
D. A diet of water without solids
E. Unfortified herbal tea

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Table 61.7 Important Principles for Weaning

- Begin around 6 mo of age.
- Introduce one new food at a time.
- Choose foods that provide key nutrients and help meet energy needs.
- Iron-containing foods (meat, iron-supplemented cereals) are required, especially for breastfed infants.
- Zinc intake should be encouraged with foods such as meat, dairy products, and fortified infant cereal.
- Phytate intake should be low to enhance mineral absorption.
- By 7-8 mo infants should be consuming foods from all food groups.
- Between 9 and 12 mo of age, encourage a cup rather than a bottle.
- Fluids other than breast milk, formula, and water should be discouraged.
- Breast milk can continue up to 24 mo of age; cow's milk can be introduced at 12 mo of age and up to 24 oz/day of cow's milk can be consumed if breastfeeding is discontinued.
- Give no more than 4 oz/day of 100% fruit juice; no sugar-sweetened beverages.
- Encourage routine mealtimes and responsive feeding, watching for and responding to the child's hunger and satiety cues.

Adapted from American Academy of Pediatrics. *Pediatric Nutrition Handbook*, 8th ed. Elk Grove Village, IL: American Academy of Pediatrics; 2019.

A 7-month-old sits with head control and begins taking smooth puree by spoon while practicing easily dissolvable finger foods. Which feeding stage fits?

A. Birth to 4 months
B. 6-9 months
C. 18-24 months
D. 24-36 months
E. Preschool only

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Table 61.8 Feeding Skills Birth to 36 Months

AGE (mo)	FEEDING/ORAL SENSORIMOTOR SKILLS
Birth to 4-6	Nipple feeding, breast or bottle Hand on bottle during feeding (2-4 mo) Maintains semiflexed posture during feeding Promotion of infant-parent interaction
6-9 (transition feeding)	Head and neck control Feeding more in upright position Spoon-feeding thin, pureed foods Both hands to hold bottle Finger feeding of easily dissolvable solids introduced Vertical munching of easily dissolvable solids
9-12	Cup drinking Eats lumpy, mashed food Finger feeding for easily dissolvable solids Chewing includes rotary jaw action
12-18	Self-feeding; grasps spoon with whole hand Holds cup with two hands Drinking with four to five consecutive swallows Holding and tipping bottle
>18-24	Swallowing with lip closure Self-feeding predominates Chewing broad range of food Up-down tongue movements
24-36	Circulatory jaw rotations Chewing with lips closed One-handed cup holding and open cup drinking with no spilling Using fingers to fill spoon Eating wide range of solid food Total self-feeding, using fork

Adapted from Arvedson JC. Swallowing and feeding in infants and young children. *GI Motility Online*. 2006. https://doi.org/10.1038/gimo17.

A pediatrician discusses a child's high BMI with a family. Which communication approach reflects the table?

A. Describe how BMI relates weight to height and invite discussion without blame
B. Label the child as lazy
C. Avoid the growth chart completely
D. Assume a single weighing proves a diagnosis
E. Use shame to motivate behavior change

Original table 61.9 | Nelson printed p. 415 | PDF p. 462

Table 61.9 Suggested Language for Discussing Growth Charts with Families

UNDERWEIGHT	NORMAL WEIGHT	OVERWEIGHT OR OBESE
• Looking at how your child's weight is matched for their height, only 2 of 100 children are at a weight that is lower at the same height. • Your child's weight for their height is lower than what is generally thought to be healthy. • BMI looks at the way height and weight are balanced with each other. Currently your child's BMI is too low, which has a higher risk of developing health problems related to weight.	• Looking at how your child's weight is matched for their height, 75 of 100 children are at a weight that is lower at the same height. • Your child's weight and height are matched for each other in a way that is generally thought to be healthy. • If you were to line up 100 children of the same age by weight, your child would be right in the middle.	• Looking at how your child's weight is matched for their height, 99 of 100 children are at a weight that is lower at the same height. • Your child's weight for their height is heavier than what is generally thought to be healthy. • BMI looks at the way height and weight are balanced with each other. Currently your child's BMI is too high, which has a higher risk of developing health problems related to weight.

At meals, a toddler varies how much food they eat from day to day. Which caregiver action follows responsive-feeding recommendations?

A. Offer healthy foods at predictable meals and let the child decide how much to eat
B. Insist the child finish every portion
C. Offer a food reward for each bite
D. Allow snacks continuously throughout the day
E. Replace each declined meal with a sweetened drink

Original table 61.12 | Nelson printed p. 417 | PDF p. 464

Table 61.12 Responsive Feeding Recommendations

WAYS TO PROMOTE RESPONSIVE FEEDING	WHAT TO AVOID
• Have set meal and snack times and a consistent place to eat. • Select and provide healthful snack and meal options. • Allow child to decide what to eat and how much. • Sit and eat with the child. • Encourage child to try what is on the plate. • Notice when child attempts to try a food: "You tried your broccoli," or "good job trying your broccoli."	• Allow child to "graze" or eat small bites throughout the day. • Allow child to eat whatever they want. • Make child eat all of the food on their plate. • Leave child to eat by themselves. • Offer the child a (food) reward for eating their food. • Offer person praise to child: "You are a good person for trying your broccoli."

A child has a weight-for-height z score less than -3. Under the WHO wasting classification in the table, how is this nutritional state categorized?

A. Severe wasting
B. Moderate wasting
C. Mild stunting
D. Normal growth
E. Severe obesity

Original table 62.2 | Nelson printed p. 423 | PDF p. 470

Table 62.2 Classification of Undernutrition

CLASSIFICATION	INDEX	GRADING
Gomez (underweight)	90–75% of median weight-for-age	Grade 1 (mild)
	75–60%	Grade 2 (moderate)
	<60%	Grade 3 (severe)
Waterlow (wasting)	90–80% of median weight-for-height	Mild
	80–70%	Moderate
	<70%	Severe
Waterlow (stunting)	95–90% of median height-for-age	Mild
	90–85%	Moderate
	<85%	Severe
WHO (wasting)	< −2 to > −3 SD weight-for-height	Moderate
	< −3	Severe
WHO (stunting)	< −2 to > −3 SD height-for-age	Moderate
	< −3	Severe
WHO (wasting) (for age-group 6-59 mo)	115-125 mm mid-upper arm circumference	Moderate
	<115 mm	Severe

SD, Standard deviation; WHO, World Health Organization.

A severely undernourished child has edema, a rounded face, and skin changes. Which phenotype in the table is associated with the rounded facial appearance?

A. Kwashiorkor
B. Marasmus without edema
C. Isolated iron deficiency
D. Simple dehydration
E. Primary hypothyroidism alone

Original table 62.6 | Nelson printed p. 426 | PDF p. 473

Table 62.6 Clinical Signs of Malnutrition

SITE	SIGNS
Face	Moon face (kwashiorkor), simian facies (marasmus)
Eye	Dry eyes, pale conjunctiva, Bitot spots (vitamin A), periorbital edema
Mouth	Angular stomatitis, cheilitis, glossitis, spongy bleeding gums (vitamin C), parotid enlargement
Teeth	Enamel mottling, delayed eruption
Hair	Dull, sparse, brittle hair; hypopigmentation; flag sign (alternating bands of light and normal color); broomstick eyelashes; alopecia
Skin	Loose and wrinkled (marasmus); shiny and edematous (kwashiorkor); dry, follicular hyperkeratosis; patchy hyperpigmentation and hypopigmentation ("crazy paving" or "flaky paint" dermatoses); erosions; poor wound healing
Nails	Koilonychia; thin and soft nail plates, fissures, or ridges
Musculature	Muscle wasting, particularly buttocks and thighs; Chvostek or Trousseau sign (hypocalcemia)
Skeletal	Deformities, usually as a result of calcium, vitamin D, or vitamin C deficiencies
Abdomen	Distended: hepatomegaly with fatty liver; ascites may be present
Cardiovascular	Bradycardia, hypotension, reduced cardiac output, small vessel vasculopathy
Neurologic	Global developmental delay, loss of knee and ankle reflexes, impaired memory
Hematologic	Pallor, petechiae, bleeding diathesis
Behavior	Lethargic, apathetic, irritable on handling
Gastrointestinal tract	Atrophy of small intestine mucosa, lactase deficiency common

Modified from Grover Z, Ee LC. Protein energy malnutrition. *Pediatr Clin North Am.* 2009;56:1055–1068.

A severely malnourished child is lethargic with cold hands and a weak, rapid pulse. Which emergency syndrome in the table requires immediate stabilization?

A. Shock
B. Uncomplicated mild malnutrition
C. Isolated picky eating
D. Stable vitamin deficiency
E. Normal fasting adaptation

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Table 62.7 Emergency Treatment in Severe Malnutrition

CONDITION	IMMEDIATE ACTION
Shock • Lethargic or unconscious *and* • Cold hands *Plus* either: • Slow capillary refill (>3 sec) *or* • Weak fast pulse	1. Give oxygen. 2. Give sterile 10% glucose (5 mL/kg) rapidly by IV injection. 3. Give IV fluid at 15 mL/kg over 1 hr, using: • Ringer lactate with 5% dextrose *or* • Half-normal saline* with 5% dextrose *or* • Half-strength Darrow solution with 5% dextrose • If all these are unavailable, Ringer lactate 4. Measure and record pulse and respirations at the start and every 10 min. If there are signs of improvement (pulse and respiration rates fall), repeat IV drip, 15 mL/kg for 1 more hr. Then switch to oral or nasogastric rehydration with ReSoMal, 5-10 mL/kg in alternate hr (see Table 62.8 step 3). If there are no signs of improvement, assume septic shock and: 1. Give maintenance fluid IV (4 mL/kg/hr) while waiting for blood. 2. Order 10 mL/kg fresh whole blood and transfuse slowly over 3 hr. If signs of heart failure, give 5-7 mL/kg packed cells rather than whole blood. 3. Give furosemide, 1 mg/kg IV at start of transfusion.
Hypoglycemia Blood glucose <3 mmol/L	See Table 62.8 step 1 for treatment.
Severe dehydration	Do *not* give IV fluids except in shock. See Table 62.8 step 3 for treatment.
Very severe anemia Hgb <4 g/dL	If very severe anemia (or Hgb 4-6 g/dL *and* respiratory distress): 1. Give whole blood 10 mL/kg slowly over 3 hr. If signs of heart failure, give 5-7 mL/kg packed cells rather than whole blood. 2. Give furosemide 1 mg/kg IV at the start of the transfusion.
Emergency eye care Corneal ulceration	If corneal ulceration: 1. Give vitamin A immediately (age <6 mo: 50,000 IU; 6-12 mo: 100,000 IU; >12 mo: 200,000 IU) 2. Instill 1 drop atropine (1%) into affected eye to relax the eye and prevent the lens from pushing out.

*Some would recommend 5% dextrose in normal saline.
Hgb, Hemoglobin; IV, intravenous(ly).

A child with severe malnutrition develops hypoglycemia and hypothermia during stabilization. Which underlying concern is explicitly linked to their coexistence?

A. Severe infection
B. Normal sleep cycle
C. Excess dietary fiber alone
D. Isolated refractive error
E. Benign tooth eruption

Original table 62.8 | Nelson printed p. 429 | PDF p. 476

Table 62.8 Therapeutic Directives for Stabilization of Malnourished Children

STEP	PREVENTION	TREATMENT
1. Prevent/treat hypoglycemia blood glucose <3 mmol/L.	Avoid long gaps without food and minimize need for glucose: 1. Feed immediately. 2. Feed every 3 hr day and night (2 hr if ill). 3. Feed on time. 4. Keep warm. 5. Treat infections (they compete for glucose). *Note:* Hypoglycemia and hypothermia often coexist and are signs of severe infection.	**If conscious:** 1. Give 10% glucose (50 mL), or a feed (see step 7), or 1 tsp sugar under tongue, whichever is quickest. 2. Feed every 2 hr for at least first day. Initially give ¼ of feed every 30 min. 3. Keep warm. 4. Start broad-spectrum antibiotics. **If unconscious:** 1. Immediately give sterile 10% glucose (5 mL/kg) rapidly by IV. 2. Feed every 2 hr for at least first day. Initially give ¼ of feed every 30 min. Use nasogastric (NG) tube if unable to drink. 3. Keep warm. 4. Start broad-spectrum antibiotics.
2. Prevent/treat hypothermia axillary <35°C (95°F); rectal <35.5°C (95.9°F).	Keep warm and dry and feed frequently. 1. Avoid exposure. 2. Dress warmly, including head, and cover with blanket. 3. Keep room hot; avoid drafts. 4. Change wet clothes and bedding. 5. Do not bathe if very ill. 6. Feed frequently day and night. 7. Treat infections.	Actively rewarm. 1. Feed. 2. Skin-to-skin contact with caregiver ("kangaroo technique") or dress in warmed clothes, cover head, wrap in warmed blanket, and provide indirect heat (e.g., heater; transwarmer mattress; incandescent lamp). 3. Monitor temperature hourly (or every 30 min if using heater). 4. Stop rewarming when rectal temperature is 36.5°C (97.7°F).
3. Prevent/treat dehydration.	Replace stool losses. 1. Give ReSoMal after each watery stool. ReSoMal (37.5 mmol Na/L) is a low-sodium rehydration solution for malnutrition.	Do *not* give IV fluids unless the child is in shock. 1. Give ReSoMal 5 mL/kg every 30 min for first 2 hr orally or NG tube. 2. Then give 5-10 mL/kg in alternate hours for up to 10 hr. Amount depends on stool loss and eagerness to drink. Feed in the other alternate hour. 3. Monitor hourly and stop if signs of overload develop (pulse rate increases by 25 beats/min and respiratory rate by 5 breaths/min; increasing edema; engorged jugular veins). 4. Stop when rehydrated (≥3 signs of hydration: less thirsty, passing urine, skin pinch less slow, eyes less sunken, moist mouth, tears, less lethargic, improved pulse and respiratory rate).
4. Correct electrolyte imbalance—deficit of potassium and magnesium, excess sodium.		1. Give extra potassium (4 mmol/kg/day) and magnesium (0.6 mmol/kg/day) for at least 2 wk (see Table 62.12). *Note:* Potassium and magnesium are already added in Nutriset F75 and F100 packets.
5. Prevent/treat infections.	Minimize risk of cross-infection. 1. Avoid overcrowding. 2. Wash hands. 3. Give measles vaccine to unimmunized children age >6 mo.	Infections are often silent. Starting on first day, give broad-spectrum antibiotics to all children. 1. For antibiotic choices/schedule, see Table 62.9. 2. Ensure all doses are given, and given on time. 3. Cover skin lesions so that they do not become infected. *Note:* Avoid steroids because they depress immune function.
6. Correct micronutrient deficiencies.	*Note:* Folic acid, multivitamins, zinc, copper, and other trace minerals are already added in Nutriset F75 and F100 packets.	Do *not* give iron in the stabilization phase. 1. Give vitamin A on day 1 (<6 mo 50,000 units; 6-12 mo 100,000 units; >12 mo 200,000 units) if child has any eye signs of vitamin A deficiency or has had recent measles. Repeat this dose on days 2 and 14. 2. Give folic acid, 1 mg (5 mg on day 1). 3. Give zinc (2 mg/kg/day) and copper (0.3 mg/kg/day). These are in the electrolyte/mineral solution and Combined Mineral Vitamin mix (CMV) and can be added to feeds and ReSoMal. 4. Give multivitamin syrup or CMV.
7. Start cautious feeding.		1. Give 8-12 small feeds of F75 to provide 130 mL/kg/day, 100 kcal/kg/day, and 1-1.5 g protein/kg/day. 2. If gross edema, reduce volume to 100 mL/kg/day. 3. Keep a 24-hr intake chart. Measure feeds carefully. Record leftovers. 4. If child has poor appetite, coax and encourage to finish the feed. If unfinished, reoffer later. Use NG tube if eating ≤80% of the amount offered. 5. If breastfed, encourage continued breastfeeding but also give F75. 6. Transfer to F100 when appetite returns (usually within 1 wk) and edema has been lost or is reduced. 7. Weigh daily and plot weight.

A malnourished adolescent develops weakness and respiratory difficulty soon after nutritional rehabilitation begins; serum phosphate falls sharply. Which complication is most likely?

A. Refeeding syndrome
B. Tic disorder
C. Acute rheumatic fever
D. Primary asthma alone
E. Iron overload

Original table 63.1 | Nelson printed p. 432 | PDF p. 479

Table 63.1 Clinical Signs and Symptoms of Refeeding Syndrome

HYPOPHOSPHATEMIA	HYPOKALEMIA	HYPOMAGNESEMIA	VITAMIN/THIAMINE DEFICIENCY	SODIUM RETENTION	HYPERGLYCEMIA
Cardiac Hypotension Decreased stroke volume *Respiratory* Impaired diaphragm contractility Dyspnea Respiratory failure *Neurologic* Paresthesia Weakness Confusion Disorientation Lethargy Areflexic paralysis Seizures Coma Hematologic Leukocyte dysfunction Hemolysis Thrombocytopenia *Other* Death	*Cardiac* Arrhythmias *Respiratory* Failure *Neurologic* Weakness Paralysis *Gastrointestinal* Nausea Vomiting Constipation *Muscular* Rhabdomyolysis Muscle necrosis *Other* Death	*Cardiac* Arrhythmias *Neurologic* Weakness Tremor Tetany Seizures Altered mental status Coma *Gastrointestinal* Nausea Vomiting Diarrhea *Other* Refractory hypokalemia and hypocalcemia Death	Encephalopathy Lactic acidosis Death	Fluid overload Pulmonary edema Cardiac compromise	*Cardiac* Hypotension *Respiratory* Hypercapnia Failure *Other* Ketoacidosis Coma Dehydration Impaired immune function

Data from Kraft MD, Btaiche IF, Sacks GS. Review of RFS. *Nutr Clin Pract.* 2005;20:625–633. From Fuentebella J, Kerner JA. Refeeding syndrome. *Pediatr Clin North Am.* 2009;56:1201–1210.

An infant has a weight-for-length z score of -3.2. How does the comprehensive malnutrition-indicators table classify this single finding?

A. Severe malnutrition
B. Moderate malnutrition
C. Mild malnutrition
D. Obesity
E. No nutritional concern

Original table 64.1 | Nelson printed p. 433 | PDF p. 480

Table 64.1 Comprehensive Malnutrition Indicators

INDICATORS*	SEVERE MALNUTRITION	MODERATE MALNUTRITION	MILD MALNUTRITION
Weight-for-length *z* score	≤−3	−2.0 to −2.99	−1.0 to −1.99†
BMI-for-age *z* score	≤−3	−2.0 to −2.99	−1.0 to −1.99†
Length *z* score	≤−3	No data	No data
Mid-upper arm circumference	≤−3	−2.0 to −2.99	−1.0 to −1.99
†Weight gain velocity (<2 years of age)	<75% of the norm for expected weight gain	<50% of the norm for expected weight gain	<25% of the norm for expected weight gain
†Weight loss (2-20 yr of age)	>10% of UBW	>7.5% UBW	>5% UBW
†Deceleration in weight-for-length/height or BMI-for-age	Deceleration across 3 *z* score lines	Deceleration across 2 *z* score lines	Deceleration across 1 *z* score line
†Inadequate nutrient intake	≤25% of estimated energy/protein need	26–50% of estimated energy/protein need	51–75% of estimated energy/protein need
^Edema	Present	Absent	Absent

Use clinical judgment when applying these diagnostic criteria.
*It is recommended that when a child meets more than one malnutrition acuity level, the highest acuity level is used for diagnosis to ensure that appropriate evaluation, monitoring, and treatment are provided.

A preschooler avoids food textures, needs oral supplements, and has faltering growth but no fear of weight gain. Which disorder is described?

A. Avoidant/restrictive food intake disorder
B. Bulimia nervosa
C. Anorexia nervosa
D. Panic disorder
E. Illness anxiety disorder

Original table 64.2 | Nelson printed p. 434 | PDF p. 481

Table 64.2 DSM-5 Diagnosis of Avoidant/Restrictive Food Intake Disorder

A. An eating or feeding disturbance (e.g., apparent lack of interest in eating or food; avoidance based on the sensory characteristics of food; concern about aversive consequences of eating) as manifested by persistent failure to meet appropriate nutritional and/or energy needs associated with one (or more) of the following:
   1. Significant weight loss (or failure to achieve expected weight gain or faltering growth in children).
   2. Significant nutritional deficiency.
   3. Dependence on enteral feeding or oral nutritional supplements.
   4. Marked interference with psychosocial functioning.
B. The disturbance is not better explained by lack of available food or by associated culturally sanctioned practice.
C. The eating disturbance does not occur exclusively during the course of anorexia nervosa or bulimia nervosa, and there is no evidence of a disturbance in the way in which one's body weight or shape is experienced.
D. The eating disturbance is not attributable to a concurrent medical condition or not better explained by another mental disorder. When the eating disturbance occurs in the context of another condition or disorder, the severity of the eating disturbance exceeds that routinely associated with the condition or disorder and warrants additional clinical attention.

From the *Diagnostic and Statistical Manual of Mental Disorders*, 5th ed. p. 947.

A child with poor growth has marked mealtime conflict, inconsistent meal schedules, and food refusal without chronic diarrhea or systemic symptoms. Which evaluation domain in the malnutrition table is especially relevant?

A. Home feeding environment and psychosocial factors
B. Congenital cardiac catheterization
C. Acute renal replacement therapy
D. Isolated fracture dating
E. Chromosomal mosaicism alone

Original table 64.3 | Nelson printed p. 435 | PDF p. 482

Table 64.3 Approach to Malnutrition Based on Review of Systems

CAUSE	HISTORY AND PHYSICAL EXAMINATION	DIAGNOSTIC CONSIDERATION	WORKUP
Psychosocial	Lack of structure, poor sleep, permissive or intrusive feeding, feeding difficulties and food refusal starting in infancy	Low caloric intake secondary to home feeding environment; in extreme cases need to consider child neglect or abuse Avoidant restrictive food intake disorder (ARFID)	May need blood tests to check for certain micronutrient deficiencies based on diet history
CNS	Developmental delay, poor feeding, vomiting, large head circumference, abnormal neurologic exam	Brain tumor, intracranial bleeding (consider child abuse)	Referral to developmental pediatrics or neurology, MRI, EEG, specific test for neuromuscular function
Gastrointestinal	Chronic vomiting or diarrhea, fatty stool, crying with feedings, nocturnal cough, snoring, history of travel to/from developing countries	Malabsorption, intestinal parasites, milk protein intolerance, pancreatic insufficiency, cystic fibrosis, celiac disease, immunodeficiency, inflammatory bowel disease, small bowel bacterial overgrowth	May need referral to gastroenterology; stool studies (reducing substance, occult blood, fat stain), upper GI with small bowel follow-through; may need endoscopic evaluation
Cardiac	Slow feeding, dyspnea, diaphoresis with feeding, restless sleep, heat murmur	Congenital heart disease, heart failure	Referral to cardiology, ECG, echocardiogram
Genetic	May have a positive family history of developmental delay; often facies typical of a syndrome, skeletal abnormalities, heart murmur; consider in symmetric IUGR.	Noonan syndrome, William syndrome, Turner syndrome, Russel Silver syndrome	Specific genetic testing
Pulmonary	Dyspnea, tachypnea, recurrent wheezing, pulmonary infections	Asthma, aspiration, food allergies, cystic fibrosis, immunodeficiency, neuroendocrine hyperplasia of infancy	Chest x-ray, sweat chloride test; specialty referral
Renal	History of recurrent UTI, abnormal urinalysis, elevated BUN and creatinine	UTI, renal tubular acidosis	General chemistry with BUN and creatinine, urinalysis, urine and serum osmolality
Endocrine	Hypothyroidism is associated with decreased activity level; diabetes is associated with polyuria and polydipsia; growth hormone deficiency is associated with decreased linear growth velocity	Hypothyroidism, type 1 diabetes, growth hormone deficiency	Thyroid function tests, blood glucose and urinalysis, pituitary function tests

BUN, Blood urea nitrogen; CNS, central nervous system; CT, computed tomography; ECG, electrocardiogram; EEG, electroencephalogram; IUGR, intrauterine growth restriction; UTI, urinary tract infection.
Adapted from Carrasco MM, Welford JE. Child abuse and neglect. In Zitelli BJ, McIntire SC, Nowalk AJ, eds. *Atlas of Pediatric Physical Diagnosis*. 7th ed. Philadelphia: Elsevier; 2018.

A child with malabsorption needs an oral supplement containing medium-chain triglycerides and partially broken-down nutrients. Which category in the table best fits?

A. Semi-elemental peptide formula
B. Standard cow-milk formula only
C. Plain water
D. Unfortified fruit juice
E. An isolated electrolyte solution

Original table 64.4 | Nelson printed p. 436 | PDF p. 483

Table 64.4 Nutritional Supplements

CATEGORY	BRAND EXAMPLES	FEATURES AND COMMENTS
ORAL SUPPLEMENTS		
Standard, cow's milk protein	Boost Kid Essentials 1.0 or 1.5 (with or without fiber) PediaSure 1.0 or 1.5 (with or without fiber) Nutren Jr 1.0 (with or without fiber) Kate Farms Pediatric Standard 1.2 *EnfaGrow *Nido *Scandishake	May or may not contain lactose.
Semi-elemental	Kate Farms Pediatric Peptide 1.5 PediaSure Peptide 1.0 or 1.5 Peptamen Jr	Used for malabsorption. Contains MCT.
Elemental	EleCare Junior Neocate Splash Neocate Jr Puramino Peptamen Jr	Used for malabsorption or severe protein allergy. Contains MCT.
Soy protein	Bright Beginnings Soy Pediasmart Soy	Cow-milk protein free.
Clear liquid	*Boost Breeze *Ensure Clear	Clear liquid, fruit flavored, fat free; cow's milk protein source. For supplemental nutrition *only;* none are a complete nutrition supplement.
Wound healing supplement	Juven Arginaid	Arginaid: L-Arginine only. Juven: Arginine glutamine, and betahydroxy-betamethylbutyrate.
TUBE FEEDING		
Standard, cow's milk protein	Boost Kid Essentials 1.0, 1.5 Nutren Junior PediaSure 1.0	Isotonic, most available with or without additional fiber.
High calorie	Boost Kid Essentials 1.5 *(1.5 kcal/mL)* PediaSure 1.5 *(1.5 kcal/mL)* Kate Farms Pediatric Peptide 1.5 *(1.5 kcal/mL)*	For increased caloric needs or fluid restriction.
Food-based formulas	Compleat Pediatric *(1.0 kcal/mL)* Compleat Pediatric Reduced Calorie *(0.6 kcal/mL)* Compleat Pediatric Organic Blends (*1.2 kcal/mL)* PediaSure Harvest *(1.0 kcal/mL)* Kate Farms Pediatric Standard (*1.2 kcal/mL)* Nourish *(1.13 kcal/mL)*	

List of products is not exhaustive and does not imply endorsement. Pediatric formulas are appropriate for children ages 1-11 years and are not appropriate for use in infants. After 11 years, adult formulations (not listed) may be used.
*Does not provide complete sole source of nutrition

A child with glycogen storage disease needs a dietary carbohydrate used in some regimens to prevent fasting hypoglycemia. Which table-listed calorie booster is relevant?

A. Uncooked cornstarch
B. Caffeine
C. Food coloring
D. Plain carbonated water
E. A nonnutritive sweetener

Original table 64.5 | Nelson printed p. 437 | PDF p. 484

Table 64.5 Calorie Boosters for Oral and Enteral Feeding

	Kcal/g	Kcal/Tbsp	FEATURES AND COMMENTS
CARBOHYDRATE (CHO)			
Cornstarch	3.8	33	Can add to formula or water to treat hypoglycemia in glycogen storage disease or other disorders; dose per weight, age, and glucose levels; suggested starting dose of 0.5 g per kg per feed.
Infant rice cereal	—	15	Thickens formula, not human milk; start with 1 teaspoon rice cereal/oz formula (adds 5 kcal/oz, dilutes other nutrients). Not recommended to administer through feeding tube.
FAT			
MCT oil	8.3	116	7.7 kcal/mL; does not mix well, can administer as small bolus.
Heavy whipping cream		50	3.3 kcal/mL can be added to milk or nutritional supplements.
Butter		100	Easy to mix and use in a variety of foods.
PROTEIN			
Beneprotein	3.6	16.7	100% whey protein; 1 packet = 1 scoop = 7 g weight, 6 g protein, 25 kcal; can add to formula, human milk, food, or beverages.
COMBINATION			
Duocal	4.9	42	Hydrolyzed corn starch and fat (35% MCT); can add to formula, human milk, food, or beverages.
MCT Procal	6.6	—	1 packet (16 g) = 105 kcal, 10 g MCT, 2 g protein. For altered fat absorption or metabolism. Contains MCT and milk protein; can add to formula, food, and beverages.
Carnation Instant Breakfast			1 packet (36 g) = 140 kcal

An adolescent with obesity snores nightly and has daytime sleepiness. Which obesity-associated comorbidity in the table should be assessed?

A. Obstructive sleep apnea
B. Primary visual migraine
C. Congenital cataract
D. Acute appendicitis
E. Tic disorder

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Table 65.2 Obesity-Associated Comorbidities

DISEASE	POSSIBLE SYMPTOMS	LABORATORY CRITERIA
CARDIOVASCULAR		
Dyslipidemia	HDL <40, LDL >130, total cholesterol >200 mg/dL	Fasting total cholesterol, HDL, LDL, triglycerides
Hypertension	SBP >95% for sex, age, height	Serial testing, urinalysis, electrolytes, blood urea nitrogen, creatinine
ENDOCRINE		
Type 2 diabetes mellitus	Acanthosis nigricans, polyuria, polydipsia	Fasting blood glucose >110, hemoglobin A_{1c}, insulin level, C-peptide, oral glucose tolerance test
Metabolic syndrome	Central adiposity, insulin resistance, dyslipidemia, hypertension, glucose intolerance	Fasting glucose, LDL and HDL cholesterol
Polycystic ovary syndrome	Irregular menses, hirsutism, acne, insulin resistance, hyperandrogenemia	Pelvic ultrasound, free testosterone, LH, FSH
GASTROINTESTINAL		
Gallbladder disease	Abdominal pain, vomiting, jaundice	Ultrasound
Nonalcoholic fatty liver disease (NAFLD)	Hepatomegaly, abdominal pain, dependent edema, ↑ transaminases Can progress to fibrosis, cirrhosis	AST, ALT, ultrasound, CT, or MRI
NEUROLOGIC		
Pseudotumor cerebri	Headaches, vision changes, papilledema	Cerebrospinal fluid opening pressure, CT, MRI
Migraines	Hemicrania, headaches	None
ORTHOPEDIC		
Blount disease (tibia vara)	Severe bowing of tibia, knee pain, limp	Knee radiographs
Musculoskeletal problems	Back pain, joint pain, frequent strains or sprains, limp, hip pain, groin pain, leg bowing	Radiographs
Slipped capital femoral epiphysis	Hip pain, knee pain, limp, decreased mobility of hip	Hip radiographs
PSYCHOLOGIC		
Behavioral complications	Anxiety, depression, low self-esteem, disordered eating, signs of depression, worsening school performance, social isolation, problems with bullying or being bullied	Child Behavior Checklist, Children's Depression Inventory, Peds QL, Eating Disorder Inventory 2, subjective ratings of stress and depression, Behavior Assessment System for Children, Pediatric Symptom Checklist
PULMONARY		
Asthma	Shortness of breath, wheezing, coughing, exercise intolerance	Pulmonary function tests, peak flow
Obstructive sleep apnea	Snoring, apnea, restless sleep, behavioral problems	Polysomnography, hypoxia, electrolytes (respiratory acidosis with metabolic alkalosis)

A teen gains substantial weight after starting a psychiatric medication. Which listed agent is particularly associated with weight gain?

A. Olanzapine
B. Amoxicillin
C. Topical mupirocin
D. Inhaled saline
E. Oral rehydration solution

Original table 65.3 | Nelson printed p. 445 | PDF p. 492

Table 65.3 Medications Associated with Obesity

Prednisone and other glucocorticoids
Thioridazine
Olanzapine
Clozapine
Quetiapine
Risperidone
Lithium
Amitriptyline and other tricyclic antidepressants
Paroxetine
Valproate
Carbamazepine
Gabapentin
Cyproheptadine
Propranolol and other β blockers

Parents offer dessert every time their child eats vegetables. Which guidance in the table would improve the long-term mealtime approach?

A. Do not use food as a reward; model and repeatedly offer varied healthy foods
B. Punish refusal to eat during meals
C. Remove all exposure to disliked foods
D. Make every meal a negotiation for dessert
E. Avoid eating with the child

Original table 65.9 | Nelson printed p. 450 | PDF p. 497

Table 65.9 Anticipatory Guidance: Establishing Healthy Eating Habits in Children

Do not punish a child during mealtimes with regard to eating. The emotional atmosphere of a meal is very important. Interactions during meals should be pleasant and happy. Do not use foods as rewards. Parents, siblings, and peers should model healthy eating, tasting new foods, and eating a well-balanced meal. Children should be exposed to a wide range of foods, tastes, and textures. New foods should be offered multiple times. Repeated exposure leads to acceptance and liking.	Forcing a child to eat a certain food will decrease the child's preference for that food. Children's wariness of new foods is normal and should be expected. Offering a variety of foods with low-energy density helps children balance energy intake. Parents should control what foods are in the home. Restricting access to foods in the home will increase rather than decrease a child's desire for that food. Children tend to be more aware of satiety than adults, so allow children to respond to satiety and stop eating. Do not force children to "clean their plate."

Adapted from Benton D. Role of parents in the determination of food preferences of children and the development of obesity. *Int J Obes Relat Metab Disord.* 2004;28:858–869.

A child with fat malabsorption develops night blindness and Bitot spots. Which fat-soluble nutrient deficiency fits the table?

A. Vitamin A
B. Vitamin C
C. Thiamine
D. Folate
E. Biotin

Original table 66.1 | Nelson printed p. 453 | PDF p. 500

Table 66.1 Vitamin A Characteristics

NAMES AND SYNONYMS	CHARACTERISTICS	BIOCHEMICAL ACTION	EFFECTS OF DEFICIENCY	EFFECTS OF EXCESS	SOURCES
Retinol (vitamin A_1); 1 μg retinol = 3.3 IU vitamin A = 1 RAE Provitamins A: the plant pigments α-, β-, and γ-carotenes and cryptoxanthin have partial retinol activity: 12 μg β-carotene, or 24 μg other provitamin A carotenoids = 1 μg retinol	Fat-soluble; heat-stable; destroyed by oxidation, drying Bile necessary for absorption Stored in liver Protected by vitamin E	In vision, as retinal, for synthesis of the visual pigments rhodopsin and iodopsin In growth, reproduction, embryonic and fetal development, bone growth, immune and epithelial functions, via retinoic acid as a ligand for specific nuclear transcription factors, regulating genes involved in many fundamental cellular processes	Nyctalopia Photophobia, xerophthalmia, Bitôt spots, conjunctivitis, keratomalacia leading to blindness Faulty epiphyseal bone formation Defective tooth enamel Keratinization of mucous membranes and skin Stunted growth Impaired resistance to infection, anemia, reproductive failure, fetal abnormalities	Anorexia, slow growth, drying and cracking of skin, enlargement of liver and spleen, swelling and pain of long bones, bone fragility, increased intracranial pressure, alopecia, carotenemia Fetal abnormalities	Liver, fish liver oils Dairy products, except skim milk Egg yolk, fortified margarine, fortified skim milk Carotenoids from plants: green vegetables, yellow fruits, and vegetables

RAE, Retinol activity equivalent.

A child develops recurrent encephalopathic episodes with dystonia and ataxia. A defect in thiamine transport/metabolism is suspected. Which gene listed in the diagnostic-criteria table is associated with such acute episodes?

A. SLC19A3
B. FMR1
C. CFTR
D. DMD
E. HBB

Original table 67.3 | Nelson printed p. 459 | PDF p. 506

Table 67.3 Suggested Criteria for the Diagnosis of Inherited Thiamine Defects with Prominent Neurologic Involvement

REQUIRED

1. Clinical criteria
   a. *SLCI9A3*: Acute or recurrent episodes of encephalopathy (decreased consciousness, irritability) with two or more of the following: (a) dystonia, (b) hypotonia, (c) bulbar dysfunction, (d) ataxia, and (e) seizures. Of note, 16% of patients may have an insidious onset of symptoms (psychomotor regression, clumsy or abnormal gait, and stiff limbs).
   b. *SLC25AI9*: Acute or recurrent episodes of encephalopathy with (a) progressive peripheral neuropathy or (b) severe congenital microcephaly with brain malformations.
   c. *TPK1*: Acute or recurrent episodes of encephalopathy, with two or more of the following: (a) dystonia, (b) hypotonia, (c) ataxia, (d) seizures, and (e) developmental delay. Of note, some patients may have a nonepisodic early-onset global developmental delay.
2. Biochemical criteria
   a. Normal total thiamine blood levels
   b. Low free-thiamine in CSF and/or fibroblasts (SLC19A3)
   c. Low TPP in blood, muscle, and/or fibroblasts (TPK1)
   d. High excretion of alpha-ketoglutaric acid in urine (common in TPK1 and SLC25A19, rare in SLC19A3)
3. Radiologic criteria
   a. MRI pattern compatible with Leigh syndrome (SLC19A3, SLC25A19, TPK1) or Wernicke encephalopathy (SLC19A3)
      i. *SLC19A3*: Symmetric T2W hyperintensity of caudate, putamen, cortico/subcortical areas, and/or ventromedial thalamus. No involvement of mammillary bodies. Diffuse T2W hyperintensity of brain white matter (single adult patient reported).
      ii. *SLC25A19*: Symmetric T2W hyperintensity in the caudate and putamen.
      iii. TPK1: Symmetric T2W hyperintensity in basal ganglia and cerebellum (dentate nuclei).
4. Therapeutic criteria
   a. Clinical improvement after thiamine supplementation

SUPPORTIVE

1. Consanguinity
2. Trigger event (e.g., infection, vaccination, trauma, intense physical activity)
3. Absence of predisposing factors of beriberi or Wernicke encephalopathy
4. Absence of systemic features of mitochondrial disease (cardiomyopathy, arrhythmia/conduction defects, renal tubulopathy, or dysmorphic features)
5. Increased lactate in blood and/or CSF or presence of a lactate peak on MRS
6. Normal OXPHOS and PDHc activity in muscle and fibroblast

CSF, Cerebrospinal fluid; MRI, magnetic resonance imaging; OXPHOS, oxidative phosphorylation: PDHc, pyruvate dehydrogenase complex; MRS, magnetic resonance spectroscopy; TPP, thiamine pyrophosphate; T2W, T2-weighted.

A child with chronic intestinal malabsorption develops rickets despite adequate sun exposure. Under which etiologic category does the table place this mechanism?

A. Secondary vitamin D deficiency due to malabsorption
B. Isolated phosphate excess
C. Primary copper deficiency
D. Purely traumatic bone disease
E. Vitamin A excess

Original table 69.2 | Nelson printed p. 3 | PDF p. 518

Table 69.2 Causes of Rickets

VITAMIN D DISORDERS
Nutritional vitamin D deficiency
Congenital vitamin D deficiency
Secondary vitamin D deficiency
Malabsorption
Increased degradation
Decreased liver 25-hydroxylase
Vitamin D–dependent rickets types 1A and 1B
Vitamin D–dependent rickets types 2A and 2B
Chronic kidney disease
CALCIUM DEFICIENCY
Low intake
Diet
Premature infants (rickets of prematurity)
Malabsorption
Primary disease
Dietary inhibitors of calcium absorption
PHOSPHORUS DEFICIENCY
Inadequate intake
Premature infants (rickets of prematurity)
Aluminum-containing antacids
RENAL LOSSES
X-linked hypophosphatemic rickets*
Autosomal dominant hypophosphatemic rickets*
Autosomal recessive hypophosphatemic rickets types 1, 2, and 3*
Hereditary hypophosphatemic rickets with hypercalciuria
Hypophosphatemic rickets with nephrolithiasis and osteoporosis types 1 and 2
Overproduction of fibroblast growth factor-23
Tumor-induced rickets*
McCune-Albright syndrome*
Epidermal nevus syndrome (cutaneous skeletal hypophosphatemia syndrome)*
Neurofibromatosis*
Fanconi syndrome
Dent disease
Distal renal tubular acidosis

*Disorders secondary to excess fibroblast growth factor 23

An infant has widening at the costochondral junctions and frontal bossing. Which clinical sign in the table names the chest finding?

A. Rachitic rosary
B. Pectus carinatum
C. Stridor
D. Wheeze
E. Clubbing

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Table 69.3 Clinical Features of Rickets

GENERAL
Failure to thrive (malnutrition)
Listlessness
Protruding abdomen
Muscle weakness (especially proximal)
Hypocalcemic dilated cardiomyopathy
Fractures (pathologic, minimal trauma)
Increased intracranial pressure
HEAD
Craniotabes
Frontal bossing
Delayed fontanel closure (usually closed by 2 yr)
Delayed dentition
No incisors by age 10 mo
No molars by age 18 mo
Caries
Craniosynostosis
CHEST
Rachitic rosary
Harrison groove
Respiratory infections and atelectasis*
BACK
Scoliosis
Kyphosis
Lordosis
EXTREMITIES
Enlargement of wrists and ankles
Valgus or varus deformities
Windswept deformity (valgus deformity of one leg with varus deformity of other leg)
Anterior bowing of tibia and femur
Coxa vara
Leg pain
HYPOCALCEMIC SYMPTOMS†
Tetany
Seizures
Stridor caused by laryngeal spasm

An exclusively breastfed infant has limited sun exposure and no vitamin D supplementation. Which nutritional-rickets risk described in the table is present?

A. Low vitamin D intake with restricted UVB exposure
B. Excess vitamin D supplementation
C. High dietary calcium intake alone
D. Frequent outdoor sunlight exposure
E. Routine iron intake

Original table 69.5 | Nelson printed p. 474 | PDF p. 521

Table 69.5 Risk Factors for Nutritional Rickets and Osteomalacia and Their Prevention

MATERNAL FACTORS
Vitamin D deficiency
Dark skin pigmentation
Full body clothing cover
High latitude during winter/spring season
Other causes of restricted sun (UVB) exposure (e.g., predominant indoor living, disability, pollution, cloud cover)
Low–vitamin D diet
Low-calcium diet
Poverty, malnutrition, special diets
INFANT/CHILDHOOD FACTORS
Neonatal vitamin D deficiency secondary to maternal deficiency/ vitamin D deficiency
Lack of infant supplementation with vitamin D
Prolonged breastfeeding without appropriate complementary feeding from 6 mo
High latitude during winter/spring season
Dark skin pigmentation and/or restricted sun (UVB) exposure (e.g., predominant indoor living, disability, pollution, cloud cover)
Avoidant restrictive food intake disorder
Low–vitamin D diet
Low-calcium diet
Poverty, malnutrition, special diets
PREVENTIVE MEASURES
Sun exposure (UVB content of sunlight depends on latitude and season)
Vitamin D supplementation
Strategic fortification of the habitual food supply
Normal calcium intake

Adapted from Munns CF, Shaw N, Kiely M, et al. Global consensus recommendations on prevention and management of nutritional rickets. *J Clin Endocrinol Metab*.

An infant develops hypernatremia after being fed overly concentrated formula. Which mechanistic category in the table best classifies the cause?

A. Excess sodium intake
B. Central diabetes insipidus
C. Renal salt wasting
D. Pseudohyponatremia
E. Primary polydipsia

Original table 73.1 | Nelson printed p. 489 | PDF p. 536

Table 73.1 Causes of Hypernatremia

EXCESSIVE SODIUM
Improperly mixed formula
Excess sodium bicarbonate
Ingestion of seawater or sodium chloride
Intentional salt poisoning (child abuse or fictitious disorder inflicted on another)
Intravenous hypertonic saline
Sodium phosphate enemas
Hyperaldosteronism
WATER DEFICIT
Nephrogenic Diabetes Insipidus
Acquired
X-linked (OMIM 304800)
Autosomal recessive (OMIM 125800)
Autosomal dominant (OMIM 125800)
Central Diabetes Insipidus
Acquired*
Autosomal recessive (OMIM 125700/600955)
Autosomal dominant (OMIM 125700)
Wolfram syndrome (OMIM 222300/604928/598500)
Hypothalamic neurogenic (essential) adipsic hypernatremia
Increased Insensible Losses
Premature infants
Radiant warmers
Phototherapy
Inadequate Intake
Ineffective breastfeeding
Child neglect or abuse
Adipsia (lack of thirst)
WATER AND SODIUM DEFICITS
Gastrointestinal Losses
Diarrhea
Emesis/nasogastric suction
Osmotic cathartics (lactulose)
Cutaneous Losses
Burns
Excessive sweating
Renal Losses
Osmotic diuretics (mannitol)
Diabetes mellitus
Chronic kidney disease (dysplasia and obstructive uropathy)
Polyuric phase of acute tubular necrosis
Postobstructive diuresis

*Acquired: central diabetes insipidus from CNS malformations, trauma, meningitis, tumor, infiltration, unknown.

A child with severe hyperglycemia has a low measured serum sodium but high serum osmolality. Which category in the hyponatremia table explains this?

A. Hyperosmolar hyponatremia
B. Euvolemic hypotonic hyponatremia
C. Hypovolemic salt loss from diarrhea
D. Pseudohyponatremia from hyperproteinemia
E. SIADH

Original table 73.2 | Nelson printed p. 492 | PDF p. 539

Table 73.2 Causes of Hyponatremia

PSEUDOHYPONATREMIA
Hyperlipidemia
Hyperproteinemia
HYPEROSMOLALITY
Hyperglycemia
Iatrogenic (mannitol, sucrose, glycine)
HYPOVOLEMIC HYPONATREMIA
Extrarenal Losses
Gastrointestinal (emesis, diarrhea)
Skin (sweating or burns)
Third space losses (bowel obstruction, peritonitis, sepsis)
Renal Losses
Thiazide or loop diuretics
Osmotic diuresis
Postobstructive diuresis
Polyuric phase of acute tubular necrosis
Juvenile nephronophthisis (OMIM 256100/606966/602088/604387/611498)
Autosomal recessive polycystic kidney disease (OMIM 263200)
Tubulointerstitial nephritis
Obstructive uropathy
Cerebral salt wasting
Proximal (type II) renal tubular acidosis (OMIM 604278)*
Lack of aldosterone effect (high serum potassium):
Absence of aldosterone (e.g., 21-hydroxylase deficiency [OMIM 201910])
Pseudohypoaldosteronism type I (OMIM 264350/177735)
Urinary tract obstruction and/or infection
Addison disease
EUVOLEMIC HYPONATREMIA
Syndrome of inappropriate antidiuretic hormone secretion (SIADH)
Nephrogenic syndrome of inappropriate antidiuresis (OMIM 304800)
Desmopressin acetate
Glucocorticoid deficiency
Hypothyroidism
Antidepressant medications
Water intoxication
Iatrogenic (excess hypotonic intravenous fluids)
Feeding infants excessive water products
Swimming lessons
Tap water enema
Child abuse
Psychogenic polydipsia
Diluted formula
Beer potomania
Exercise-induced hyponatremia
HYPERVOLEMIC HYPONATREMIA
Heart failure
Cirrhosis
Nephrotic syndrome
Acute, chronic kidney injury
Capillary leak caused by sepsis
Hypoalbuminemia caused by gastrointestinal disease (protein-losing enteropathy)

*Most cases of proximal renal tubular acidosis are not caused by this primary genetic disorder. Proximal renal tubular acidosis is usually part of Fanconi syndrome, which

A euvolemic hospitalized child has hypotonic hyponatremia with inappropriately concentrated urine and high urine sodium after adrenal, thyroid, and renal failure are excluded. Which diagnosis matches the criteria?

A. SIADH
B. Central diabetes insipidus
C. Primary hyperaldosteronism
D. Hypernatremic dehydration
E. Pseudohyponatremia

Original table 73.3 | Nelson printed p. 492 | PDF p. 539

Table 73.3 Diagnostic Criteria for Syndrome of Inappropriate Antidiuretic Hormone Secretion

- Absence of:
  Renal, adrenal, or thyroid insufficiency
  Heart failure, nephrotic syndrome, or cirrhosis
  Diuretic ingestion
  Dehydration
- Urine osmolality >100 mOsm/kg (usually > plasma)
- Serum osmolality <280 mOsm/kg and serum sodium <135 mEq/L
- Urine sodium >30 mEq/L
- Reversal of "sodium wasting" and correction of hyponatremia with water restriction

A child develops hyperkalemia after a change in chronic medication. Which medication category is listed as a cause of decreased potassium excretion?

A. Potassium-sparing diuretics
B. Loop diuretics
C. Thiazide diuretics
D. Inhaled beta-agonists
E. Insulin

Original table 73.4 | Nelson printed p. 496 | PDF p. 543

Table 73.4 Causes of Hyperkalemia

SPURIOUS LABORATORY VALUE
Hemolysis
Tissue ischemia during blood drawing
Thrombocytosis
Leukocytosis
Familial pseudohyperkalemia (OMIM 609153)
INCREASED INTAKE
Intravenous or oral
Blood transfusions
TRANSCELLULAR SHIFTS
Acidosis
Rhabdomyolysis
Tumor lysis syndrome
Tissue necrosis
Hemolysis/hematomas/gastrointestinal bleeding
Succinylcholine
Digitalis intoxication
Fluoride intoxication
β-Adrenergic blockers
Exercise
Hyperosmolality
Insulin deficiency
Malignant hyperthermia (OMIM 145600/601887/601888)
Hyperkalemic periodic paralysis (OMIM 170500)
DECREASED EXCRETION
Kidney failure
Primary adrenal disease
Acquired Addison disease
21-Hydroxylase deficiency (OMIM 201910)
3β-Hydroxysteroid dehydrogenase deficiency (OMIM 201810)
Lipoid congenital adrenal hyperplasia (OMIM 201710)
Adrenal hypoplasia congenita (OMIM 300200)
Aldosterone synthase deficiency (OMIM 203400/610600)
Adrenoleukodystrophy (OMIM 300100)
Hyporeninemic hypoaldosteronism
Urinary tract obstruction
Sickle cell disease (OMIM 603903)
Kidney transplant
Lupus nephritis
Renal tubular disease
Pseudohypoaldosteronism type I (OMIM 264350/177735)
Pseudohypoaldosteronism type II (OMIM 614491/614492/614495)
Bartter syndrome, type 2 (OMIM 241200)
Urinary tract obstruction
Kidney transplant
Medications
Renin inhibitors
Angiotensin-converting enzyme inhibitors
Angiotensin II blockers
Potassium-sparing diuretics
Calcineurin inhibitors
Nonsteroidal antiinflammatory drugs
Trimethoprim
Heparin
Drospirenone (in some oral contraceptives)

OMIM, database number from the Online Mendelian Inheritance in Man (http://www.n

A child with persistent vomiting develops hypokalemia. Which mechanism in the causes table fits this presentation?

A. Gastrointestinal loss and secondary renal potassium wasting
B. Excess cell breakdown
C. Potassium-sparing drug exposure
D. Renal failure with reduced excretion
E. Pseudohyperkalemia from hemolysis

Original table 73.5 | Nelson printed p. 499 | PDF p. 546

Table 73.5 Causes of Hypokalemia

SPURIOUS LABORATORY VALUE
High white blood cell count

TRANSCELLULAR SHIFTS
Alkalemia
Insulin
α-Adrenergic agonists
Drugs/toxins (theophylline, barium, toluene, cesium chloride, hydroxychloroquine)
Hypokalemic periodic paralysis (OMIM 170400)
Thyrotoxic period paralysis
Refeeding syndrome

DECREASED INTAKE
Anorexia nervosa

EXTRARENAL LOSSES
Diarrhea
Laxative abuse
Sweating
Sodium polystyrene sulfonate (Kayexalate) or clay ingestion

RENAL LOSSES
With Metabolic Acidosis
Distal renal tubular acidosis (OMIM 179800/602722/267300/611590)
Proximal renal tubular acidosis (OMIM 604278)*
Ureterosigmoidostomy
Diabetic ketoacidosis

Without Specific Acid-Base Disturbance
Tubular toxins: amphotericin, cisplatin, aminoglycosides
Interstitial nephritis
Diuretic phase of acute tubular necrosis
Postobstructive diuresis
Hypomagnesemia
High urine anions (e.g., penicillin or penicillin derivatives)

With Metabolic Alkalosis
Low urine chloride
  Emesis or nasogastric suction
  Chloride-losing diarrhea (OMIM 214700)
  Cystic fibrosis (OMIM 219700)
  Low-chloride formula
  Posthypercapnia
  Previous loop or thiazide diuretic use
High urine chloride and normal blood pressure
  Gitelman syndrome (OMIM 263800)
  Bartter syndrome (OMIM 241200/607364/602522/601678/300971/601198/613090)
  Autosomal dominant hypoparathyroidism (OMIM 146200)
  EAST syndrome (OMIM 612780)
  Autosomal dominant kidney hypomagnesemia due to *RRAGD* variant (OMIM not assigned)
  Loop and thiazide diuretics (current)
High urine chloride and high blood pressure
  Adrenal adenoma or hyperplasia
  Glucocorticoid-remediable aldosteronism (OMIM 103900)
  Hyperaldosteronism type II (OMIM 605635)
  Familial hyperaldosteronism type III (OMIM 613677)
  Familial hyperaldosteronism type IV (OMIM 617027)
  Renovascular disease
  Renin-secreting tumor
  17β-Hydroxylase deficiency (OMIM 202110)
  11β-Hydroxylase deficiency (OMIM 202010)
  Cushing syndrome
  11β-Hydroxysteroid dehydrogenase deficiency (OMIM 218030)
  Licorice ingestion
  Liddle syndrome (OMIM 177200)
  Early-onset autosomal dominant hypertension with exacerbation in pregnancy (OMIM 605115)

*Most cases of proximal renal tubular acidosis are not caused by this primary genetic disorder. Proximal renal tubular acidosis is usually part of Fanconi syndrome, which has multiple etiologies.

A child treated with cisplatin develops refractory hypomagnesemia. Which loss mechanism in the table is most likely?

A. Renal magnesium wasting from medication
B. Excess magnesium intake
C. Isolated respiratory alkalosis
D. Vitamin A toxicity
E. Pseudohypermagnesemia

Original table 73.7 | Nelson printed p. 503 | PDF p. 550

Table 73.7 Causes of Hypomagnesemia

GASTROINTESTINAL LOSSES
Diarrhea
Nasogastric suction or emesis
Inflammatory bowel disease
Celiac disease
Cystic fibrosis
Intestinal lymphangiectasia
Small bowel resection or bypass
Pancreatitis
Protein-calorie malnutrition
Patiromer
Hypomagnesemia with secondary hypocalcemia (OMIM 602014)*

RENAL DISORDERS
Medications
- Amphotericin
- Cisplatin
- Cyclosporine, tacrolimus
- Loop and thiazide diuretics
- Mannitol
- Pentamidine
- Proton pump inhibitors
- Aminoglycosides
- Thiazide diuretics
- Epidermal growth factor receptor inhibitors

Diabetes
Acute tubular necrosis (recovery phase)
Postobstructive nephropathy
Chronic kidney diseases
- Interstitial nephritis
- Glomerulonephritis
- Post–renal transplantation

Hypercalcemia
Intravenous fluids
Primary aldosteronism
Genetic diseases
- Gitelman syndrome (OMIM 263800)
- Bartter syndrome (OMIM 241200/607364/602522/601678/300971/601198/613090)
- Familial hypomagnesemia with hypercalciuria and nephrocalcinosis (OMIM 248250)
- Familial hypomagnesemia with hypercalciuria, nephrocalcinosis, and severe ocular involvement (OMIM 248190)
- Autosomal recessive renal magnesium wasting with normocalciuria (OMIM 611718)
- Renal cysts and diabetes syndrome due to *HNF1β* variants (OMIM 137920)
- Autosomal dominant hypomagnesemia (OMIM 160120/613882/154020)
- EAST syndrome (OMIM 612780)
- Autosomal dominant hypoparathyroidism (OMIM 146200)
- Mitochondrial disorders (OMIM 500005)

Hyperuricemia, pulmonary hypertension, renal failure in infancy and alkalosis, HUPRA syndrome (OMIM 613845)
Transient neonatal hyperphenylalaninemia followed by hypomagnesemia and maturity onset diabetes of the young (OMIM 264070)
Hypomagnesemia, seizures and mental retardation due to *CNNM2* pathogenic variants (OMIM 616418)
Autosomal dominant kidney hypomagnesemia due to *RRAGD* pathogenic variants (OMIM not assigned)

MISCELLANEOUS CAUSES
Poor intake
Hungry bone syndrome
Insulin administration
Pancreatitis
Intrauterine growth restriction
Infants of diabetic mothers
Exchange transfusion

*This disorder is also associated with renal magnesium wasting.

A severely malnourished patient begins feeding and develops a rapid fall in serum phosphate. Which mechanism in the table explains this association?

A. Intracellular shift during refeeding
B. Decreased renal phosphate clearance
C. Phosphate enema absorption
D. Hypoparathyroidism
E. Excess phosphate supplementation

Original table 73.9 | Nelson printed p. 506 | PDF p. 553

Table 73.9 Causes of Hypophosphatemia

TRANSCELLULAR SHIFTS
Glucose infusion
Insulin
Refeeding
Total parenteral nutrition
Respiratory alkalosis
Tumor growth
Bone marrow transplantation
Hungry bone syndrome
DECREASED INTAKE
Nutritional
Premature infants
Low phosphorus formula
Antacids and other phosphate binders
RENAL LOSSES
Hyperparathyroidism
Parathyroid hormone–related peptide
X-linked hypophosphatemic rickets (OMIM 307800)
Overproduction of fibroblast growth factor-23
Tumor-induced rickets
McCune-Albright syndrome (OMIM 174800)
Epidermal nevus syndrome
Neurofibromatosis
Autosomal dominant hypophosphatemic rickets (OMIM 193100)
Autosomal recessive hypophosphatemic rickets, types 1, 2, and 3 (OMIM 241520/613312)
Ferric carboxymaltose
Dent disease (OMIM 300009/300555)
Fanconi syndrome (OMIM 134600/613388/615605/616026/618913/612392)*
Hypophosphatemic rickets with hypercalciuria (OMIM 241530)
Hypophosphatemic rickets with nephrolithiasis and osteoporosis types 1 and 2 (OMIM 612286/612287)
Volume expansion and intravenous fluids
Metabolic acidosis
Diuretics
Glycosuria
Glucocorticoids
Chemotherapy (cisplatin, ifosfamide)
Kidney transplantation
MULTIFACTORIAL
Vitamin D deficiency
Vitamin D–dependent rickets type 1 (OMIM 264700)
Vitamin D–dependent rickets type 2 (OMIM 277440)
Alcoholism
Sepsis
Dialysis

*These are primary genetic causes of Fanconi syndrome. Fanconi syndrome may also

A child with newly treated leukemia develops hyperphosphatemia after cell breakdown. Which listed cause is most likely?

A. Tumor lysis syndrome
B. Chronic diarrhea
C. Refeding syndrome
D. Phosphate binder ingestion
E. Renal phosphate wasting

Original table 73.10 | Nelson printed p. 508 | PDF p. 555

Table 73.10 Causes of Hyperphosphatemia

TRANSCELLULAR SHIFTS
Tumor lysis syndrome
Rhabdomyolysis
Acute hemolysis
Diabetic ketoacidosis and lactic acidosis
INCREASED INTAKE
Enemas and laxatives
Cow's milk in infants
Treatment of hypophosphatemia
Vitamin D intoxication
DECREASED EXCRETION
Kidney failure
Hypoparathyroidism or pseudohypoparathyroidism (OMIM 146200/603233/103580/241410/203330)
Acromegaly
Hyperthyroidism
Tumoral calcinosis with hyperphosphatemia: genetic (OMIM 211900/617993/617994) or autoimmune

OMIM, database number from the Online Mendelian Inheritance in Man (http://www.ncbi.nlm.nih.gov/omim).

A child has metabolic acidosis with serum bicarbonate 12 mEq/L. Which PaCO2 is closest to the expected respiratory compensation by the table's formula?

A. 14 mm Hg
B. 26 mm Hg
C. 40 mm Hg
D. 55 mm Hg
E. 70 mm Hg

Original table 73.11 | Nelson printed p. 513 | PDF p. 560

Table 73.11 Appropriate Compensation During Simple Acid-Base Disorders

DISORDER	EXPECTED COMPENSATION
Metabolic acidosis	$P_{CO_2} = 1.5 \times [HCO_3^-] + 8 \pm 2$
Metabolic alkalosis	P_{CO_2} increases by 7 mm Hg for each 10 mEq/L increase in serum $[HCO_3^-]$
Respiratory Acidosis	
Acute	$[HCO_3^-]$ increases by 1 for each 10 mm Hg increase in P_{CO_2}
Chronic	$[HCO_3^-]$ increases by 3.5 for each 10 mm Hg increase in P_{CO_2}
Respiratory Alkalosis	
Acute	$[HCO_3^-]$ falls by 2 for each 10 mm Hg decrease in P_{CO_2}
Chronic	$[HCO_3^-]$ falls by 4 for each 10 mm Hg decrease in P_{CO_2}

A toddler develops metabolic acidosis after profuse diarrhea, with no elevation of the anion gap. Which cause category in the table matches?

A. Normal-anion-gap bicarbonate loss
B. High-anion-gap lactic acidosis from shock
C. Organic acidemia
D. Toxic alcohol ingestion
E. Tumor lysis syndrome

Original table 73.13 | Nelson printed p. 515 | PDF p. 562

Table 73.13 Causes of Metabolic Acidosis

NORMAL ANION GAP
Diarrhea
RTA
  Distal (type I) RTA (OMIM 179800/602722/267300/611590)*
  Proximal (type II) RTA (OMIM 604278)†
  Mixed (type III) RTA (OMIM 259730)
  Hyperkalemic (type IV) RTA (OMIM 201910/264350/177735/145260)‡
  Urinary tract diversions
  Posthypocapnia
  Ammonium chloride intake

INCREASED ANION GAP
Lactic Acidosis
Tissue hypoxia
  Shock
  Hypoxemia
  Severe anemia
Liver failure
Malignancy
Intestinal bacterial overgrowth
Inborn errors of metabolism
Medications
  Nucleoside reverse transcriptase inhibitors
  Metformin
  Propofol
  Linezolid

Ketoacidosis
Diabetic ketoacidosis
Starvation ketoacidosis
Alcoholic ketoacidosis

Kidney Failure
Poisoning
Ethylene glycol
Methanol
Salicylate
Toluene
Paraldehyde

*Along with these genetic disorders, distal RTA may be secondary to renal disease or medications.
†Most cases of proximal RTA are not caused by this primary genetic disorder. Proximal

A child with repeated vomiting has metabolic alkalosis and low urine chloride. Which category best matches the table?

A. Chloride-responsive alkalosis due to gastric loss
B. Chloride-resistant mineralocorticoid excess
C. Respiratory alkalosis from hyperventilation
D. High-anion-gap acidosis
E. Pseudohypokalemia

Original table 73.14 | Nelson printed p. 518 | PDF p. 565

Table 73.14 Causes of Metabolic Alkalosis

CHLORIDE-RESPONSIVE (URINARY CHLORIDE <15 MEQ/L)
Gastric losses
Emesis
Nasogastric suction
Diuretics (loop or thiazide)
Chloride-losing diarrhea (OMIM 214700)
Low chloride formula
Cystic fibrosis (OMIM 219700)
Posthypercapnia

CHLORIDE-RESISTANT (URINARY CHLORIDE >20 MEQ/L)
High Blood Pressure
Adrenal adenoma or hyperplasia
Glucocorticoid-remediable aldosteronism/Familial hyperaldosteronism type I (OMIM 103900)
Familial hyperaldosteronism type II (OMIM 605635)
Familial hyperaldosteronism type III (OMIM 613677)
Familial hyperaldosteronism type IV (OMIM 617027)
Renovascular disease
Renin-secreting tumor
17α-Hydroxylase deficiency (OMIM 202110)
11β-Hydroxylase deficiency (OMIM 202010)
Cushing syndrome
11β-Hydroxysteroid dehydrogenase deficiency (OMIM 218030)
Licorice ingestion
Liddle syndrome (OMIM 177200)

Normal Blood Pressure
Gitelman syndrome (OMIM 263800)
Bartter syndrome (OMIM 241200/607364/602522/601678/300971/601198/613090)
Autosomal dominant hypoparathyroidism (OMIM 146200)
EAST syndrome (OMIM 612780)
Hyperuricemia, Pulmonary Hypertension, Renal Failure in Infancy and Alkalosis, HUPRA Syndrome (OMIM 613845)
Autosomal dominant kidney hypomagnesemia due to *RRAGD* variant (OMIM not assigned)
Base administration

EAST, Epilepsy, ataxia, sensorineural hearing loss, and tubulopathy; OMIM, database number from the Online Mendelian Inheritance in Man (http://www.ncbi.nlm.nih.gov/omim).

A child given excessive opioid medication becomes hypoventilated and has elevated PaCO2. Which category in the respiratory-acidosis table fits?

A. Central nervous system respiratory depression
B. Compensatory response to primary respiratory alkalosis
C. Increased pulmonary ventilation
D. Excess renal bicarbonate excretion
E. Isolated phosphate loss

Original table 73.15 | Nelson printed p. 522 | PDF p. 569

Table 73.15 Causes of Respiratory Acidosis

CENTRAL NERVOUS SYSTEM DEPRESSION
- Encephalitis
- Head trauma
- Brain tumor
- Central sleep apnea
- Primary pulmonary hypoventilation (Ondine curse)
- Stroke
- Hypoxic brain damage
- Obesity-hypoventilation (Pickwickian) syndrome
- Increased intracranial pressure
- Medications
  - Narcotics
  - Barbiturates
  - Anesthesia
  - Benzodiazepines
  - Propofol
  - Alcohols

DISORDERS OF SPINAL CORD, PERIPHERAL NERVES, OR NEUROMUSCULAR JUNCTION
- Diaphragmatic paralysis
- Guillain-Barré syndrome
- Poliomyelitis
- Acute flaccid myelitis
- Spinal muscular atrophies
- Tick paralysis
- Botulism
- Myasthenia
- Multiple sclerosis
- Spinal cord injury
- Medications
  - Vecuronium
  - Aminoglycosides
  - Organophosphates (pesticides)

RESPIRATORY MUSCLE WEAKNESS
- Muscular dystrophy
- Hypothyroidism
- Malnutrition
- Hypokalemia
- Hypophosphatemia
- Medications
  - Succinylcholine
  - Corticosteroids

PULMONARY DISEASE
- Pneumonia
- Pneumothorax
- Asthma
- Bronchiolitis
- Pulmonary edema
- Pulmonary hemorrhage
- Acute respiratory distress syndrome
- Neonatal respiratory distress syndrome
- Cystic fibrosis
- Bronchopulmonary dysplasia
- Hypoplastic lungs
- Meconium aspiration
- Pulmonary thromboembolus
- Interstitial fibrosis

UPPER AIRWAY DISEASE
- Aspiration
- Laryngospasm
- Angioedema
- Obstructive sleep apnea
- Tonsillar hypertrophy
- Vocal cord paralysis
- Extrinsic tumor
- Extrinsic or intrinsic hemangioma

MISCELLANEOUS
- Flail chest
- Cardiac arrest
- Kyphoscoliosis
- Decreased diaphragmatic movement due to ascites or peritoneal dialysis

A child with pneumonia is tachypneic and has reduced PaCO2. Which listed path to respiratory alkalosis applies?

A. Hypoxemia and lung receptor stimulation
B. Primary renal bicarbonate retention
C. Opioid-induced hypoventilation
D. Diaphragmatic paralysis
E. Severe airway obstruction with CO2 retention

Original table 73.16 | Nelson printed p. 524 | PDF p. 571

Table 73.16 Causes of Respiratory Alkalosis

HYPOXEMIA OR TISSUE HYPOXIA
Pneumonia
Pulmonary edema
Cyanotic heart disease
Congestive heart failure
Asthma
Severe anemia
High altitude
Laryngospasm
Aspiration
Carbon monoxide poisoning
Pulmonary embolism
Interstitial lung disease
Hypotension

LUNG RECEPTOR STIMULATION
Pneumonia
Pulmonary edema
Asthma
Pulmonary embolism
Hemothorax
Pneumothorax
Respiratory distress syndrome (adult or infant)

CENTRAL STIMULATION
Central nervous system disease
  Subarachnoid hemorrhage
  Encephalitis or meningitis
  Trauma
  Brain tumor
  Stroke
Fever
Pain
Anxiety (panic attack)
Psychogenic hyperventilation or anxiety
Liver failure
Sepsis
Pregnancy
Mechanical ventilation
Hyperammonemia
Extracorporeal membrane oxygenation or hemodialysis
Medications
  Salicylate intoxication
  Theophylline
  Progesterone
  Exogenous catecholamines
  Caffeine

A metabolic acidosis is the dominant acid-base disturbance in a patient with acidemia and a low P_{CO_2}, even though there could still

A stable inpatient child needs routine maintenance fluids while unable to eat. Which goal is explicitly listed in the table?

A. Prevent dehydration and electrolyte disturbance
B. Replace blood loss from an active hemorrhage as the only goal
C. Treat intracranial hypertension
D. Induce ketoacidosis
E. Eliminate all urine output

Original table 74.1 | Nelson printed p. 525 | PDF p. 572

Table 74.1 Goals of Maintenance Fluids

- Prevent dehydration
- Prevent electrolyte disorders
- Prevent ketoacidosis
- Prevent protein degradation

Source: Nelson Textbook of Pediatrics, 22nd ed., Vol. 1. Answer key follows all questions.

Using the body-weight method in the table, what is the approximate daily maintenance fluid volume for a stable 15-kg child before other adjustments?

A. 750 mL
B. 1,000 mL
C. 1,250 mL
D. 1,500 mL
E. 2,000 mL

Original table 74.2 | Nelson printed p. 526 | PDF p. 573

Table 74.2 Body Weight Method for Calculating Daily Maintenance Fluid Volume

BODY WEIGHT	FLUID PER DAY
0-10 kg	100 mL/kg
11-20 kg	1,000 mL + 50 mL/kg for each kg >10 kg
>20 kg	1,500 mL + 20 mL/kg for each kg >20 kg*

*The maximum total fluid per day is normally 2,400 mL.

By the hourly maintenance-water formula, what is the approximate rate for a stable 25-kg child before individualized adjustment?

A. 25 mL/hr
B. 40 mL/hr
C. 60 mL/hr
D. 65 mL/hr
E. 100 mL/hr

Original table 74.3 | Nelson printed p. 526 | PDF p. 573

Table 74.3 Hourly Maintenance Water Rate

For body weight 0-10 kg: 4 mL/kg/hr
For body weight 10-20 kg: 40 mL/hr + 2 mL/kg/hr × (wt − 10 kg)
For body weight >20 kg: 60 mL/hr + 1 mL/kg/hr × (wt − 20 kg)*

*The maximum fluid rate is normally 100 mL/hr.

A clinician compares crystalloid solutions. Which sodium concentration is listed for 0.9% normal saline?

A. 34 mEq/L
B. 77 mEq/L
C. 130 mEq/L
D. 154 mEq/L
E. 200 mEq/L

Original table 74.4 | Nelson printed p. 527 | PDF p. 574

Table 74.4 Composition of Intravenous Solutions*

FLUID	[NA^+]	[CL^-]	[K^+]	[CA^{2+}]	[$LACTATE^-$]
Normal saline (0.9% NaCl)	154	154	—	—	—
Half-normal saline (0.45% NaCl)	77	77	—	—	—
0.2 normal saline (0.2% NaCl)	34	34	—	—	—
Ringer lactate	130	109	4	3	28

*Electrolyte concentrations in mEq/L.

A child's daily maintenance water losses are estimated in the table. Which route accounts for the largest typical share?

A. Urine
B. Stool
C. Insensible skin and respiratory losses
D. Vomiting
E. Surgical drains

Original table 74.5 | Nelson printed p. 527 | PDF p. 574

Table 74.5 Sources of Water Loss

- Urine: 60%
- Insensible losses: ≈35% (skin and lungs)
- Stool: 5%

A premature infant receives phototherapy under a radiant warmer. Which maintenance-fluid adjustment does the table suggest considering?

A. Increased water needs from skin losses
B. Reduced water needs from complete suppression of insensible loss
C. No adjustment for any neonatal heat source
D. Replace all fluid with blood products
E. Automatically double potassium supplementation

Original table 74.6 | Nelson printed p. 528 | PDF p. 575

Table 74.6 Adjustments in Maintenance Water

SOURCE	CAUSES OF INCREASED WATER NEEDS	CAUSES OF DECREASED WATER NEEDS
Skin	Radiant warmer Phototherapy Fever Sweat Burns	Incubator (premature infant)
Lungs	Tachypnea Tracheostomy	Humidified system (nasal cannula, mask, ventilator)
Gastrointestinal tract	Diarrhea Emesis Nasogastric suction	—
Renal	Polyuria	Oliguria/anuria
Miscellaneous	Surgical drain Third spacing	—

A child remains hospitalized with large ongoing diarrheal stool losses. Which principle in the table addresses losses beyond maintenance and the initial deficit?

A. Measure stool output and replace ongoing losses volume for volume
B. Ignore output once maintenance fluid has begun
C. Replace each stool only with free water
D. Stop all enteral intake indefinitely
E. Assume diarrhea contains no electrolytes

Original table 74.7 | Nelson printed p. 528 | PDF p. 575

Table 74.7 Replacement Fluid for Diarrhea

AVERAGE COMPOSITION OF DIARRHEA
Sodium: 55 mEq/L
Potassium: 25 mEq/L
Bicarbonate: 15 mEq/L
APPROACH TO REPLACEMENT OF ONGOING LOSSES
Solution: D5 1/2NS + 30 mEq/L sodium bicarbonate + 20 mEq/L KCl
Replace stool mL/mL every 1-6 hr

D5, 5% dextrose; NS, normal saline.

A child has high nasogastric drainage after surgery. Which ion in the table is especially abundant in gastric fluid and relevant to replacement planning?

A. Chloride
B. Phosphate
C. Bicarbonate
D. Calcium
E. Magnesium

Original table 74.8 | Nelson printed p. 528 | PDF p. 575

Table 74.8 Replacement Fluid for Emesis or Nasogastric Losses

AVERAGE COMPOSITION OF GASTRIC FLUID
Sodium: 60 mEq/L
Potassium: 10 mEq/L
Chloride: 90 mEq/L
APPROACH TO REPLACEMENT OF ONGOING LOSSES
Solution: normal saline + 10 mEq/L KCl
Replace output mL/mL every 1-6 hr

Source: Nelson Textbook of Pediatrics, 22nd ed., Vol. 1. Answer key follows all questions.

A child with polyuria has large, variable urine output. Which approach from the table most directly guides replacement fluid composition?

A. Measure urine electrolytes and replace measured output accordingly
B. Ignore urine output and give a fixed volume
C. Replace urine only with concentrated glucose
D. Assume urine is pure water
E. Add potassium without checking renal status

Original table 74.9 | Nelson printed p. 528 | PDF p. 575

Table 74.9 Adjusting Fluid Therapy for Altered Renal Output

OLIGURIA/ANURIA
Replacement of insensible fluid losses (25–40% of maintenance) with D5 1/2NS
Replace urine output mL/mL with D5 1/2NS ± KCl
POLYURIA
Replacement of insensible fluid losses (25–40% of maintenance) with D5 1/2NS ± KCl
Measure urine electrolytes
Replace urine output mL/mL with solution based on measured urine electrolytes

D5, 5% dextrose; NS, normal saline.

A child with gastroenteritis is tachycardic, has little urine output, dry mucosa, decreased tears, and delayed capillary refill. Which dehydration category best matches the table?

A. Moderate dehydration
B. No dehydration
C. Stable hypervolemia
D. Isolated fever without fluid deficit
E. Severe dehydration only if unconscious

Original table 75.1 | Nelson printed p. 529 | PDF p. 576

Table 75.1 Clinical Evaluation of Dehydration

Mild dehydration (<5% in an infant; <3% in an older child or adult): Normal or increased pulse; decreased urine output; thirsty; normal physical findings

Moderate dehydration (5–10% in an infant; 3–6% in an older child or adult): Tachycardia; little or no urine output; irritable/lethargic; sunken eyes and fontanel; decreased tears; dry mucous membranes; mild delay in elasticity (skin turgor); delayed capillary refill (>1.5 sec); cool and pale

Severe dehydration (>10% in an infant; >6% in an older child or adult): Peripheral pulses either rapid and weak or absent; decreased blood pressure; no urine output; very sunken eyes and fontanel; no tears; parched mucous membranes; delayed elasticity (poor skin turgor); very delayed capillary refill (>3 sec); cold and mottled; limp, depressed consciousness

A child with clinically significant dehydration needs volume restoration. According to the sequence in the table, what is the first priority?

A. Restore intravascular volume with an isotonic crystalloid
B. Calculate the entire monthly maintenance volume
C. Give free water intravenously
D. Start only oral potassium
E. Defer assessment of perfusion

Original table 75.2 | Nelson printed p. 530 | PDF p. 577

Table 75.2 Fluid Management of Dehydration

1. Restore intravascular volume
   Isotonic fluid (NS or LR): 20 mL/kg over 20 min
   Repeat as needed
2. Calculate 24 hr fluid needs: maintenance + deficit volume
3. Subtract isotonic fluid already administered from 24 hr fluid needs
4. Administer remaining volume over 24 hr using 5% dextrose NS + 20 mEq/L KCl
5. Replace ongoing losses as they occur

LR, Ringer lactate; NS, normal saline.

During treatment of dehydration, which set of measures from the monitoring table helps detect both under-replacement and fluid overload?

A. Weight, fluid balance, vital signs, and serial examination
B. Temperature only once at admission
C. Family history alone
D. Only the initial hemoglobin concentration
E. Only a one-time electrocardiogram

Original table 75.3 | Nelson printed p. 530 | PDF p. 577

Table 75.3 Monitoring Therapy

Vital signs
Pulse
Blood pressure
Intake and output
Fluid balance
Urine output
Physical examination
Weight
Clinical signs of depletion or overload
Electrolytes

A child arrives at emergency triage in cardiac arrest. Which Emergency Severity Index level in the table applies?

A. Level 1
B. Level 2
C. Level 3
D. Level 4
E. Level 5

Original table 78.1 | Nelson printed p. 549 | PDF p. 596

Table 78.1 Definition of Emergency Severity Index for Children

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
Cardiac arrest Respiratory arrest Severe respiratory distress SpO_2 <90 Critically injured and unresponsive trauma patient Severe respiratory distress with agonal or Gasping-type respirations Severe bradycardia or tachycardia with signs of Hypoperfusion Hypotension with signs of hypoperfusion Trauma patient who needs resuscitation Anaphylactic reaction Baby who is flaccid Hypoglycemia with a change in mental status	Seizures Sepsis, severe dehydration Diabetic ketoacidosis Child abuse, burns Head trauma Vitamins/iron or other overdoses/ ingestions Infant less than 28 days of age with a fever of 38°C (100.4°F) or greater 1-3 mo of age with a fever of 38°C (100.4°F) or greater may be considered up to II Vital signs not stable	Multiple resources needed 3 mo to 3 yr of age T >39°C (102.2°F)	Single resource needed	Only history, physical exam required

From Wang L, Zhou H, Zhu JF. Application of emergency severity index in pediatric emergency department. *World J Emerg Med*. 2011;2(4):279-282, Table 1, p. 280.

A young child is sitting forward, drooling, and in respiratory distress. Which action is supported by the listed emergency red flags?

A. Immediate intervention and emergency transfer
B. Routine review at the next annual visit
C. Give food to test swallowing
D. Leave the child unobserved
E. Treat as a benign feeding preference

Original table 78.2 | Nelson printed p. 550 | PDF p. 597

Table 78.2 History and Examination Findings that Should Prompt Immediate Intervention and/or Transfer to Emergency Department

HISTORY AND EXAM FINDINGS	RISK FACTORS
RED FLAGS FOR RESPIRATORY FAILURE	
Tachycardia Tachypnea Cyanosis Apnea Brief resolved unexplained event (BRUE) with cyanosis or change in tone Suspected button-battery ingestion Foreign body aspiration with respiratory distress Sitting up, leaning forward, drooling Respiratory distress with hypoxemia Altered mental status	Tracheostomy Ventilator dependence History of critical airway
RED FLAGS FOR CIRCULATORY FAILURE	
Tachycardia Tachypnea Cyanosis Cold extremities, poor pulses Apnea Petechial or purpuric rashes Erythroderma Peritonitis Bilious emesis Post-tonsillectomy or post-adenoidectomy with bleeding Extremity trauma with neurovascular deficits	Oncology (or other immunosuppressed) patients Bone marrow or solid organ transplants Sickle cell (or otherwise asplenic) patients Infants <60 days old Unrepaired or repaired congenital heart disease with change from baseline pulse oximetry Bleeding disorder with trauma
RED FLAGS FOR NEUROLOGIC FAILURE	
Tachycardia Bradycardia-hypertension Double vision Ptosis Unequal pupils Apnea Frequent or prolonged seizure(s) Focal neurologic deficit(s) Acute onset of severe headache Suicidal or homicidal ideation Psychosis	Ventriculoperitoneal shunt Diabetes or metabolic disease with altered mental status Hypoxic-ischemic encephalopathy Clotting disorder with neurologic change(s) Drug ingestion

Adapted from Farah MM, Tay Y, Lavelle J. A general approach to ill and injured

A healthy adolescent is awake and resting with a heart rate of 80/min. Which interpretation is closest to the table's age-based range?

A. Within the adolescent resting range
B. Typical only for a premature infant
C. Always pathologic bradycardia
D. A sign of cardiac arrest
E. Above the adolescent maximum

Original table 79.1 | Nelson printed p. 555 | PDF p. 602

Table 79.1 Normal Vital Signs According to Age

AGE	HEART RATE (beats/min)	BLOOD PRESSURE† (mm Hg)	RESPIRATORY RATE+ (breaths/min)
Premature	120-205*	60-76/31-45	40-70
Neonate	100-205*	67-84/35-53	35-55
Infant	100-180	72-104/37-56	30-53
Toddler	98-140	86-106/42-63	22-37
Preschooler	80-120	89-112/46-72	20-29
School-age child	75-118	97-120/57-80	18-25
Adolescent	60-100	110-131/64-83	12-20

*In sleep, heart rates may be significantly lower, but if perfusion is maintained, no intervention is required.
†A blood pressure cuff should cover approximately two-thirds of the arm; too small a

An injured child opens the eyes and responds only when their name is called loudly. Which AVPU category applies?

A. Alert
B. Voice
C. Pain
D. Unresponsive
E. Not assessable

Original table 79.2 | Nelson printed p. 555 | PDF p. 602

Table 79.2 AVPU Neurologic Assessment

A	The child is awake, alert, and appropriately responsive to caregivers and stimuli.
V	The child responds only to voice such as calling the child's name or speaking loudly.
P	The child responds only to painful stimuli, such as sternal rub or pinching the trapezius.
U	The child is unresponsive to all stimuli.

A, Alert; V, verbal; P, pain; U, unresponsive.
From Ralston M, Hazinski MF, Zaritsky AL, et al., eds. *Pediatric Advanced Life Support Course Guide and PALS Provider Manual*. Dallas: American Heart

A 10-month-old opens the eyes spontaneously and babbles normally for age during neurologic assessment. Which scoring domains in the modified pediatric Glasgow Coma Scale are illustrated?

A. Eye 4 and verbal 5
B. Eye 1 and verbal 1
C. Eye 2 and verbal 3
D. Eye 3 and verbal 2
E. Eye 4 and verbal 1

Original table 79.3 | Nelson printed p. 555 | PDF p. 602

Table 79.3 Modified Pediatric Glasgow Coma Scale

≥2 YEARS		<2 YEARS	
EYE OPENING			
Spontaneous	4	Spontaneous	4
To sound	3	To sound	3
To pressure	2	To pressure	2
None	1	None	1
VERBAL RESPONSE			
Oriented; words/phrases normal for chronological age	5	Babbles, coos; words/phrases normal for chronological age	5
Confused; some words/phrases not normal for chronological age	4	Some words/phrases not normal for chronological age	4
Words	3	Inconsolable crying	3
Sounds	2	Sounds	2
None	1	None	1
MOTOR RESPONSE			
Obeys commands	6	Normal spontaneous movement	6
Localizes pain	5	Rapidly withdraws extremity to stimulation	5
Normal flexion	4	Normal flexion	4
Abnormal flexion	3	Abnormal flexion	3
Extension	2	Extension	2
None	1	None	1

Adapted from Kirschen MP, Snyder M, Smith K, et al. Inter-rater reliability between critical care nurses performing a pediatric modification to the Glasgow Coma Scale.

An obtunded adolescent has bilateral pinpoint pupils after a suspected exposure. Which listed class is associated with this pupillary pattern?

A. Opioids
B. Anticholinergics
C. Sympathomimetics
D. Third-nerve compression
E. Serotonin syndrome

Original table 79.4 | Nelson printed p. 556 | PDF p. 603

Table 79.4 Pupillary Responses

DILATED (MYDRIASIS)	PINPOINT (MIOSIS)
Bilateral Anticholinergic agents (systemic, topical) Sympathomimetic agents Serotonin syndrome Botulism Brain death (fixed, nonreactive usually midposition)	Bilateral Opiates Organophosphates Barbiturates Pontine lesions
Unilateral Third nerve compression with uncal herniation	**Unilateral** Horner syndrome

A child arrests after massive hemorrhage. Which potentially reversible cause in the cardiac-arrest table should be addressed?

A. Hypovolemia
B. Hyperthyroidism alone
C. Chronic language delay
D. Simple myopia
E. Isolated eczema

Original table 79.6 | Nelson printed p. 567 | PDF p. 614

Table 79.6 Potentially Reversible Causes of Cardiac Arrest

CONDITION	COMMON CLINICAL SETTINGS	TREATMENT
THE H'S		
Hypovolemia	Dehydration, hemorrhage, major burns, diabetes, gastrointestinal losses, shock, and trauma	Administer fluids For hemorrhage, administer packed red blood cells and other blood products
Hypoxemia	Upper airway obstruction (croup, anaphylaxis, foreign body) Lower airway obstruction (asthma, bronchiolitis) Parenchymal lung disease (pneumonia) Restrictive lung disease (pleural effusion)	Provide supplemental oxygen Confirm endotracheal tube placement and chest rise
Hydrogen ion (acidosis)	Preexisting acidosis, diabetes, diarrhea, drugs and toxins, prolonged resuscitation, renal disease, and shock	Reassess the adequacy of cardiopulmonary resuscitation, oxygenation, and ventilation; reconfirm endotracheal tube placement Ensure adequate ventilation and avoid concomitant respiratory acidosis Administer IV fluids May consider bicarbonate administration with documented severe acidosis
Hypoglycemia	Starvation, toxin, diabetes medications, metabolic disease	Administer dextrose (glucagon if dextrose not available) Discontinue causative medications
Hyperkalemia	Metabolic acidosis, excessive administration of potassium, renal failure, drugs and toxins, vigorous exercise, hemolysis, rhabdomyolysis, tumor lysis syndrome, and clinically significant tissue injury	Stop potassium-containing fluids Stabilize cardiac membrane: calcium Treat acidosis: sodium bicarbonate Shift potassium intracellularly: sodium bicarbonate, insulin (with glucose to prevent hypoglycemia), and albuterol Promote potassium excretion: loop diuretics, Kayexalate Removal of potassium: dialysis
Hypokalemia	Diabetes, diuretic use, drugs and toxins, profound gastrointestinal losses	If profound hypokalemia is accompanied by cardiac arrest, initiate urgent IV potassium replacement
Hypothermia	Alcohol abuse, burns, central nervous system disease, debilitated patient, drowning, drugs and toxins, endocrine disease, history of exposure, homelessness, extensive skin disease, spinal cord disease, and trauma	If hypothermia is severe (temperature <30°C [86°F]), defibrillation may be ineffective; initiate active internal rewarming with cardiopulmonary support; can consider extracorporeal rewarming If hypothermia is moderate (temperature 30-34°C [86-93.2°F]), actively rewarm during CPR
THE T'S		
Tension pneumothorax	Procedural complication, mechanical ventilation complication, pulmonary disease with "air leak" (including asthma, chronic obstructive pulmonary disease, and necrotizing pneumonia), thoracentesis, and trauma	Needle decompression followed by chest tube insertion or primary chest tube insertion
Cardiac tamponade	Hemorrhage, malignancy, pericarditis, trauma, cardiac surgery, post–myocardial infarction	Administer fluids to increase cardiac preload (temporizing only); obtain bedside echocardiogram, if available Perform pericardiocentesis; immediate surgical intervention is appropriate if pericardiocentesis is unhelpful but cardiac tamponade is known or highly suspected
Toxins	Alcohol abuse, behavioral or metabolic presentation, classic toxicologic syndrome, psychiatric disease, depressed mental status of unclear etiology, medications in the home, history of depression/suicidality	Supportive care and toxin-directed therapies in consultation with a toxicologist
Thrombosis, pulmonary	Hospitalized patient, recent surgical procedure, peripartum, known risk factors for venous thromboembolism, history of venous thromboembolism, or prearrest presentation consistent with a diagnosis of acute pulmonary embolism, recent immobility or fractures	Administer fluids; augment with vasoactive medications as necessary Consider pulmonary vasodilators (e.g., inhaled nitric oxide) Consider systemic or site-directed thrombolytic therapy Consider mechanical thrombectomy Consider ECMO
Thrombosis, coronary	Known risk factors for myocardial infarction (congenital heart disease, family history of sudden cardiac death)	Consider fibrinolytic therapy Consider percutaneous coronary intervention

Adapted from Kleinman ME, Chameides L, Schexnayder SM, et al. Part 14: Pediatric advanced life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2010;122(18 Suppl 3):S876-S908.

After chest trauma, a child has unilateral diminished breath sounds, hyperresonance to percussion, tracheal deviation, and distended neck veins. Which injury best matches the comparison table?

A. Tension pneumothorax
B. Massive hemothorax
C. Cardiac tamponade
D. Uncomplicated rib contusion
E. Isolated pericarditis

Original table 80.2 | Nelson printed p. 574 | PDF p. 621

Table 80.2 Differential Diagnosis of Immediately Life-Threatening Cardiopulmonary Injuries

	TENSION PNEUMOTHORAX	MASSIVE HEMOTHORAX	CARDIAC TAMPONADE
Breath sounds	Ipsilaterally decreased more than contralaterally	Ipsilaterally decreased	Normal
Percussion note	Hyperresonant	Dull	Normal
Tracheal location	Contralaterally shifted	Midline or shifted	Midline
Neck veins	Distended	Flat	Distended
Heart tones	Normal	Normal	Muffled

Modified from Cooper A, Foltin GL. Thoracic trauma. In: Barkin RM, ed. *Pediatric Emergency Medicine*, 2nd ed. St Louis: Mosby; 1997:325.

A trauma patient develops unilateral absent breath sounds and signs of obstructed venous return after a one-way air leak. Which life-threatening chest injury is described?

A. Tension pneumothorax
B. Simple pulmonary contusion
C. Isolated sternal fracture
D. Nontraumatic asthma
E. Minor chest-wall bruising

Original table 80.3 | Nelson printed p. 574 | PDF p. 621

Table 80.3 Life-Threatening Chest Injuries

TENSION PNEUMOTHORAX

One-way valve leak from the lung parenchyma or tracheobronchial tree
Lung collapse with mediastinal and tracheal shift to the side opposite the leak
Compromises venous return and decreases ventilation of the other lung
Clinically, manifests as respiratory distress, unilateral absence of breath sounds, tracheal deviation, distended neck veins, tympany to percussion of the involved side, and cyanosis
Relieve first with needle aspiration, then with chest tube drainage

OPEN PNEUMOTHORAX (SUCKING CHEST WOUND)

Effect on ventilation depends on size

MAJOR FLAIL CHEST

Usually caused by blunt injury resulting in multiple rib fractures
Loss of bone stability of the thoracic cage
Major disruption of synchronous chest wall motion
Mechanical ventilation and positive end-expiratory pressure required

MASSIVE HEMOTHORAX

Must be drained with a large-bore tube
Initiate drainage only with concurrent vascular volume replacement

CARDIAC TAMPONADE

Beck's triad:

1. Decreased or muffled heart sounds
2. Jugular venous distention
3. Hypotension (with narrow pulse pressure)

Must be drained

Modified from Krug SE. The acutely ill or injured child. In: Behrman RE, Kliegman RM, eds. *Nelson Essentials of Pediatrics*, 4th ed. Philadelphia: Saunders; 2002:97.

A child with traumatic hemorrhage has a rapid heart rate and weak peripheral pulses but a normal systolic blood pressure. Which concept from the systemic-response table explains why this is still concerning?

A. Blood pressure can remain normal in early blood loss
B. Normal pressure excludes significant hemorrhage
C. Bradycardia is always the first blood-loss response
D. Peripheral perfusion never changes during hemorrhage
E. Blood loss always raises pulse pressure

Original table 80.4 | Nelson printed p. 575 | PDF p. 622

Table 80.4 Systemic Responses to Blood Loss in Pediatric Patients

SYSTEM	MILD BLOOD LOSS (<30%)	MODERATE BLOOD LOSS (30–45%)	SEVERE BLOOD LOSS (>45%)
Cardiovascular	Increased heart rate; weak, thready peripheral pulses; normal systolic blood pressure; normal pulse pressure	Markedly increased heart rate; weak, thready central pulses; peripheral pulses absent; low normal systolic blood pressure; narrowed pulse pressure	Tachycardia followed by bradycardia; central pulses very weak or absent; peripheral pulses absent; hypotension; narrowed pulse pressure (or undetectable diastolic blood pressure)
Central nervous	Anxiety; irritability; confusion	Lethargy; dulled response to pain	Coma
Skin	Cool, mottled; capillary refill prolonged	Cyanotic; capillary refill markedly prolonged	Pale and cold
Urine output	Low to very low	Minimal	None

Adapted from American College of Surgeons Committee on Trauma. *Advanced Trauma Life Support: Student Course Manual*, 10th ed. Chicago: American College of Surgeons; 2018:196.

An alert adolescent has neck pain after blunt trauma but no neurologic deficit. Which finding in the NEXUS table prevents low-risk clinical clearance?

A. Midline cervical tenderness
B. Normal alertness
C. No intoxication
D. No distracting injury
E. Normal motor function

Original table 80.5 | Nelson printed p. 576 | PDF p. 623

Table 80.5 National Emergency X-Radiography Utilization Study (NEXUS) to Rule Out Cervical Spine Injury After Blunt Trauma

*If **NONE** of the following is present, the patient is at very low risk for clinically significant cervical spine injury:*

Midline cervical tenderness
Evidence of intoxication
Altered level of alertness
Focal neurologic deficit
Distracting painful injury

Data from Hoffman JR, Mower WR, Wolfson AB, et al. Validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunt trauma. *N Engl J Med*.

After thoracic trauma, a child has ongoing massive air leakage through a chest drain and the lung cannot be expanded for ventilation. Which management category is listed?

A. Early operative thoracic evaluation
B. Routine outpatient review only
C. Immediate discharge
D. Observation without respiratory support
E. Elective dental consultation

Original table 80.6 | Nelson printed p. 577 | PDF p. 624

Table 80.6 Indications for Operation in Thoracic Trauma

THORACOTOMY IMMEDIATELY OR SHORTLY AFTER INJURY

Massive continuing pneumothorax or large air leak from tracheobronchial injury (cannot expand lung and ventilate)
Cardiac tamponade
Open pneumothorax
Esophageal injury
Aortic or other vascular injury
Acute rupture of the diaphragm

DELAYED THORACOTOMY OR THORACOSCOPY

Chronic rupture of the diaphragm
Clotted hemothorax
Persistent chylothorax
Traumatic intracardiac defects
Evacuation of large foreign bodies
Chronic atelectasis from traumatic bronchial stenosis

Modified from O'Neill JA Jr. *Principles of Pediatric Surgery,* 2nd ed. St Louis: Mosby; 2003:157.

A 13-month-old has blunt head trauma and a palpable skull fracture. Which statement follows the low-risk prediction-rule table?

A. The child does not meet the very-low-risk criteria
B. The fracture is irrelevant below age 2
C. Head imaging is prohibited in every case
D. A brief history alone proves no brain injury
E. Only vomiting matters in this age band

Original table 80.7 | Nelson printed p. 578 | PDF p. 625

Table 80.7 Prediction Rule for Identification of Children at Very Low Risk of Clinically Important Brain Injuries After Head Trauma

*Children <2 yr old are at very low risk of clinically important traumatic brain injury if they have **NONE** of the following:*

- Severe mechanism of injury
- History of LOC >5 sec
- GCS ≤14 or other signs of altered mental status
- Not acting normally per parent
- Palpable skull fracture
- Occipital/parietal/temporal scalp hematoma

*Children 2-18 yr old are at very low risk of clinically important traumatic brain injury if they have **NONE** of the following:*

- Severe mechanism of injury
- History of LOC
- History of vomiting
- GCS ≤14 or other signs of altered mental status
- Severe headache in the ED
- Signs of basilar skull fracture

LOC, Loss of consciousness; GCS, Glasgow Coma Scale score; ED, emergency department.

A child struck in a motor-vehicle collision has a seatbelt mark across the abdomen. Under the table's blunt-trauma prediction rule, what does this finding mean?

A. The very-low-risk intraabdominal-injury rule is not met
B. Intraabdominal injury is definitively absent
C. The abdomen need not be examined
D. Seatbelt marks apply only to head trauma
E. Only a chest radiograph is indicated

Original table 80.8 | Nelson printed p. 578 | PDF p. 625

Table 80.8 Prediction Rule for Identification of Children at Very Low Risk of Clinically Important Intraabdominal Injuries After Blunt Trauma

*If **NONE** of the following is present, the patient is at very low risk for clinically significant intraabdominal injury:*

Glasgow Coma Scale score <14
Vomiting
Evidence of thoracic wall trauma
Decreased breath sounds
Evidence of abdominal wall trauma or seatbelt sign
Abdominal pain
Abdominal tenderness

Modified from Holmes JF, Lillis K, Monroe D, et al. Identifying children at very low risk of clinically important blunt abdominal injuries. *Ann Emerg Med*. 2013;62:107-116, e2.

A child with trisomy 21 is assessed after a fall. Which anatomic vulnerability in the table raises particular concern during cervical-spine evaluation?

A. Abnormal cervical-spine development
B. Isolated lumbar spondylosis
C. Congenital tooth eruption
D. Primary cortical blindness
E. Hypermobile spleen

Original table 81.1 | Nelson printed p. 579 | PDF p. 626

Table 81.1 Conditions that Predispose Patients to a Cervical Spine Injury

CATEGORY	CONDITIONS
Abnormal development of the cervical spine	Trisomy 21 Larsen syndrome Mucopolysaccharidosis IV/Morquio syndrome Klippel-Feil syndrome Achondroplasia Chiari malformation Syringomyelia
Abnormal bone and soft tissue	Marfan syndrome Ehlers-Danlos syndrome Osteogenesis imperfecta
Arthritis	Ankylosing spondylitis Rheumatoid arthritis
History of cervical spine injury or surgery	

Modified from McCollum M, Guse S. Neck trauma: Cervical spine, seatbelt sign and penetrating palate injuries. *Emerg Med Clin N Am*. 2021;39:573-588, Table 1, p. 574.

After a collision, a child remains with persistent neck pain and a focal hand sensory change. Which disposition concerning clinical cervical-spine clearance follows the table?

A. Do not clear clinically on examination alone
B. Clear because the child is talking
C. Ignore sensory findings if a parent is present
D. Remove all precautions without evaluation
E. Only look for abdominal tenderness

Original table 81.2 | Nelson printed p. 580 | PDF p. 627

Table 81.2 Risk Factors that Preclude Clinical Clearance of the C-Spine

HISTORY	PHYSICAL EXAMINATION
Child or parent reports persistent neck pain, abnormal head posture, or difficulty with neck movement	Visible known substantial injury to chest, abdomen, or pelvis (injury that is life-threatening, warrants surgical intervention or inpatient admission)
History of focal sensory abnormality or motor deficit	GCS of <14
High-risk injury*	Torticollis/abnormal head position
	Posterior midline neck tenderness
	Limited cervical range of motion
	Inability to maintain focus due to other injuries

*Diving, high speed motor vehicle crash, bike crash, motorized all-terrain vehicle.
GCS, Glasgow Coma Scale.

An injured child has neck pain radiating along one arm with focal weakness in a root distribution but no diffuse long-tract signs. Which localization best fits the comparison table?

A. Radiculopathy
B. Myelopathy
C. Generalized peripheral polyneuropathy
D. Isolated cortical aphasia
E. Primary syncope

Original table 81.3 | Nelson printed p. 581 | PDF p. 628

Table 81.3 History and Examination Features Allowing for Discrimination of Myelopathy, Radiculopathy, and Peripheral Neuropathy

FINDING	PERIPHERAL NEUROPATHY	RADICULOPATHY	MYELOPATHY
Pain • Quality • Location	"Electric" Radiates either proximally or distally from injury site	Sharp, aching Radiates distally from the neck	Typically painless
Weakness	Variable, usually present	Variable, usually present	Variable, may be present
Sensory loss	Sharply demarcated borders	Indistinct borders	Indistinct borders, typically extends beyond single extremity
Tone/reflexes	Decreased	Decreased	Increased

From Jea A, Belal A, Zaazoue MA, Martin J. Cervical spine injury in children and adolescents. *Pediatr Clin N Am*. 2021;68:875-894, Table 4, p. 883.

A comatose adolescent opens the eyes to voice, makes incomprehensible sounds, and withdraws from pain. Which assessment framework in the table records eye, verbal, and motor responses separately?

A. Glasgow Coma Scale
B. BMI z score
C. APGAR score at 5 minutes
D. Phoenix sepsis score only
E. NEXUS criterion count

Original table 82.1 | Nelson printed p. 583 | PDF p. 630

Table 82.1 Commonly Used Coma Scores

GLASGOW COMA SCALE

Eye Opening
1 = does not open eyes
2 = opens eyes in response to noxious stimuli
3 = opens eyes in response to voice
4 = opens eyes spontaneously

Verbal Output
1 = makes no sounds
2 = makes incomprehensible sounds
3 = utters inappropriate words
4 = confused and disoriented
5 = speaks normally and oriented

Motor Response (Best)
1 = makes no movements
2 = extension to painful stimuli
3 = abnormal flexion to painful stimuli
4 = flexion/withdrawal to painful stimuli
5 = localized to painful stimuli
6 = obeys commands

FULL OUTLINE OF UNRESPONSIVENESS (FOUR) SCORE

Eye Response
4 = eyelids open or opened, tracking, or blinking to command
3 = eyelids open but not tracking
2 = eyelids closed but open to loud voice
1 = eyelids closed but open to pain
0 = eyelids remain closed with pain

Motor Response
4 = thumbs-up, fist, or peace sign
3 = localizing to pain
2 = flexion response to pain
1 = extension response to pain
0 = no response to pain or generalized myoclonus status

Brainstem Reflexes
4 = pupil and corneal reflexes present
3 = one pupil wide and fixed
2 = pupil or corneal reflexes absent
1 = pupil and corneal reflexes absent
0 = absent pupil, corneal, and cough reflex

Respiration
4 = not intubated, regular breathing pattern
3 = not intubated, Cheyne-Stokes breathing pattern
2 = not intubated, irregular breathing
1 = breathes above ventilatory rate
0 = breathes at ventilator rate or apnea

From Edlow JA, Rabinstein A, Traub SJ, Wijdicks EFM. Diagnosis of reversible causes of coma. *Lancet*. 2014;384:2064-2076.

During a formal pediatric brain-death evaluation, a clinician assesses pupillary responses and other brainstem reflexes. Which additional clinical domain in the table must be addressed?

A. Deep coma with absent meaningful responses
B. School grades in the prior year
C. A normal speech-language test
D. Dental eruption
E. A family history of migraine

Original table 83.1 | Nelson printed p. 2 | PDF p. 638

Table 83.1 | Neurologic Examination to Evaluate a Patient for Brain Death

EXAM COMPONENT	HOW TO PERFORM	RESPONSE CONSISTENT WITH BRAIN DEATH
Coma	Visual response: blink to visual threat Auditory response: clapping and yelling the child's name loudly Tactile response: apply deep pressure to the condyles at the level of the temporomandibular joints, the supraorbital notch bilaterally, the sternum, and all four extremities proximally and distally	No response to visual or auditory stimuli; noxious stimuli do not produce grimacing, facial or body muscle movement, or any motor response other than spinally mediated reflexes
Pupillary light reflex (CNs II and III)	Shine a bright light into each eye while closely observing pupillary size and reactivity	Absence of ipsilateral and contralateral pupillary response, with pupils fixed in a midsize or dilated position (4-6 mm) in both eyes
Corneal reflex (CNs III, V, VII)	Touch the cornea of each eye with a cotton swab at the external border of the iris, applying light pressure and observing for any eyelid movement	Absence of eyelid movement
Oculocephalic reflex (CNs III, VI, and VIII)	Confirm integrity of the cervical spine. Secure the endotracheal tube to prevent dislodgement; briskly rotate the head horizontally to both sides and observe for movement of the eyes	Absence of movement of the eyes relative to head movement; eyes follow the head movement, staying in mid-position
Oculovestibular reflex (CNs III, IV, VI, and VIII)	Irrigate the ear canal with 50-60 mL of ice water for at least 60 sec while observing for eye movement; test each side separately and with a 5-min interval in between	Absence of eye movement
Gag and cough reflex (CNs IX and X)	Touch the posterior pharynx with a tongue depressor or a rigid suction catheter to stimulate a gag; touch the tracheobronchial wall at the level of the carina with placement of a suction catheter through the endotracheal tube to stimulate a cough	Absence of both cough and gag
Sucking and rooting reflexes	Place a gloved finger inside the baby's mouth to stimulate sucking; stroke the external surface of both cheeks and corners of the mouth to stimulate rooting	Absence of sucking and rooting

CN, Cranial nerve.

A child undergoing formal brain-death determination cannot complete a required clinical component because of a confounder. How should an ancillary-test choice be viewed according to the table?

A. Select an accepted test while accounting for test limitations and confounders
B. Treat every blood-flow modality as interchangeable
C. Use a normal CT as proof of brain death
D. Skip documented prerequisites
E. Replace the clinical examination with a screening questionnaire

Original table 83.2 | Nelson printed p. 2 | PDF p. 638

Table 83.2 Ancillary Tests for Determining Brain Death

TEST	CONFOUNDER/LIMITATION*	SENSITIVITY/ SPECIFICITY
BRAIN BLOOD FLOW		
Computed tomography angiography	Requires transport to the scanner Image variability based on injection technique Potential to miss a slow flow state Risk of nephrotoxicity Not recommended by AAN 2023 Guidelines[#]	52–97% / 100%
Digital subtraction angiography[†]	Requires transport to angiography suite Risk of nephrotoxicity Image variability based on injection technique	100% / 100%
Magnetic resonance angiography	Requires transport to the scanner Image variability based on injection technique	93–100% / 100%
Radionuclide angiography[†]	Limited evaluation of brainstem	99% / 56%
Radionuclide scintigraphy[†]	Requires transport to the scanner Planar imaging may have limited evaluation of brainstem	Planar: 78% / 100% SPECT: 88% / 100%
Transcranial Doppler ultrasonography[†]	Potential for technical difficulties in performance Potential for lack of windows	90% / 98%
ELECTROPHYSIOLOGIC FUNCTION		
Electroencephalography	Risk of environmental artifact Confounded by sedation, hypothermia and toxic-metabolic derangements Predominantly provides information about cortical function	53–80% / 97%
Evoked potentials-auditory	Can be absent in comatose patients with other intact brainstem reflexes Confounded by sedation, hypothermia, isolated eighth nerve and brainstem lesions Only evaluates auditory pathways Performance/interpretation may be limited by experience	NA / NA
Evoked potentials-somatosensory	Can be absent in comatose patients with ongoing brain function Confounded by cervical spine injury, isolated brainstem lesions, sedation, and hypothermia Only evaluates somatosensory pathways Performance/interpretation may be limited by experience	100% / 78%
Evoked potentials-visual	Can be absent in comatose patients with ongoing brain function Confounded by sedation, retinal or optic nerve lesions Only evaluates visual pathways Performance/interpretation may be limited by experience	NA / NA

*Performance/interpretation of all ancillary tests may be limited by experience
[†]Accepted by the World Brain Death Project (WBDP).

A teenager faints immediately after a painful needle stick and quickly recovers. Which noncardiac category in the table best fits?

A. Reflex vasodepressor syncope
B. Primary ventricular tachycardia
C. Cardiac tamponade
D. Aortic stenosis
E. Acute stroke

Original table 84.1 | Nelson printed p. 593 | PDF p. 640

Table 84.1 Noncardiac Causes of Syncope

REFLEX VASODEPRESSOR SYNCOPE	**CENTRAL NERVOUS SYSTEM**
Neurocardiogenic (vasovagal)	Seizure (atonic, absence, myoclonic-astatic)
Emotion (seeing blood)	Hyperekplexia
Pain (needle phobia)	Stroke, transient ischemic attack
Reflex asystolic syncope (pallid breath-holding)	Friedreich ataxia
MISCELLANEOUS SITUATIONAL REFLEX	Subarachnoid hemorrhage
Tussive	**OTHER NEUROLOGIC**
Sneeze	Dysautonomia
Exercise, after exercise	Myotonic dystrophy
Swallowing	Kearns-Sayre syndrome
Stretching	Congenital myasthenia gravis
Defecation	Basilar artery migraine
Micturition	Arnold Chiari malformation
Hair grooming	**DRUG EFFECTS**
Valsalva (increased intrathoracic pressure)	β-Blocking agents
Trumpet playing	Vasodilating agents
Weightlifting	Opiates
Breath-holding spells (cyanotic)	Sedatives
SYSTEMIC ILLNESS	Diuretics
Hypoglycemia	Anticonvulsant agents
Anemia	Antihistamines
Infection	Antidepressant agents
Hypovolemia, dehydration	Anxiolytic agents
Adrenal insufficiency	Drugs of abuse
Narcolepsy, cataplexy	Insulin, oral hypoglycemic agents
Pulmonary embolism	Carbon monoxide
Pheochromocytoma	**OTHER ETIOLOGIES**
Mastocytosis	Carotid sinus sensitivity
Ruptured ectopic pregnancy	Subclavian steal
	Panic attack, anxiety
	Conversion disorder

A child briefly loses consciousness after standing in a hot room; the child becomes pale and sweaty and awakens quickly without prolonged confusion. Which event is favored by the comparison table?

A. Syncope
B. Generalized tonic-clonic seizure
C. Psychotic episode
D. Narcolepsy with cataplexy
E. Delirium

Original table 84.2 | Nelson printed p. 593 | PDF p. 640

Table 84.2 Comparison of Clinical Features of Syncope and Seizures

FEATURES	SYNCOPE	SEIZURES
Relation to posture	Common	No
Time of day	Diurnal	Diurnal or nocturnal
Precipitating factors	Emotion, injury, pain, crowds, heat, exercise, fear, dehydration, coughing, micturition, venipuncture, prolonged standing	Sleep loss, drug/alcohol withdrawal, illness, medication nonadherence
Skin color	Pallor	Cyanosis or normal
Diaphoresis	Common	Rare
Aura or premonitory symptoms	Often minutes or longer, but can be very brief	Brief
Convulsion	Rare	Common
Other abnormal movements	Minor irregular twitching	Rhythmic jerks
Injury	Rare	Common (with convulsive seizures)
Urinary incontinence	Rare	Common
Tongue biting	No	Common with convulsive seizures
Postictal confusion	Rare	Common
Postictal headache	No	Common
Focal neurologic signs	No	Occasional
Cardiovascular signs	Common to have low blood pressure and heart rate during event; cardiovascular exam may be completely normal after event unless there is an underlying cardiac disorder	Rare
Abnormal findings on EEG	Rare (generalized slowing may occur during the event)	Common

From Winkel D, Cassimatis D. Episodic impairment of consciousness. In: Jankovic JM, Mazziotta JC, Pomeroy SL, Newman NJ, eds. *Bradley and Daroff's Neurology in Clinical Practice*, 8th ed. Philadelphia: Elsevier; 2021.

A child says “the room is spinning” while remaining fully conscious. Which symptom category in the table best describes this?

A. Vertigo
B. Presyncope
C. Disequilibrium
D. Lightheadedness
E. Syncope

Original table 84.3 | Nelson printed p. 594 | PDF p. 641

Table 84.3 Syncope and Dizziness

	VERTIGO	PRESYNCOPE	DISEQUILIBRIUM	LIGHTHEADEDNESS
Patient complaint	“My head is spinning.” “The room is whirling.”	“I feel I might pass out.” “I feel faint.” “I feel like blacking out.”	“I feel unsteady.” “My balance is off.”	“I feel dizzy.” “I feel disconnected, drugged.”
Associated features	Motion, swaying, spinning, nystagmus	Syncope: loss of postural tone, brief loss of consciousness Situational	Poor balance No vertigo or ataxia	Anxiety, hyperventilation, paresthesias, respiratory alkalosis, panic attacks
Usual cause	Vestibular disorders	Impaired cerebral perfusion	Sensory and/or central neurologic dysfunction	Decreased venous return
Key differential diagnoses	Peripheral (labyrinthine-cochlear) vs central neurologic disorder	Neurocardiogenic (vagal) vs cardiac syncope vs neuropsychiatric syncope	Sensory deficit vs central neurologic disease	Anxiety/depression vs hyperventilation vs medication effects

Adapted from Cohen G. Syncope and dizziness. In: Kliegman RM, Lye PS, Bordini BJ, et al., eds. *Nelson Pediatric Symptom-Based Diagnosis*; 2018: Table 6.1, p. 84.

A teen faints while running and reports a family history of sudden cardiac death. Which potentially fatal category listed in the table requires evaluation?

A. Inherited cardiac arrhythmia
B. Habitual motion sickness
C. Simple fear of needles alone
D. Primary constipation
E. Normal pubertal growth

Original table 84.4 | Nelson printed p. 594 | PDF p. 641

Table 84.4 Causes of Cardiovascular Syncope: Potentially Fat

ARRHYTHMIAS

Bradyarrhythmias

1. Sinus node dysfunction (especially in patients with congenital heart defects)
2. Atrioventricular block (congenital or acquired; Lyme, Fabry, Chagas diseases)
3. Kearns-Sayre syndrome
4. Pacemaker malfunction

Tachyarrhythmias

1. Supraventricular
   a. Wolff-Parkinson-White syndrome
   b. Supraventricular tachycardia/atrial arrhythmias (especially in patients with congenital heart defects)
2. Ventricular: ventricular tachycardia/torsades/ventricular fibrillation
   a. Channelopathies
      - Long QT syndromes
      - Catecholaminergic polymorphic ventricular tachycardia
      - Brugada syndrome
      - Short QT syndrome
   b. Drug induced
   c. Idiopathic
      - Ventricular fibrillation
      - Ventricular tachycardia from outflow tract

From MacNeill E, Vashist S. Approach to syncope and altered mental status. *Pediatr Clin N*

An adolescent with congenital sensorineural deafness has syncope and a prolonged QT interval. Which electrical disorder variant in the table matches this combination?

A. Jervell-Lange-Nielsen syndrome
B. Romano-Ward syndrome with normal hearing
C. Typical AV nodal reentrant tachycardia
D. Isolated vasovagal syncope
E. Sinus arrhythmia

Original table 84.5 | Nelson printed p. 595 | PDF p. 642

Table 84.5 Primary Electrical Abnormalities: Features, ECG, and Treatment

PRIMARY ELECTRICAL ABNORMALITIES	FEATURES	ECG	TREATMENT
LQTS: Romano-Ward, Jervell–Lange-Nielsen, acquired	• Familial genetic or acquired disorders • Ion channel pathologic gene variant (~17 genes)* • Presents in torsades de pointes • Romano-Ward is most common inherited • LQTS Jervell–Lange-Nielsen has congenital deafness	• Prolonged QT measured from the onset of the Q wave to the end of the T wave in lead II • Varies with HR but >0.44 in men, >0.46 in children and women for HR 50-90 beats/min is prolonged • Torsades de pointes can occur • Can deteriorate from polymorphic ventricular tachycardia to ventricular fibrillation	• β-Blocker therapy • Recommendations on exercise intensity by a cardiologist • ICD if β blockers fail
Brugada syndrome	• Inherited autosomal dominant arrhythmogenic syndrome characterized by life-threatening ventricular arrhythmias • Pathologic gene variant in *SCN5A* and 13 other genes	• ECG abnormalities are from repolarization and depolarization abnormalities • Coved-type ST-segment elevations in the right precordial leads • J wave amplitude ≥2 mm followed by a negative T wave	• Placement of ICD
Wolff-Parkinson-White	• Owing to one or more reentrant pathways inducing SVT or atrial fibrillation • Up to 14% associated with malignant tachycardias • Malignant arrhythmias from short reentrant pathway repolarization or multiple pathways	• Short PR interval • Delta waves present	• Undergo EPS and ablation
Dilated cardiomyopathy: ventricular tachycardia/ fibrillation	• Cardiac dilation and systolic dysfunction • Inherited or acquired • Lamin AC pathologic gene variant a common cause of DCM and SCD	• Marked LVH • Poor R-wave progression • Left atrial enlargement • Right axis deviation	• Permanent pacemaker and ICD placement
Catecholamine-exercise: ventricular tachycardia	• Ventricular ectopy induced by exercise or emotional stress • Variant in gene that encodes Ca-mediated sarcoplasmic fibers • Lethal in 30–50% if left untreated	• Preexercise ECG is usually normal, stress testing recommended • ECG with exercise • Nonsustained wide ventricular tachycardia	• β-Blocker therapy • Recommendations on exercise intensity by a cardiologist • ICD if β blockers fail

DCM, Dilated cardiomyopathy; EPS, electrophysiology study; HR, heart rate; ICD, implantable cardioverter defibrillator; LQTS, long QT syndrome; LVH, left ventricular hypertrophy; SCD, sudden cardiac death; SVT, supraventricular tachycardia.
*Main genes: KCNQ1, KCNH2, SCN5A in ~75%

A well-trained adolescent athlete faints after finishing a strenuous run, not during exercise, and had a prodrome. Which category is compatible with the differentiation table?

A. Neurocardiogenic syncope
B. A diagnosis of ventricular tachycardia is proven
C. Uncal herniation
D. Uncomplicated epilepsy is proven
E. Pheochromocytoma is mandatory

Original table 84.6 | Nelson printed p. 595 | PDF p. 642

Table 84.6 Differentiating Features for Causes of Syncope

NEUROCARDIOGENIC Symptoms after prolonged motionless standing, sudden unexpected pain, fear, or unpleasant sight, sound, or smell; pallor Syncope in a well-trained athlete *after* exertion (without heart disease) Situational syncope during or immediately after micturition, cough, swallowing, or defecation Syncope with throat or facial pain (glossopharyngeal or trigeminal neuralgia)
ORGANIC HEART DISEASE (PRIMARY ARRHYTHMIA, OBSTRUCTIVE HYPERTROPHIC CARDIOMYOPATHY, PULMONARY HYPERTENSION) Brief sudden loss of consciousness, no prodrome, history of heart disease Syncope while sitting or supine Syncope with exertion History of palpitations Family history of sudden death
NEUROLOGIC Seizures: preceding aura, postevent symptoms lasting >5 min (includes postictal state of decreased level of consciousness, confusion, headache, or paralysis) Migraine: syncope associated with antecedent headaches with or without aura
OTHER VASCULAR Carotid sinus: syncope with head rotation or pressure on the carotid sinus (as in tumors, shaving, tight collars) Orthostatic hypotension: syncope immediately on standing, especially after prolonged bed rest
DRUG INDUCED Patient is taking a medication that may lead to long QT syndrome, orthostasis, or bradycardia
PSYCHIATRIC ILLNESS Frequent syncope, somatic complaints, no heart disease

A 15-year-old suddenly faints while swimming and has a family history of unexplained drowning. Which interpretation best follows the red-flag table?

A. Urgent evaluation for cardiac syncope is warranted
B. This is a reassuring classic prolonged-standing faint
C. The family history has no relevance
D. The event is automatically a seizure
E. No ECG should be considered

Original table 84.7 | Nelson printed p. 596 | PDF p. 643

Table 84.7 Red Flags in Evaluation of Patients with Syncope

Syncope with activity or exercise or supine
Syncope not associated with prolonged standing
Syncope precipitated by loud noise or extreme emotion
Absence of presyncope or lightheadedness
Family history of syncope, drowning, sudden death, familial ventricular arrhythmia syndromes,* cardiomyopathy
Syncope requiring CPR
Injury with syncope
Anemia
Other cardiac symptoms
Chest pain
Dyspnea
Palpitations
History of cardiac surgery
History of Kawasaki disease
Implanted pacemaker
Abnormal physical examination
Murmur
Gallop rhythm
Loud and single second heart sound
Systolic click
Increased apical impulse (tachycardia)
Irregular rhythm
Hypotension or hypertension
Digital clubbing
Cyanosis

*Long QT syndrome, Brugada syndrome, catecholamine polymorphic ventricular tachycardia, arrhythmogenic cardiomyopathy.

A teen has recurrent uncomplicated vasovagal faints triggered by prolonged standing in a warm room. Which first-line counseling element is listed?

A. Explain triggers and teach avoidance or countermeasures
B. Require lifelong bed rest
C. Give a stimulant before every school day
D. Avoid hydration without assessment
E. Ignore the patient's warning symptoms

Original table 84.8 | Nelson printed p. 596 | PDF p. 643

Table 84.8 Treatment of Neurocardiogenic Syncope/Vasovagal Syncope (V-VS)

Patient education on the diagnosis and prognosis of V-VS is recommended. In all patents with the common faint or V-VS, an explanation of the diagnosis, education targeting awareness of and possible avoidance of triggers (prolonged standing, warm environments, coping with dental and medical settings), and reassurance about the benign nature of the condition should be provided.
Physical counterpressure maneuvers can be useful in patients with V-VS who have a sufficiently long prodromal period. Patients with a syncope prodrome should be instructed to assume a supine position to prevent a faint and minimize possible injury. In patients with a sufficiently long prodrome, physical counter-maneuvers (leg crossing, limb and/or abdominal contraction, squatting, isometric handgrip, arm tensing) are a core management strategy.
Midodrine is reasonable in patients with recurrent V-VS with no history of hypertension, heart failure, or urinary retention. Midodrine is a prodrug that is metabolized to desglymidodrine, which is a peripherally active α-agonist used to ameliorate the reduction in peripheral sympathetic neural outflow responsible for venous pooling and vasodepression in V-VS.
The usefulness of orthostatic training is uncertain in patients with frequent V-VS. There are 2 main methods of orthostatic training. Patients undergo repetitive tilt-table tests in a monitored setting until a negative tilt-table test occurs and then are encouraged to stand quietly against a wall for 30-60 min daily, or patients simply stand quietly against a wall at home for a prolonged period daily.
Fludrocortisone might be reasonable for patients with recurrent V-VS and inadequate response to salt and fluid intake, unless contraindicated. Fludrocortisone has mineralocorticoid activity resulting in sodium and water retention and potassium excretion, which results in increased blood volume. Serum potassium level should be monitored because of potential drug-induced hypokalemia. POST II (Prevention of Syncope Trial II) reported a marginally insignificant 31% risk of reduction in adults with moderately frequent V-VS, which was significant in patients after a 2-wk dose stabilization period.
Encouraging increases in salt and fluid intake may be reasonable in selected patients with V-VS, unless contraindicated. Evidence for the effectiveness of salt and fluid intake for patients with V-VS is limited. Nonetheless, in patients with recurrent V-VS and no clear contraindication, such as a history of hypertension, renal disease, heart failure, or cardiac dysfunction, it may be reasonable to encourage ingestion of 2-3 L of fluid per day and a total of 6-9 g (100-150 mmol) of salt per day, or about 1-2 heaping teaspoonfuls. The long-term balance of risks and benefits of a strategy of increasing salt and water intake is unknown.
In selected patients with V-VS, it may be reasonable to reduce or withdraw medications that cause hypotension when appropriate. A careful examination of the patient's history for medications that may lower blood pressure (hypotensive agents) should be performed. Care should be taken to withdraw or reduce medications only when safe to do so and in conjunction with the prescribing healthcare provider.
In patients with recurrent V-VS, a selective serotonin reuptake inhibitor might be considered. Serotonin has central neurophysiologic effects on blood pressure and heart rate and acutely induces syncope during tilt-table testing.

Modified from Shen WK, Sheldon RS, Benditt DG, et al. 2017 ACC/AHA/HRS guideline for the evaluation and management of patients with syncope: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice

An adolescent with POTS is being considered for midodrine. Which mechanism in the medication table explains its effect?

A. Alpha-1 agonism causing vasoconstriction
B. Direct beta-2 bronchodilation
C. Renal glucose wasting
D. Inhibition of platelet aggregation
E. Dopamine receptor blockade

Original table 84.9 | Nelson printed p. 599 | PDF p. 646

Table 84.9 First-Line Medications in Treatment of Postural Tachycardia Syndrome (POTS)

DRUG	MECHANISM OF ACTION	SIDE EFFECTS	TREATMENT GUIDELINES
Fludrocortisone	Low dose: sensitizes α-receptors Higher doses: mineralocorticoid effect	Peripheral edema, headache, irritability, hypokalemia, hypomagnesemia, acne	Monitor basic metabolic panel and magnesium
Midodrine	α_1-Agonist; produces vasoconstriction	Scalp tingling, urinary retention, goosebumps, headache, supine hypertension	Monitor supine blood pressure 30-60 min after dose
Metoprolol succinate/ tartrate	β Blocker	Worsening of asthma, dizziness, fatigue	Use with caution in asthma If fatigue is severe, use at bedtime
Propranolol	Nonselective β blocker	Bradycardia, gastrointestinal symptoms, lightheadedness, sleepiness, hypotension, syncope	Use with caution in diabetes and asthma
Pyridostigmine	Peripheral acetylcholinesterase inhibitor that increases synaptic acetylcholine in autonomic ganglia and at peripheral muscarinic receptors	Symptoms of excessive cholinergic activity (diarrhea, urinary incontinence, salivation)	Very useful if patient has POTS and constipation Use with caution in asthma Contraindicated in urinary or bowel obstruction

A child with severe gastroenteritis has cool extremities, tachycardia, narrow pulse pressure, and poor urine output. Which shock type best matches the table?

A. Hypovolemic shock
B. Neurogenic shock
C. Obstructive shock from tamponade
D. Anaphylactic shock
E. Cardiogenic shock from myocarditis

Original table 85.1 | Nelson printed p. 601 | PDF p. 648

Table 85.1 Types of Shock

TYPES OF SHOCK	PATHOPHYSIOLOGY	APPEARANCE	EXAMPLES	TREATMENTS
Hypovolemic*	Decreased cardiac output due to volume depletion → decreased preload	Tachycardia and vasoconstriction maintain adequate circulation up to 30% of circulating volume Narrowed pulse pressure, delayed capillary refill, orthostatic changes, late hypotension, AMS, and decreased UOP	Nonhemorrhagic (vomiting and diarrhea) Hemorrhagic (trauma)	IV fluid bolus Vasopressors Blood replacement
Cardiogenic	Decreased cardiac output due to myocardial dysfunction, increased afterload, and/or lack of ventricular filling	Tachycardia, vasoconstriction, cool extremities, narrow pulse pressure, delayed capillary refill, respiratory distress, rales or gallop rhythm, enlarged liver, JVD, cardiomegaly on chest radiograph Significant gradient between upper and lower extremity blood pressures	Cardiomyopathies, infectious myocarditis, and systemic inflammatory process, autoimmune disease, impaired coronary perfusion, cardiopulmonary bypass, acidosis, HIE, and dysrhythmias Infants: ductal-dependent lesions, tachydysrhythmias	Judicious IV fluid resuscitation, ionotropic agents to improve contractility, vasodilators to reduce afterload, and management of tachyarrhythmias PGE for infants <2 mo
Distributive	Decreased cardiac output and systemic vascular resistance due to peripheral vasodilation → decreased afterload and preload, redistribution of blood flow away from vital organs, and loss of sympathetic outflow	Tachycardic, vasodilated, flushed, warm extremities, wide pulse pressure, bounding pulses, flash capillary refill Anaphylaxis: rash; facial swelling; lip, tongue, or airway swelling; bronchospasm; hypotension Spinal shock: unable to raise HR, hypotension Neurogenic: Control ↑ ICP	Septic shock Toxic ingestions Anaphylaxis Spinal cord injuries	IV fluids, vasopressors, antibiotics Specific antidotes Remove triggers, IV fluids, IM epinephrine, antihistamines, vasopressors IV fluids, vasoconstrictors
Obstructive	Decreased cardiac output due to increased afterload of the right ventricle from an obstructive process	Tachycardia, delayed capillary refill, cool extremities, narrow pulse pressure, distended neck veins, distant heart tones, asymmetric breath sounds	Tension pneumothorax Pulmonary embolism Cardiac tamponade	Anticoagulants Drain pericardial effusion Evacuate pneumothorax
Dissociative	High cardiac output failure due to inadequate oxygen-releasing capacity	Tachycardia ± delayed capillary refill, cool extremities, weakened pulse, pallor or flushed cheeks	Anemia Carbon monoxide Methemoglobinemia Cyanide	Gradual fluid replacement and blood replacement 5 mL/dL Oxygen, hyperbaric chamber Methylene blue Hydroxocobalamin and cyanide antidote kit (sodium thiosulfate, sodium nitrate, amyl nitrite) plus oxygen

*Most common.
AMS, Altered mental status; HIE, hypoxic ischemic encephalopathies; HR, heart rate; IM, intramuscular; ICP, intracranial pressure; IV, intravenous; JVD, jugular venous distention; PGE, prostaglandin; UOP, urine output

A child with suspected infection has respiratory failure, vasoactive support, thrombocytopenia, and neurologic dysfunction. Which score in the table assesses organ dysfunction across these domains?

A. Phoenix Sepsis Score
B. NEXUS
C. Glasgow Coma Scale alone
D. Apgar score
E. Gomez malnutrition grade

Original table 85.2 | Nelson printed p. 603 | PDF p. 650

Table 85.2 The Phoenix Sepsis Score[a]

VARIABLES	0 POINTS	1 POINT	2 POINTS	3 POINTS
RESPIRATORY, 0–3 POINTS	PaO_2:FIO_2 ≥400 or SpO_2:FIO_2 ≥292[b]	PaO_2:FIO_2 <400 on any respiratory support or SpO_2:FIO_2 <292 on any respiratory support[b,c]	PaO_2:FIO_2 100–200 and IMV or SpO_2:FIO_2 148–220 and IMV[b]	PaO_2:FIO_2<100 and IMV or SpO_2:FIO_2 <148 and IMV[b]
CARDIOVASCULAR, 0–6 POINTS		1 point each (up to 3)	2 points each (up to 6)	
	No vasoactive medications[d]	1 Vasoactive medication[d]	≥2 Vasoactive medications[d]	
	Lactate <5 mmol/L[e]	Lactate 5–10.9 mmol/L[e]	Lactate ≥11 mmol/L[e]	
AGE BASED[f]		Mean Arterial Pressure, mm Hg[g]		
<1 mo	>30	17–30	<17	
1 to 11 mo	>38	25–38	<25	
1 to <2 yr	>43	31–43	<31	
2 to <5 yr	>44	32–44	<32	
5 to <12 yr	>48	36–48	<36	
12 to 17 yr	>51	38–51	<38	
COAGULATION, 0–2 POINTS[H]		1 point each (maximum 2 points)		
	Platelets ≥100 × 10^3/μL	Platelets <100 × 10^3/μL		
	International normalized ratio ≤1.3	International normalized ratio >1.3		
	D-dimer ≤2 mg/L FEU	D-dimer >2 mg/L FEU		
	Fibrinogen ≥100 mg/dL	Fibrinogen <100 mg/dL		
NEUROLOGIC, 0–2 POINTS[i]	Glasgow Coma Scale score >10; pupils reactive[j]	Glasgow Coma Scale score ≤10[j]	Fixed pupils bilaterally	
PHOENIX SEPSIS CRITERIA				
Sepsis	Suspected infection and Phoenix Sepsis Score ≥2 points			
Septic shock	Sepsis with ≥1 cardiovascular point(s)			

[a]The score may be calculated in the absence of some variables (eg, even if lactate level is not measured and vasoactive medications are not used, a cardiovascular score can still be ascertained using blood pressure). It is expected that laboratory tests and other measurements will be obtained at the discretion of the medical team based on clinical

A child has fever, tachycardia, and systemic inflammation without an identified infection. Which noninfectious differential category in the SIRS table should be considered?

A. Inflammatory or rheumatologic illness
B. Isolated age-appropriate babbling
C. Physiologic tooth eruption
D. Normal night sleep
E. Uncomplicated myopia

Original table 85.3 | Nelson printed p. 604 | PDF p. 651

Table 85.3 Differential Diagnosis of Systemic Inflammatory Response Syndrome (SIRS)

INFECTION
Bacteremia or meningitis (*Streptococcus pneumoniae, Haemophilus influenzae* type b, *Neisseria meningitidis*, group A *Streptococcus*, *Staphylococcus aureus*)
Viral illness (influenza, enteroviruses, hemorrhagic fever group, herpes simplex virus, respiratory syncytial virus, cytomegalovirus, Epstein-Barr virus, COVID-19)
Encephalitis (arboviruses, enteroviruses, herpes simplex virus)
Rickettsiae (Rocky Mountain spotted fever, Ehrlichia, Q fever)
Syphilis
Vaccine reaction (pertussis, influenza, measles)
Toxin-mediated reaction (toxic shock, staphylococcal scalded skin syndrome)

CARDIOPULMONARY
Pneumonia (bacteria, virus, mycobacteria, fungi, allergic reaction)
Pulmonary emboli
Heart failure
Arrhythmia
Pericarditis
Myocarditis

METABOLIC-ENDOCRINE
Adrenal insufficiency (adrenogenital syndrome, Addison disease, corticosteroid withdrawal)
Electrolyte disturbances (hyponatremia or hypernatremia, hypocalcemia or hypercalcemia)
Diabetes insipidus
Diabetes mellitus
Inborn errors of metabolism (organic acidosis, urea cycle, carnitine deficiency, mitochondrial disorders)
Hypoglycemia

GASTROINTESTINAL
Gastroenteritis with dehydration
Volvulus
Intussusception
Appendicitis
Peritonitis (spontaneous, associated with perforation or peritoneal dialysis)
Necrotizing enterocolitis
Hepatitis
Hemorrhage
Pancreatitis

HEMATOLOGIC/IMMUNE
Anemia (sickle cell disease, blood loss, nutritional)
Methemoglobinemia
Splenic sequestration crisis
Leukemia or lymphoma
Hemophagocytic syndromes
Cytokine release syndrome s/p CAR-T therapy
Immune reconstitution syndrome
Graft-versus-host disease

NEUROLOGIC
Intoxication (drugs, carbon monoxide, intentional or unintentional overdose)
Intracranial hemorrhage
Infant botulism
Trauma (child abuse, accidental)
Guillain-Barre syndrome
Myasthenia gravis

OTHER
Anaphylaxis (food, drug, insect sting, idiopathic)
Hemolytic-uremic syndrome
Kawasaki disease
Erythema multiforme, toxic epidermal necrolysis
MIS-C
Poisoning, iron, cyanide
Toxic envenomation
Systemic JIA
Macrophage activation syndrome
Idiopathic systemic capillary leak (Clarkson) syndrome

CAR-T, Chimeric antigen receptor T-cell; JIA, juvenile idiopathic arthritis; MIS-C, multisystem inflammatory syndrome in children; S/P, status post.
From Baumer-Mouradian SH, Drendel AL. Shock. In: Kliegman RM, Bordini BJ, Toth H, Basel D, eds. *Nelson Pediatric Symptom-Based Diagnosis*, 2nd ed. Elsevier: Philadelphia; 2022: Table 10.6

A child in shock develops progressively reduced urine output and confusion. Which shared underlying process does the perfusion table depict?

A. Worsening end-organ perfusion
B. Improving renal blood flow
C. An isolated speech-language delay
D. Normal adaptation to hydration
E. Primary overfeeding

Original table 85.4 | Nelson printed p. 605 | PDF p. 652

Table 85.4 Signs of Decreased Perfusion

ORGAN SYSTEM	↓ PERFUSION	↓↓ PERFUSION	↓↓↓ PERFUSION
Central nervous system	—	Restless, apathetic, anxious	Agitated/confused, stuporous, coma
Respiratory	—	↑ Ventilation	↑↑ Ventilation
Metabolic	—	Compensated metabolic acidemia	Uncompensated metabolic acidemia
Gastrointestinal	—	↓ Motility	Ileus
Kidney	↓ Urine volume ↑ Urinary specific gravity	Oliguria (<0.5 mL/kg/hr)	Oliguria/anuria
Skin	Delayed capillary refill	Cool extremities	Mottled, cyanotic, cold extremities
Cardiovascular system	↑ Heart rate	↑↑ Heart rate ↓ Peripheral pulses	↑↑ Heart rate ↓ Blood pressure, central pulses only

A child with sepsis develops striking hyperferritinemia and persistent organ dysfunction. Which diagnostic consideration in the specialized management table is emphasized?

A. Search for occult or co-infection and hyperinflammatory triggers
B. Assume all fever is from a single isolated virus
C. Avoid assessment for infectious contributors
D. Dismiss the ferritin result without context
E. Limit evaluation to dental examination

Original table 85.5 | Nelson printed p. 606 | PDF p. 653

Table 85.5 Considerations in Management of Hyperferritinemic Sepsis Beyond Usual Diagnostic and Therapeutic Measures Used in Sepsis Patients Without Hyperferritinemia

WHAT OCCULT INFECTION IS PRIMING AND WHAT CO-INFECTION IS PRESENT FOR THE HYPERFERRITINEMIC PROCESS?
Perform diagnostic workup for **viruses** (e.g., herpes simplex virus 1, HHV-6, HHV-8, Epstein-Barr virus, adenovirus, cytomegalovirus, parvovirus, Ebola, COVID-19, Dengue, hepatitis A, HIV, severe fever with thrombocytopenia syndrome virus, influenza, hemorrhagic fevers), **parasites** (e.g., toxoplasmosis, leishmaniasis, malaria, scrub typhus, babesiosis), **intracellular bacteria** (e.g., tuberculosis, atypical mycobacteria, mycoplasma, fusobacteria, babesiosis, ehrlichiosis), rickettsia, and **fungi** (e.g., histoplasmosis).
Begin empiric therapy and specific therapies according to context.
Give IVIG if no specific therapy is available to neutralize infection.
IS HEMOLYSIS AND FREE HEMOGLOBIN DRIVING THE HYPERFERRITINEMIC PROCESS?
Measure free hemoglobin and ferritin sequentially.
Minimize blood transfusions.
If unable to reverse hemolysis or hyperferritinemia, consider 5 days of plasma exchange to remove free hemoglobin and ferritin and to resolve inflammation.
IS AN ANTIINFLAMMATORY STRATEGY NEEDED TO SAFELY CONTROL INFLAMMASOME ACTIVATION?
If ferritin is >3,000 ng/mL in the high-resource PICU setting, or >500 ng/mL in the resource-poor PICU setting, then mortality risk is increased.
Methylprednisone, IVIG, and interleukin 1 receptor antagonist (anakinra) can be safely given to reduce mortality risk in these children.

HHV, human herpes virus; PICU; pediatric intensive care unit; IVIG, IV immunoglobulin.
Modified from Carcillo JA, Kernan KK, Horvat CM, et al. Why and how is hyperferritinemic sepsis different from sepsis without hyperferritinemia? *Pediatr Crit*

A child in shock has restlessness, confusion, and low urine output even while blood pressure is near the lower end of normal. Which interpretation fits the examination table?

A. End-organ hypoperfusion may be present despite a nonprofound blood-pressure reduction
B. Normal pressure excludes shock
C. Confusion proves a primary psychotic disorder
D. Oliguria indicates preserved kidney perfusion
E. Vital signs make serial assessment unnecessary

Original table 85.6 | Nelson printed p. 607 | PDF p. 654

Table 85.6 Physical Examination and Selected Laboratory Signs in Shock

Central nervous system	Acute delirium, restlessness, disorientation, confusion, and coma, which may be secondary to decreased cerebral perfusion pressure (mean arterial pressure minus intracranial pressure). Patients with chronic hypertension or increased intracranial pressure may be symptomatic at normal blood pressures. Cheyne-Stokes respirations may be seen with severe decompensated heart failure. Blindness can be a presenting complaint or complication.
Temperature	Hyperthermia results in excess tissue respiration and greater systemic oxygen delivery requirements. Hypothermia can occur when decreased systemic oxygen delivery or impaired cellular respiration decreases heat generation.
Skin	Cool distal extremities (combined low serum bicarbonate and high arterial lactate levels) aid in identifying patients with hypoperfusion. Pallor, cyanosis, sweating, and decreased capillary refill and pale, dusky, clammy, or mottled extremities indicate systemic hypoperfusion. Dry mucous membranes and decreased skin turgor indicate low vascular volume. Low toe temperature correlates with the severity of shock.
General cardiovascular	Neck vein distention (e.g., heart failure, pulmonary embolus, pericardial tamponade) or flattening (e.g., hypovolemia), tachycardia, and arrhythmias. Decreased coronary perfusion pressures can lead to ischemia, decreased ventricular compliance, and increased left ventricular diastolic pressure. A "mill wheel" heart murmur may be heard with an air embolus.
Heart rate	Usually elevated. However, paradoxical bradycardia can be seen in patients with preexisting cardiac disease and severe hemorrhage. Heart rate variability is associated with poor outcomes.
Systolic blood pressure	May actually increase slightly when cardiac contractility increases in early shock and then fall as shock advances.
Diastolic blood pressure	Correlates with arteriolar vasoconstriction and may rise early in shock and then fall when cardiovascular compensation fails.
Pulse pressure	Defined as systolic minus diastolic pressure and related to stroke volume and the rigidity of the aorta. Increases early in shock and decreases before systolic pressure decreases.
Pulsus paradoxus	An exaggerated change in systolic blood pressure with respiration (systolic blood pressure declines >10 mm Hg with inspiration) seen in asthma, cardiac tamponade, and air embolus.
Mean arterial blood pressure	Diastolic blood pressure + [pulse pressure/3]
Shock index	Heart rate/systolic blood pressure. Normal = 0.5-0.7. A persistent elevation of the shock index (>1.0) indicates impaired left ventricular function (as a result of blood loss or cardiac depression) and is associated with increased mortality.
Respiratory	Tachypnea, increased minute ventilation, increased dead space, bronchospasm, hypocapnia with progression to respiratory failure, acute lung injury, and adult respiratory distress syndrome.
Abdomen	Low-flow states may result in abdominal pain, ileus, gastrointestinal bleeding, pancreatitis, acalculous cholecystitis, mesenteric ischemia, and shock liver.
Renal	Because the kidney receives 20% of cardiac output, low cardiac output reduces the glomerular filtration rate and redistributes renal blood flow from the renal cortex toward the renal medulla, thereby leading to oliguria. Paradoxical polyuria in early sepsis may be confused with adequate hydration.
Metabolic	Respiratory alkalosis is the first acid-base abnormality, but metabolic acidosis rapidly occurs as shock progresses. Hyperglycemia, hypoglycemia, and hyperkalemia may develop. Hyperferritinemia suggests a poor prognosis.

From Angus DC. Approach to the patient with shock. In Goldman L, Schafer AI, eds. *Goldman-Cecil Medicine,* 26th ed. Philadelphia: Elsevier; 2020:643, Table 98-1.

A child with vasodilatory shock needs a vasoactive agent with potent vasoconstrictor effects. Which agent has that effect in the table?

A. Norepinephrine
B. Albuterol
C. Furosemide
D. Acetazolamide
E. Aspirin

Original table 85.7 | Nelson printed p. 610 | PDF p. 657

Table 85.7 Vasoactive Medications to Treat Shock

DRUG	EFFECT(S)	DOSING RANGE	COMMENT(S)
Epinephrine	↑ Heart rate and ↑ cardiac contractility Vasodilator at low doses, but potent vasoconstrictor at doses >0.1 mcg/kg/min	0.05-2.0 µg/kg/min	May ↓ renal perfusion at high doses ↑ Myocardial O_2 consumption Risk of arrhythmia at high doses
Norepinephrine	Potent vasoconstriction ↑ Cardiac contractility (but may be blunted by increased afterload)	0.05-2.0 µg/kg/min	↑ Blood pressure secondary to ↑ systemic vascular resistance ↑ Left ventricular afterload
Dopamine	↑ Cardiac contractility Significant peripheral vasoconstriction at >10 µg/kg/min	3-20 µg/kg/min	↑ Risk of arrhythmias at high doses
Dobutamine	↑ Cardiac contractility Peripheral vasodilator	3-10 µg/kg/min	—
Phenylephrine	Potent vasoconstriction No effect on cardiac contractility	0.25-2.0 µg/kg/min	Can cause sudden hypertension
Vasopressin	Potent vasoconstriction	0.5-20 milliunits/kg/min	Can cause sudden hypertension
Angiotensin II	Potent vasoconstrictor	Stepwise increase 5-10-25-40-80 ng/kg/min over 3 hr with titration down to 1.25-40 ng/kg/min after 3 hr	Can cause sudden hypertension, arterial ischemia
Methylene blue	Reduce responsiveness to cGMP-dependent (e.g., ischemia-reperfusion, NO mediated) vasodilators	Bolus 1-2 mg/kg, then consider continuous infusion 0.5-.01 mg/kg/hr	Causes blue/green discoloration of skin and urine
Milrinone	Increased cardiac contractility Improves cardiac diastolic function Peripheral vasodilation	0.25-1.0 µg/kg/min	Phosphodiesterase inhibitor—slows cyclic adenosine monophosphate breakdown
Prostaglandin E_1	Vasodilator Maintains an open ductus arteriosus in the newborn with ductal-dependent congenital heart disease	0.01-0.2 µg/kg/min	Can lead to hypotension Risk of apnea

A child has inspiratory stridor and marked retractions. Which anatomic level best matches the localization table?

A. Extrathoracic airway
B. Alveolar compartment
C. Pleural space only
D. Renal collecting system
E. Myocardium

Original table 86.1 | Nelson printed p. 612 | PDF p. 659

Table 86.1 Typical Localizing Signs for Pulmonary Pathology

SITE OF PATHOLOGY	RESPIRATORY RATE	RETRACTIONS	AUDIBLE MANIFESTATION
Extrathoracic airway	↑	↑↑↑↑	Stridor
Intrathoracic extrapulmonary	↑	↑↑	Wheezing
Intrathoracic intrapulmonary	↑↑	↑↑	Wheezing
Alveolar or interstitial	↑↑↑	↑↑↑	Grunting, crackles

A child with severe scoliosis develops respiratory pump failure. Which anatomic category in the table is most relevant?

A. Thoracic cage
B. Alveolar epithelial cells
C. Large airway foreign body
D. Pulmonary vein alone
E. Nasal mucosa alone

Original table 86.2 | Nelson printed p. 613 | PDF p. 660

Table 86.2 Examples of Anatomic Sites of Lesions Causing Respiratory Failure

LUNG	RESPIRATORY PUMP
CENTRAL AIRWAY OBSTRUCTION	**THORACIC CAGE**
Choanal atresia Tonsilloadenoidal hypertrophy Retropharyngeal/peritonsillar abscess Laryngomalacia Epiglottitis Vocal cord paralysis Laryngotracheitis Subglottic stenosis Vascular ring/pulmonary sling Mediastinal mass Foreign body	Kyphoscoliosis Diaphragmatic hernia Flail chest Eventration of diaphragm Asphyxiating thoracic dystrophy Prune-belly syndrome Dermatomyositis Abdominal distention
PERIPHERAL AIRWAY OBSTRUCTION	**BRAINSTEM**

A child with diabetic ketoacidosis has rapid deep breathing despite clear lungs. Which nonpulmonary mechanism in the table accounts for respiratory distress?

A. Metabolic acidosis
B. Primary asthma exacerbation
C. Pleural empyema
D. Lobar consolidation
E. Foreign body aspiration

Original table 86.3 | Nelson printed p. 613 | PDF p. 660

Table 86.3 Nonpulmonary Causes of Respiratory Distress

DOMAIN	EXAMPLE(S)	MECHANISM(S)
Cardiovascular	Left-to-right shunt Congestive heart failure Cardiogenic shock	↑ Pulmonary blood/water content Metabolic acidosis Baroreceptor stimulation
CNS	Increased intracranial pressure Encephalitis Neurogenic pulmonary edema Toxic encephalopathy	Stimulation of brainstem respiratory centers
Metabolic	Diabetic ketoacidosis Organic acidemia Hyperammonemia	Stimulation of central and peripheral chemoreceptors
Renal	Renal tubular acidosis Hypertension	Stimulation of central and peripheral chemoreceptors Left ventricular dysfunction → increased pulmonary blood/water content
Infection	Toxic shock syndrome Septic shock Meningococcemia	Cytokine stimulation of respiratory centers Baroreceptor stimulation from shock Metabolic acidosis

CNS, Central nervous system.
Courtesy Dr. Ashok Sarnaik.

An infant with a large left-to-right cardiac shunt develops tachypnea and increased work of breathing. Which cardiovascular mechanism in the table is relevant?

A. Increased pulmonary blood flow and reduced lung compliance
B. Isolated upper-airway foreign body
C. Primary diaphragmatic paralysis
D. Pulmonary embolism in every case
E. Exclusive central sleep apnea

Original table 86.4 | Nelson printed p. 614 | PDF p. 661

Table 86.4 Cardiovascular Pathology Manifesting as Respiratory Distress

I. DECREASED LUNG COMPLIANCE
A. Left-to-right shunts
1. Ventricular septal defect, atrial septal defect, patent ductus arteriosus, atrioventricular canal, truncus arteriosus
2. Cerebral or hepatic arteriovenous fistula

B. Ventricular failure
1. Left heart obstructive lesions
   a. Aortic stenosis
   b. Coarctation of the aorta
   c. Interrupted aortic arch
   d. Mitral stenosis
   e. Hypoplastic left heart syndrome
2. Myocardial infarction
   a. Anomalous left coronary artery from the pulmonary artery (ALCAPA)
   b. Ventriculocoronary arterial connections (coronary sinusoids)
3. Hypertension
   a. Acute glomerulonephritis
4. Inflammatory/infectious
   a. Myocarditis
   b. Pericardial effusion
5. Idiopathic/genetic
   a. Dilated cardiomyopathy
   b. Hypertrophic obstructive cardiomyopathy
   c. Takotsubo syndrome

C. Pulmonary venous obstruction
1. Total anomalous pulmonary venous connection with obstruction
2. Cor triatriatum

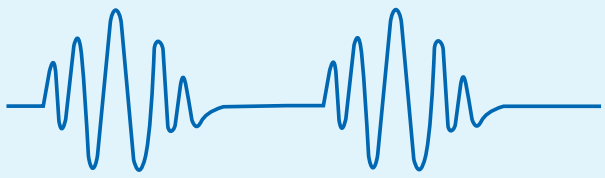
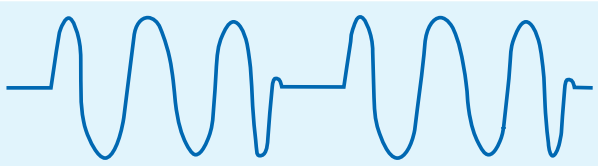
II. SHOCK RESULTING IN METABOLIC ACIDOSIS
A. Left heart obstructive lesions
B. Acute ventricular failure
1. Myocarditis, myocardial infarction

An unconscious child exhibits a prolonged inspiratory pause followed by prolonged expiration. Which neurologic level in the respiratory-pattern table is associated with apneustic breathing?

A. Pons
B. Cerebral cortex
C. Peripheral sensory nerve
D. Cerebellar hemisphere
E. Spinal anterior horn alone

Original table 86.6 | Nelson printed p. 615 | PDF p. 662

Table 86.6 Respiratory Patterns in Neurologic Disease

INJURY SITE	PATTERN*	COMMENTS
Normal		Variable V_T with normal respiratory pauses and sighs
Cortex		Hyperpnea and tachypnea
Midbrain		*Cheyne-Stokes breathing:* Gradually increasing and decreasing V_T
Pons		*Apneustic breathing:* Prolonged inspiration followed by prolonged expiration
Medulla and pons		*Biot breathing*: Rapid and irregular respirations with pauses

*Pattern tracings represent lung volume over time.
V_T, Tidal volume.

A child develops new bilateral pulmonary opacities and respiratory failure 2 days after sepsis, not explained by cardiac failure or fluid overload. Which syndrome's definition in the table should be assessed?

A. Pediatric acute respiratory distress syndrome
B. Isolated chronic obstructive lung disease
C. Stable neonatal transitional physiology
D. Acute heart failure as the only cause
E. Simple upper-airway obstruction

Original table 86.7 | Nelson printed p. 616 | PDF p. 663

Table 86.7 Pediatric Acute Respiratory Distress Syndrome (PARDS 2.0) Definition

Age	Excludes patients with perinatal-related lung disease		
Timing	Within 7 days of a known clinical insult		
Origin of edema	Not fully explained by cardiac failure or fluid overload		
Chest imaging	New opacities (unilateral or bilateral) consistent with acute pulmonary parenchymal disease and which are not due primarily to atelectasis or pleural effusion[a]		
Oxygenation[b]	IMV: OI ≥ 4 or OSI ≥ 5 NIV[c]: Pa_{O_2}/ F_{IO_2} ≤ 300 or SP_{O_2}/ F_{IO_2} ≤ 250		
	Stratification of PARDS severity: Apply ≥ 4 after initial diagnosis of PARDS		
	IMV PARDS	Mild/moderate: OI <16 or OSI <12	Severe: OI ≥16 or OSI ≥12
	NIV PARDS[c]	Mild/moderate: Pa_{O_2}/ F_{IO_2}>100 or SP_{O_2}/ F_{IO_2} >150	Severe: Pa_{O_2}/ F_{IO_2} ≤ 100 or SP_{O_2}/ F_{IO_2} ≤ 150
Special Populations[d]			
Cyanotic heart disease	Above criteria, with acute deterioration in oxygenation not explained by cardiac disease		
Chronic lung disease	Above criteria, with acute deterioration in oxygenation from baseline		

[a]Children in resource-limited settings where imaging is not available who otherwise meet PARDS criteria are considered to have possible PARDS.
[b]Oxygenation should be measured at steady state and not during transient desaturation episodes. When S_{PO_2} is used, ensure that S_{PO_2} is ≤ 97%.
[c]Diagnosis of PARDS on NIV (NIV PARDS) requires full facemask interface with continuous airway positive pressure/positive end-expiratory pressure ≥ 5cm H_2O

A child needs a device capable of delivering a high inspired oxygen fraction while awaiting definitive respiratory assessment. Which listed device can deliver a higher approximate FiO2 than a standard low-flow nasal cannula?

A. Non-rebreather face mask
B. Room air
C. A disconnected nasal cannula
D. An empty oxygen cylinder
E. Unpowered humidifier alone

Original table 86.9 | Nelson printed p. 618 | PDF p. 665

Table 86.9 Approximate Oxygen Delivery According to Device and Flow Rates in Infants and Older Children*

DEVICE	FLOW (L/min)	F_{IO_2} DELIVERED
Nasal cannula	0.1-6	0.21-0.4
Simple face mask	5-10	0.4-0.6
Partial rebreather	6-15	0.55-0.7
Non-rebreather	6-15	0.7-0.95
Venturi mask	5-10	0.25-0.5
Hood/tent	7-12	0.21-1.0
High-flow systems	1-60	0.21-1.0

*Individual delivery varies and depends on the patient's size, respiratory rate, and gas

A child with bronchospasm requires intubation, and an induction agent with bronchodilating properties is desired. Which table-listed drug fits?

A. Ketamine
B. Propofol
C. Lorazepam
D. Midazolam
E. Thiopental

Original table 86.11 | Nelson printed p. 620 | PDF p. 667

Table 86.11 Medications Commonly Used for Intubation

DRUG	DOSE	ONSET (min)	DURATION (min)	COMMENTS
SEDATIVES/ANESTHETICS				
Midazolam	0.1 mg/kg IV	3-5	60-120	Amnesia Respiratory depression
Lorazepam	0.1 mg/kg IV	3-5	120-240	Amnesia Respiratory depression
Ketamine	1-2 mg/kg IV 4-6 mg/kg IM	2-3	10-15	↑ HR, BP, and ICP Bronchodilation, sialorrhea
Propofol	1-3 mg/kg IV	0.5-2	10-15	↓ BP Apnea
Thiopental	4-7 mg/kg IV	0.5-1	5-10	↓ BP Apnea
ANALGESICS				
Fentanyl	2-5 µg/kg IV	3-5	30-90	Respiratory depression Chest wall rigidity
Morphine	0.1 mg/kg IV	5-15	120-240	↓ BP Respiratory depression
NEUROMUSCULAR BLOCKING AGENTS				
Vecuronium	0.1 mg/kg IV	1.5-2	30-75	↑ HR Renal elimination
Rocuronium	0.6-1.2 mg/kg IV 1 mg/kg IM	1-1.5	15-60	↑ HR Renal elimination
Cisatracurium	0.1 mg/kg IV	3-5	25-30	Histamine release Nonrenal elimination

BP, Blood pressure; HR, heart rate; ICP, intracranial pressure; IM, intramuscularly; IV, intravenously.

A ventilated child develops a sudden reduction in lung compliance. Under which ventilation mode in the comparison table would the delivered tidal volume change when the set inflation pressure remains fixed?

A. Pressure-controlled ventilation
B. Volume-controlled ventilation
C. Neither mode
D. A humidified face mask
E. Room-air spontaneous breathing

Original table 86.12 | Nelson printed p. 625 | PDF p. 672

Table 86.12 Characteristics of Pressure-Controlled and Volume-Controlled Methods of Ventilation

	PRESSURE-CONTROLLED VENTILATION	VOLUME-CONTROLLED VENTILATION
Control setting(s)	Inflation pressure Inspiratory time Rise time	Tidal volume Flow rate Inspiratory flow pattern (constant vs decelerating)
Machine-delivered volume	Depends on respiratory system compliance and resistance	Constant
Inflation pressure	Constant	Depends on respiratory system compliance and resistance
Endotracheal tube leak	Somewhat compensated	Leaked volume part of tidal volume
Distribution of ventilation	More uniform in lungs with varying time constant units	Less uniform in lungs with varying time constant units
Patient comfort	Possibly compromised	Possibly enhanced
Weaning	Inflation pressure adjustment required to deliver desired tidal volume	Tidal volume remains constant; inflation pressure automatically weaned

A child with ARDS has low respiratory-system compliance with relatively normal airway resistance. Which category of ventilation strategy does the table group with this physiology?

A. Pressure-controlled ventilation strategies
B. No assisted ventilation under any circumstances
C. Only simple nasal cannula regardless of severity
D. A fixed spontaneous-only setting for every patient
E. Cardiac pacing

Original table 86.13 | Nelson printed p. 628 | PDF p. 675

Table 86.13 Suggested Mechanical Ventilation Strategies in Various Clinical Situations

SITUATION	DISEASE	STRATEGY
Low compliance, normal resistance	ARDS	PCV, APRV, HFOV
Normal compliance, high resistance	Asthma	PCV, PRVC
Normal compliance, normal resistance, for weaning	Head trauma, drug overdose, subglottic stenosis	VCV

APRV, Airway pressure release ventilation; ARDS, acute respiratory distress syndrome; HFOV, high-frequency oscillatory ventilation; PCV, pressure-controlled ventilation; PRVC, pressure-regulated volume control; VCV, volume-controlled ventilation.

A 12-year-old develops headache, nausea, and marked fatigue soon after rapid ascent to high altitude. Which assessment instrument listed in the table combines these symptom domains?

A. Lake Louise Acute Mountain Sickness Score
B. Glasgow Coma Scale
C. NEXUS
D. CRIES
E. Phoenix Sepsis Score

Original table 87.1 | Nelson printed p. 631 | PDF p. 677

Table 87.1 2018 Lake Louise Acute Mountain Sickness Score

HEADACHE 0 – None at all 1 – Mild headache 2 – Moderate headache 3 – Severe headache, incapacitating
GASTROINTESTINAL SYMPTOMS 0 – Good appetite 1 – Poor appetite or nausea 2 – Moderate nausea or vomiting 3 – Severe nausea and vomiting, incapacitating
FATIGUE AND/OR WEAKNESS 0 – Not tired or weak 1 – Mild fatigue/weakness 2 – Moderate fatigue/weakness 3 – Severe fatigue/weakness, incapacitating
DIZZINESS/LIGHTHEADEDNESS 0 – No dizziness/lightheadedness 1 – Mild dizziness/lightheadedness 2 – Moderate dizziness/lightheadedness 3 – Severe dizziness/lightheadedness, incapacitating
AMS CLINICAL FUNCTIONAL SCORE Overall, if you had AMS symptoms, how did they affect your activities? 0 – Not at all 1 – Symptoms present, but did not force any change in activity or itinerary 2 – My symptoms forced me to stop the ascent or to go down on my own power 3 – Had to be evacuated to a lower altitude To obtain the AMS score, add number from each category earlier. Although no official severity rankings exist, many consider mild AMS to be 3-5 points, moderate AMS 6-9 points, and severe AMS 10-12 points.

From Roach RC, Hackett PH, Oelz O, et al. The 2018 Lake Louise Acute Mountain Sickness Score. *High Alt Med Biol*. 2018:19(1):4–6. Table 1.

A child develops acute mountain sickness after ascent. Which listed drug acts as a carbonic anhydrase inhibitor?

A. Acetazolamide
B. Midodrine
C. Propranolol
D. Amoxicillin
E. Olanzapine

Original table 87.2 | Nelson printed p. 633 | PDF p. 679

Table 87.2 Medications for Treatment of Altitude-Associated Illness in Children*

MEDICATION	CLASSIFICATION	INDICATION	DOSE AND ROUTE	ADVERSE EFFECTS
Acetazolamide	Carbonic anhydrase inhibitor	AMS treatment	2.5 mg/kg PO every 12 hours; maximum 250 mg/dose	Collateral effects include paresthesias, altered taste and visual acuity, electrolyte disturbance
		AMS or re-entry HAPE prevention[1]	1.25 mg/kg PO every 12 hours; maximum dose 125 mg/dose	Collateral effects reduced at lower doses
Dexamethasone	Steroid	AMS or HACE treatment[2,3]	0.15 mg/kg PO/IM/IV every 6 hours; maximum 4 mg/dose	Hypertension, GI hemorrhage, pancreatitis, growth inhibition
Nifedipine	Calcium-channel blocker	HAPE treatment or prevention[4]	If > 50 kg use adult dosing of 30 mg extended-release PO every 12 hours	Flushing, gastrointestinal distress, hypotension
Amlodipine	Calcium-channel blocker	HAPE treatment or prevention[4,5]	*1-5 years:* 0.1-0.6 mg/kg/dose PO daily; maximum 5 mg/day *6-17 years:* 2.5-5.0 mg PO daily (tablet or liquid suspension)	Flushing, abdominal pain, dizziness, hypotension

*No studies in children for high-altitude indications.
[1]AMS prophylaxis is not routinely recommended in children but indicated when rapid ascent profile is unavoidable or previous altitude illness occurred in a child about to undergo

A child with a congenital left-to-right shunt plans a rapid trip to high altitude. Why does the table flag this condition for high-altitude pulmonary edema risk?

A. It can increase pulmonary blood flow or arterial pressure
B. It always prevents pulmonary vasoconstriction
C. It causes absence of all pulmonary circulation
D. It is a form of altitude acclimatization
E. It eliminates oxygen requirements

Original table 87.3 | Nelson printed p. 634 | PDF p. 680

Table 87.3 Conditions Associated with Increased Risk of HAPE

ENVIRONMENTAL
Ascent above 2,500 m (~8,200 ft)
Rapid rate of ascent (generally >1,000 m [~3,300 ft] per day)
Cold exposure
CARDIAC
Anomalies causing increased pulmonary blood flow or increased pulmonary arterial pressure
• Ventricular septal defect, atrial septal defect, patent foramen ovale, patent ductus arteriosus
• Anomalous pulmonary venous return or pulmonary vein stenosis
• Unilateral absent pulmonary artery or isolated pulmonary artery of ductal origin
Coarctation of the aorta
Congestive heart failure
PULMONARY
Chronic lung disease
Bronchopulmonary dysplasia
Cystic fibrosis (FEV-1 <30% predicted)
Pulmonary hypoplasia
Supplemental oxygen requirement at sea level
Pulmonary hypertension
Perinatal respiratory distress
Persistent pulmonary hypertension of the newborn
Perinatal asphyxia or depression
Sleep apnea
INFECTIOUS
Upper respiratory tract infection
Bronchitis/bronchiolitis
Pneumonitis
Otitis media
PHARMACOLOGIC
Any medication causing central nervous system and respiratory depression
Alcohol
Sympathomimetics
SYSTEMIC
Down syndrome (trisomy 21)
History of premature birth or low birthweight

A toddler lives in a home with a swimming pool and is sometimes watched by several adults who assume another adult is supervising. Which prevention gap from the table is most relevant?

A. Lapse in designated supervision
B. Excess vaccination
C. High dietary fiber
D. Insufficient school homework
E. Need for ECG screening

Original table 88.1 | Nelson printed p. 645 | PDF p. 691

Table 88.1 Approach to Prevention Strategies for Drowning

	HOME	RECREATION	NEIGHBORHOOD
Water hazards	• Swimming pools • Ponds • Bathtubs • Large buckets • Drain entrapment	• Playing in water (swimming, wading) • Playing near water • Being on water (boating)	• Irrigation ditches • Watering holes • Water drainage

Common risks	• Lapse in supervision
	• Unexpected toddler exposure
	• Delayed discovery of child
	• Reliance on water wings or pool toys
	• Reliance on sibling or bath seat for bathing supervision
	• Epilepsy
	• Autism
	• ADHD
	• LQTS
		• Lapse in supervision
		• Change in weather
		• Unfamiliarity with or change(s) in water conditions:
		  • Steep drop-off
		  • Current/tide
		  • Low temperature
		• Alcohol and other drug use
		• Peer pressure
			• Lapse in supervision, particularly when caregiver is socializing
			• Risky behavior when with peers

Prevention strategies	• Recognize hazards and risks • Provide constant adult supervision around water • Install 4-sided, isolation locked fencing of pools • Install rescue equipment and phone at poolside • Learn swimming and water survival skills • Avoid unsupervised baths in older child/teen with seizure disorder; instead, shower • Learn first aid and CPR	• Provide constant adult supervision • Swim in lifeguarded areas • Know when and how to wear US Coast Guard–approved PFDs • Avoid alcohol and other drugs • Learn swimming and water survival skills • Teach children about water safety • Be aware of current weather and water conditions • Buddy system • Learn first aid and CPR	• Identify hazardous bodies of water • Prevent access to water with barriers • Provide fenced-in "safe area" for water recreation • Provide lifeguarded swim sites • Provide access to low-cost swim/water survival lessons

ADHD, attention deficit hyperactivity disorder; CPR, cardiopulmonary resuscitation; LQTS, long QT syndrome; PFDs, personal floatation devices.

A family wants to reduce hot-water scald risk for young children. Which prevention measure is listed?

A. Set the hot-water thermostat no higher than 48.9 C (120 F)
B. Leave hot beverages within reach
C. Disable smoke alarms
D. Place curling irons near the bathtub
E. Encourage children to play with lighters

Original table 89.1 | Nelson printed p. 646 | PDF p. 692

Table 89.1 Burn Prophylaxis

PREVENT FIRES

Install and use smoke detectors.

Control the hot water thermostat; maximum water temperature should be 48.9°C (120°F).

Keep fire, matches, and lighters out of the reach of children.

Avoid cigarette smoking, especially in bed.

Do not leave lit candles unattended.

Keep hair appliances such as curling irons and straighteners out of the reach of children.

Use caution when cooking, especially with oil.

Keep cloth items off heaters.

PREVENT INJURY

Stop, drop, and roll (do not run) if clothing catches fire; wrap in a blanket.

Practice escape procedures.

Crawl beneath smoke if a fire occurs indoors.

Use educational materials.*

*National Fire Protection Association pamphlets and videos

A child has a small facial burn after inhaling smoke in a closed room and now has signs of airway injury. Which reason in the table supports referral to a burn center?

A. Suspected inhalation injury regardless of burned body-surface area
B. Only the presence of a foot burn
C. Need for routine school follow-up
D. No referral because the skin injury is small
E. Only injury from cold exposure

Original table 89.2 | Nelson printed p. 647 | PDF p. 693

Table 89.2 Indications for Referral to a Burn Center

Partial-thickness burns affecting >10% TBSA
Full-thickness burn affecting >5% TBSA
Third-degree burns
Electrical burns caused by high-tension wires or lightning
Chemical burns
Inhalation injury, regardless of the amount of TBSA burned
Inadequate home or social environment
Suspected child abuse or neglect
Burns to the face, hands, feet, perineum, genitals, or major joints
Burns in patients with preexisting medical conditions that may complicate the acute recovery phase
Associated injuries (fractures)

TBSA, Total body surface area.
Adapted from American Burn Association/American College of Surgeons. Guidelines for the operation of burn centers. *J Burn Care Res.* 2007;28(1):134–141 and Bettencourt

A child arrives soon after a significant burn. Which early care priority is included in the acute-treatment table?

A. Fluid resuscitation and pain control
B. Immediate return to full-contact sports
C. Deliberate withholding of all nutrition
D. Routine neglect of wound hygiene
E. Avoidance of assessment for infection

Original table 89.3 | Nelson printed p. 647 | PDF p. 693

Table 89.3 Acute Treatment of Burns

First aid, including washing of wounds and removal of devitalized tissue
Fluid resuscitation
Provision of energy requirements
Control of pain
Prevention of infection
Early excision and grafting
Prevention of excessive metabolic expenditures
Control of bacterial wound flora
Early mobility, range of motion, and strength exercises

A child is in the first 24 hours after a major burn, with capillary leak and developing edema. Which phase and priority in the table best apply?

A. Resuscitation with airway, breathing, circulation, and fluid assessment
B. Late rehabilitation only
C. Scar revision as the sole immediate goal
D. Uncomplicated outpatient feeding advice
E. No monitoring until edema resolves

Original table 89.4 | Nelson printed p. 648 | PDF p. 694

Table 89.4 Phases of Burn Care

PHASE AND TIMING	PHYSIOLOGIC CHANGES	OBJECTIVES
1: Resuscitation, 0-72 hours	Massive capillary leak, edema, and burn shock	Airway, breathing, and circulation optimization via accurate fluid resuscitation and thorough evaluation
2: Acute treatment phase, day 3 through discharge	Hyperdynamic and catabolic state, immunosuppression, risk of infection	Enteral nutrition to optimize wound healing; excision and biologic wound closure of full-thickness wounds with excision and grafting within 7 days of injury
3: Rehabilitation, day 1 through discharge	Gradual waning of initial catabolic state, wounds heal, scars form, and strength recovers	Maintain and restore range of motion; reduce edema; strengthen muscles; facilitate return to home, work, and school

A child has a dry, leathery, insensate burn with no blanching. Which depth category best matches the table?

A. Full-thickness burn
B. Superficial first-degree burn
C. Superficial partial-thickness burn
D. Intact unburned skin
E. Frostbite only

Original table 89.5 | Nelson printed p. 649 | PDF p. 695

Table 89.5 Categories of Burn Depth

	FIRST-DEGREE BURN	SECOND-DEGREE BURN (PARTIAL THICKNESS)	THIRD-DEGREE BURN (FULL-THICKNESS)
Surface appearance	Dry, no blisters Minimal or no edema Erythematous Blanches, bleeds	Moist blebs, blisters Underlying tissue is mottled pink and white, with fair capillary refill Bleeds	Dry, leathery eschar Mixed white, waxy, khaki, mahogany, soot-stained No blanching or bleeding
Pain	Very painful	Very painful	Insensate centrally, edges (usually less deep) may still have sensation
Histologic depth	Epidermal layers only	Epidermis, papillary, and reticular layers of dermis May include domes of subcutaneous layers	Through all layers of the skin to subcutaneous tissue (loss of muscle, bone is fourth-degree burn)
Healing time	2-5 days with no scarring	Superficial: 5-21 days with no grafting Deep partial: 21-35 days with no infection, but scar is expected; if infected, converts to full-thickness burn	Large areas require grafting, but small areas may heal from the edges after weeks

A burn wound expected to heal within about a week needs a clear topical agent active mainly against gram-positive organisms. Which listed agent best matches?

A. Bacitracin
B. Plain petrolatum without any antimicrobial claim
C. Systemic amphotericin
D. Oral acetazolamide
E. Intravenous midodrine

Original table 89.7 | Nelson printed p. 652 | PDF p. 698

Table 89.7 Topical Agents Used for Burns

AGENT	EFFECTIVENESS	SIDE EFFECTS	EASE OF USE
Bacitracin	Gram-positive organisms; good for wounds that will heal in 7-10 days	May cause yeast overgrowth rash or pustules if on intact skin; resolves with discontinuation	Clear ointment, 1-2 times daily, easy to clean off
Silver sulfadiazine cream (Silvadene)	Broad spectrum including gram-positive and -negative organisms, some fungus; may cause leukopenia	Leukopenia, self-limited; may be painful Leaves adherent residue	Changed twice daily Residue *must* be washed off with each dressing change
Mafenide acetate cream* (Sulfamylon)	Targets resistant gram-negative organisms, particularly *Pseudomonas,* some gram-positive coverage Rapid and deep wound penetration; used on cartilage (ears) and deep wound infection	Carbonic anhydrase inhibitor, may cause metabolic acidosis	Changed twice daily; application may be painful Residue *must* be washed off with each dressing change
0.5% Silver nitrate solution	Bacteriostatic Broad spectrum, including some fungi Superficial penetration	Permanent staining of surfaces from silver oxidation; electrolyte disturbances from hypotonic solution, potential methemoglobinemia	Closed bulky dressing soaked every 2 hr and changed 1-2 times daily

*Mafenide acetate solution at concentrations of 2.5% or 5% for use on heavily colonized, multidrug-resistant organisms to be used for 5 days only.

Months after a large burn, a child has limited joint movement from tight scar tissue. Which long-term complication listed in the table explains the limitation?

A. Contracture
B. Acute hypovolemia
C. Simple fever
D. Primary tic disorder
E. Transient photophobia

Original table 89.8 | Nelson printed p. 655 | PDF p. 701

Table 89.8 Common Long-Term Complications and Disabilities in Patients with Burn Injuries

COMPLICATIONS AFFECTING THE SKIN AND SOFT TISSUE
Hypertrophic scars
Susceptibility to minor trauma
Dry skin
Contractures
Itching and neuropathic pain
Alopecia
Chronic open wounds
Skin cancers
Epidermal inclusion cysts
Cutaneous abscesses

ORTHOPEDIC DISABILITIES
Amputations
Contractures
Heterotopic ossification
Temporary reduction in bone density
Decreased endurance and weakness

METABOLIC DISABILITIES
Heat sensitivity
Obesity
Glucose intolerance
Hypertension

PSYCHIATRIC AND NEUROLOGIC DISABILITIES
Sleep disorders
Adjustment disorders
Posttraumatic stress disorder
Depression
Body image issues
Neuropathy and neuropathic pain
Long-term neurologic effects of carbon monoxide poisoning
Anoxic brain injury

LONG-TERM COMPLICATIONS OF CRITICAL CARE
Deep vein thrombosis, venous insufficiency, or varicose veins
Tracheal stenosis, vocal cord disorders, or swallowing disorders
Renal or adrenal dysfunction
Hepatobiliary or pancreatic disease
Cardiovascular disease
Reactive airway disease or bronchial polyposis

PREEXISTING DISABILITIES THAT CONTRIBUTED TO THE INJURIES
Risk-taking behavior
Untreated or poorly treated psychiatric disorder

Modified from Sheridan RL, Schultz JT, Ryan CM, et al. Case records of the Massachusetts General Hospital. Weekly clinicopathological exercises. Case 6-2004: A 35-year-old woman with extensive, deep burns from a nightclub fire. *N Engl J Med.* 2004;350:810–821.

A child exposed to a high-voltage electrical source has a small entrance wound. Which hidden organ complication in the table should be considered?

A. Cardiac dysrhythmia
B. Only superficial skin itching
C. Isolated allergic rhinitis
D. Simple speech delay
E. A predictable absence of deep injury

Original table 89.9 | Nelson printed p. 656 | PDF p. 702

Table 89.9 Electrical Injury: Clinical Considerations

SYSTEM	CLINICAL MANIFESTATIONS	MANAGEMENT
General	—	• Extricate the patient • Perform ABCs of resuscitation; immobilize the spine • Obtain history: voltage, type of current • Obtain complete blood count with platelets, electrolytes, BUN, creatinine, and glucose
Cardiac	Dysrhythmias: asystole, ventricular fibrillation, sinus tachycardia, sinus bradycardia, premature atrial contractions, premature ventricular contractions, conduction defects, atrial fibrillation, ST- and T-wave changes	• Treat dysrhythmias • Provide cardiac monitor, electrocardiogram, and radiographs with suspected thoracic injury • Perform creatinine phosphokinase with isoenzyme measurements if indicated
Pulmonary	Respiratory arrest, acute respiratory distress, aspiration syndrome	• Protect and maintain the airway • Provide mechanical ventilation if indicated, chest radiograph, and arterial blood gas levels
Renal	Acute kidney injury, myoglobinuria	• Provide aggressive fluid management unless central nervous system injury is present • Maintain adequate urine output, >1 mL/kg/hr if myoglobinuria; addition of HCO_3^-, mannitol may be needed to alkalinize urine and stimulate diuresis, respectively • Consider central venous or pulmonary artery pressure monitoring • Measure urine myoglobin; perform urinalysis; measure BUN, creatinine
Neurologic	Immediate: loss of consciousness, motor paralysis, visual disturbances, amnesia, agitation; intracranial hematoma	• Treat seizures • Provide fluid restriction if indicated
	Secondary: pain, paraplegia, brachial plexus injury, syndrome of inappropriate antidiuretic hormone secretion, autonomic disturbances, cerebral edema	• Consider spine radiographs and MRI, especially cervical
	Delayed: paralysis, seizures, headache, peripheral neuropathy	• Perform CT or MRI scan of the brain if indicated
Cutaneous/oral	Oral commissure burns, tongue and dental injuries; skin burns resulting from ignition of clothes, entrance and exit burns, and arc burns	• Document entrance and exit wounds • Treat cutaneous burns; determine patient's tetanus status • Obtain consultation for plastic surgery of ear, nose, and throat, if indicated
	Electrical burns to mouth could include oral commissures and lips; low-voltage electrical burns secondary to high conductivity of saliva	• Ensure no entry or exit wounds and no cardiac involvement • Confirm all injuries are localized • Management is observation until eschar sloughs off and granulation tissue fills in • If bleeding at corner of mouth from labial artery, pinch lower lip to stop bleeding and consult surgeon • High risk for scarring; refer to burn center for long-term management
Abdominal	Viscus perforation and solid-organ damage; ileus; abdominal injury rare without visible abdominal burns	• Place nasogastric tube if patient has airway compromise or ileus • Obtain serum ALT, AST, amylase, BUN, and creatinine measurements and CT scans as indicated
Musculoskeletal	Compartment syndrome from subcutaneous necrosis limb edema and deep burns	• Monitor patient for possible compartment syndrome
	Long-bone fractures, spine injuries	• Obtain radiographs and orthopedic/general surgery consultations as indicated
Ocular	Visual changes, optic neuritis, cataracts, extraocular muscle paresis	• Obtain an ophthalmology consultation to document and follow for cataract formation

AST, Aspartate transaminase; ALT, alanine transaminase; BUN, blood urea nitrogen.
Adapted from Hall ML, Sills RM. Electrical and lightning injuries. In: Barkin RM, ed. *Pediatric Emergency Medicine*. St Louis: Mosby; 1997: p. 484.

A hypothermic child develops ataxia and apathy as core temperature falls. Which general severity progression is shown in the table?

A. Worsening neurologic function with lower core temperature
B. Guaranteed normal cognition at every temperature
C. Only skin color changes as temperature falls
D. Immediate fever after cooling
E. No effect on respiratory physiology

Original table 90.1 | Nelson printed p. 658 | PDF p. 704

Table 90.1 Physiologic Characteristics of the Four Zones of Hypothermia

STATE	CORE TEMPERATURE °C (°F)	CHARACTERISTICS
Mild	35 (95)	Urine temperature, 34.8°C (94.6°F); increased shivering thermogenesis; increase in metabolic rate
	34 (93.2)	Amnesia and dysarthria develop; normal blood pressure; maximum respiratory stimulation
	33 (91.4)	Ataxia, apathy develop
Moderate	32 (89.6)	Stupor; 25% decrease in oxygen consumption
	31 (87.8)	Decreased shivering thermogenesis
	30 (86)	Atrial fibrillation and other dysrhythmias; poikilothermia; pulse and cardiac output two-thirds normal; insulin ineffective
	29 (85.2)	Progressive decrease in level of consciousness, pulse, and respiration; pupils dilated
Severe	28 (82.4)	Ventricular fibrillation susceptibility; 50% decrease in oxygen consumption and pulse
	27 (80.6)	Losing reflexes and voluntary motion
	26 (78.8)	Major acid-base disturbances; no reflexes or response to pain
	25 (77)	Cerebral blood flow one-third normal; cardiac output 45% normal; pulmonary edema may develop
	24 (75.2)	Significant hypotension
	23 (73.4)	No corneal or oculocephalic reflexes
	22 (71.6)	Maximum risk of ventricular fibrillation; 75% decrease in oxygen consumption
Profound	20 (68)	Lowest resumption of cardiac electromechanical activity; pulse 20% of normal
	19 (66.2)	Flat electroencephalogram
	18 (64.4)	Asystole develops
	14.2 (57.6)	Lowest accidental hypothermia survival in an infant
	13.7 (56.7)	Lowest accidental hypothermia survival in an adult
	9 (48.2)	Lowest therapeutic hypothermia survival

From Zafren K, Danzl DF. Accidental hypothermia. In: Walls RM, Hockberger RS, Gausche-Hill M, et al., eds. *Rosen's Emergency Medicine*, 9th ed. Philadelphia: Elsevier; 2018, Table 132.1, p. 1744.

A child after cold exposure has frostbitten fingers with redness and swelling but no blister or tissue necrosis. Which grade from the table best fits?

A. Grade I
B. Grade II
C. Grade III
D. Grade IV
E. Unrelated chronic burn

Original table 90.2 | Nelson printed p. 660 | PDF p. 706

Table 90.2 Different Degrees of Frostbite and Their Physiologic Characteristics

GRADE I INJURY	GRADE II INJURY	GRADE III INJURY	GRADE IV INJURY
• Superficial • Edema and redness without tissue necrosis in the affected area • Numbness, firm white-yellow plaque • No blisters or necrosis • Occasional skin desquamation (5-10 days later)	• Blister formation • Erythema, substantial edema • Vesicles with clear or milky fluid • Blisters • Desquamation and black eschar formed	• Tissue necrosis • Hemorrhagic deeper blisters • Skin necrosis • Blue-gray discoloration	• Development of gangrene, requiring amputation • Full-thickness skin, subcutaneous tissue, muscle, tendon, and bone freezing • Little edema • Initially mottled, deep red or eventually dry, black, and mummified

Modified from Joshi K, Govary D, Mazumder B, et al. Frostbite: Current status and advancements in therapeutics. *J Therm Biol*. 2020;93:102716. Table 1.

A child previously had difficult mask ventilation during anesthesia. Which historical source should the preanesthetic assessment specifically review?

A. Prior anesthetic records and airway details
B. The current medication list alone
C. The most recent routine growth chart alone
D. The standard preoperative laboratory panel alone
E. A caregiver report without prior airway documentation

Original table 91.2 | Nelson printed p. 665 | PDF p. 711

Table 91.2 The Preanesthetic History

Child's Previous Anesthetic and Surgical Procedures
- Review previous anesthetic records:
  Ease of mask ventilation
  Grade of laryngoscopy; type and size of laryngoscope; endotracheal tube size
  Issues during emergence (awakening) from anesthesia (postoperative vomiting, emergence delirium)
  History of hyperthermia or acidosis in the child or family members

Perinatal Problems (Especially for Infants)
- Prematurity
- Need for supplemental oxygen or intubation and ventilation
- History of apnea and bradycardia
- History of cardiovascular compromise
- Other major illnesses and hospitalizations
- Family history of anesthetic complications, malignant hyperthermia, or pseudocholinesterase deficiency

Respiratory Problems
- Long-term exposure to environmental tobacco smoke
- Obstructive breathing score
- STBUR (snoring, trouble breathing, unrefreshed)
- Cyanosis (especially in infants <6 mo of age)
- Recurrent respiratory infections
- Recent lower respiratory tract infection
- Previous laryngotracheitis (croup) or laryngomalacia
- Reactive airway disease
- Airway abnormalities, facial anomalies, mucopolysaccharidosis

Cardiac Problems
- Murmur or history of congenital heart disease
- Dysrhythmia
- Exercise intolerance
- Syncope
- Cyanosis

Gastrointestinal Problems
- Reflux and vomiting
- Feeding difficulties
- Failure to thrive
- Liver disease
- Exposure to infectious pathogens

Neuromuscular Problems
- Neuromuscular diseases
- Developmental delay
- Myopathy
- Seizure disorder

Hematologic Problems
- Anemia
- Bleeding diathesis
- Tumor
- Immunocompromise
- Prior blood transfusions and reactions

Renal Problems
- Renal insufficiency, oliguria, anuria
- Fluid and electrolyte abnormalities

Psychosocial Considerations
- Drug abuse, use of cigarettes or alcohol
- Physical or sexual abuse
- Family dysfunction
- Previous traumatic medical or surgical experience
- Psychosis, anxiety, depression

Gynecologic Considerations
- Sexual history (sexually transmitted infections)
- Possibility of pregnancy

Current Medications
- Prior administration of corticosteroids

Allergies
- Drugs
- Iodine
- Latex products
- Surgical tape
- Food (especially soy and egg albumin)

Other
- Dental condition (loose or cracked teeth)
- When and what the child last ate (especially in emergency procedures)

in children with seizure disorders because the seizure threshold may

rapid-onset anxiolysis and amnesia and may decrease negative behav-

A child with poorly controlled asthma is scheduled for anesthesia. Which perioperative risk in the disease-implications table warrants optimization?

A. Intraoperative bronchospasm
B. Obligatory atrioventricular block
C. Guaranteed lack of airway reactivity
D. Isolated postoperative alopecia
E. An unavoidable blood transfusion

Original table 91.3 | Nelson printed p. 666 | PDF p. 712

Table 91.3 Specific Pediatric Diseases and Their Anesthetic Implications

DISEASE	IMPLICATIONS
RESPIRATORY SYSTEM	
Asthma	Intraoperative bronchospasm that may be life threatening
	Pneumothorax or atelectasis
	Optimal preoperative medical management is essential
Difficult airway	Special equipment and personnel may be required
	Should be anticipated with dysmorphic features or storage diseases
	Patients with trisomy 21 may require atlantooccipital joint evaluation
	Increased risk with acute airway obstruction, epiglottitis, laryngotracheobronchitis, or airway foreign body
Bronchopulmonary dysplasia	Barotrauma with positive pressure ventilation
	Oxygen toxicity, pneumothorax a risk
Cystic fibrosis	Airway reactivity, bronchorrhea, increased intraoperative pulmonary shunt and hypoxia
	Risk of pneumothorax, pulmonary hemorrhage
	Atelectasis, risk of prolonged postoperative ventilation
	Patient should be assessed for cor pulmonale
Sleep apnea	Pulmonary hypertension and cor pulmonale must be excluded
	Careful postoperative observation for obstruction required
CARDIAC	
	Bacterial endocarditis prophylaxis as indicated
	Use of air filters; careful purging of air from the intravenous equipment
	Physician must understand the effects of various anesthetics on the hemodynamics of specific lesions
	Possible need for preoperative evaluation of myocardial function and pulmonary vascular resistance
	Provide information about pacemaker function and ventricular device function
HEMATOLOGIC	
Sickle cell disease	Possible need for simple or exchange transfusion based on preoperative hemoglobin concentration and percentage of hemoglobin S
	Avoid hypoxemia, hypothermia, dehydration, and hyperviscosity states
Oncology	Pulmonary evaluation of patients who have received bleomycin, *bis*-chloroethyl-nitrosourea, chloroethyl-cyclohexyl-nitrosourea, methotrexate, or radiation to the chest
	Avoidance of high oxygen concentration
	Cardiac evaluation of patients who have received anthracyclines; risk of severe myocardial depression with volatile agents
	Potential for coagulopathy
RHEUMATOLOGIC	
	Limited mobility of the temporomandibular joint, cervical spine, arytenoid cartilages
	Careful preoperative evaluation required
	Possible difficult airway

DISEASE	IMPLICATIONS
GASTROINTESTINAL	
Esophageal, gastric	Potential for reflux and aspiration
Liver	Altered metabolism of many anesthetic drugs
	Potential for coagulopathy and uncontrollable intraoperative bleeding
RENAL	
	Altered electrolyte and acid-base status
	Altered clearance of many anesthetic drugs
	Need for preoperative dialysis in selected cases
	Succinylcholine to be used with extreme caution and only when the serum potassium level has recently been shown to be normal
NEUROLOGIC	
Seizure disorder	Avoidance of anesthetics that may lower the seizure threshold
	Optimal control ascertained preoperatively
	Preoperative serum anticonvulsant measurements
Increased intracranial pressure	Avoidance of agents that increase cerebral blood flow
	Maintain cerebral perfusion pressure.
Neuromuscular disease	Avoidance of depolarizing relaxants; at risk for hyperkalemia
	Patient may be at risk for malignant hyperthermia; avoid volatile anesthetics in myopathies
Developmental delay	Patient may be uncooperative during induction and emergence
Psychiatric	Monoamine oxidase inhibitor (or cocaine) may interact with meperidine, resulting in hyperthermia and seizures
	Selective serotonin reuptake inhibitors may induce or inhibit various hepatic enzymes that may alter anesthetic drug clearance
	Illicit drugs may have adverse effects on cardiorespiratory homeostasis and may potentiate the action of anesthetics
ENDOCRINE	
Diabetes	Greatest risk is unrecognized intraoperative hypoglycemia; intraoperative blood glucose level monitoring needed especially when insulin is administered
SKIN	
Burns	Difficult airway
	Fluid shifts
	Bleeding
	Risk of rhabdomyolysis and hyperkalemia from succinylcholine after burns for many months
IMMUNOLOGIC	
	Retroviral drugs may inhibit benzodiazepine clearance
	Immunodeficiency requires careful infection control practices
	Cytomegalovirus-negative blood products, irradiation, or leukofiltration may be required
METABOLIC	
	Careful assessment of glucose homeostasis in infants

in water [D5W]) facilitate gastric emptying, prevent hypoglycemia, duration of preoperative fasting in otherwise well patients without risk

A child with Pierre Robin sequence needs anesthesia. Which preparation follows from its inclusion in the difficult-airway list?

A. Anticipate difficult airway and plan appropriate personnel and equipment
B. Assume routine mask ventilation is guaranteed
C. Avoid airway assessment
D. Postpone all nutrition for a month
E. Limit evaluation to a urine dipstick

Original table 91.5 | Nelson printed p. 667 | PDF p. 713

Table 91.5 Common Difficult Airway Syndromes

Achondroplasia
Airway tumors, hemangiomas
Apert syndrome
Beckwith-Wiedemann syndrome
Choanal atresia
Cornelia de Lange syndrome
Cystic hygroma/teratoma
DiGeorge syndrome
Fractured mandible
Goldenhar syndrome
Juvenile rheumatoid arthritis
Mucopolysaccharidosis
Pierre Robin syndrome
Smith-Lemli-Opitz syndrome
Treacher-Collins syndrome
Trisomy 21
Turner syndrome

A toddler is scheduled for procedural sedation. Which safety preparation is included in the systematic approach table?

A. Review airway and comorbidities and prepare correctly sized rescue equipment
B. Skip a pre-sedation assessment
C. Use an adult fixed dose in all children
D. Avoid monitoring vital signs
E. Omit informed consent

Original table 92.1 | Nelson printed p. 676 | PDF p. 722

Table 92.1 Systematic Approach to Sedation in Children

Comprehensive medical history and organ system assessment, anticipating underlying medical problems that predispose the patient to anesthetic complications
Careful physical examination focused on the cardiorespiratory system and airway
Appropriate fasting
Informed consent
Pediatric drug dosing (mg/kg)
Appropriately sized equipment
Documentation of vital signs and condition on a time-based record
Rapid response ("code") team to respond to emergencies with "crash cart"
Fully equipped and staffed recovery area
Discharge criteria documenting recovery from sedation

A child with a fresh superficial burn reports sharp, well-localized pain. Which pain category in the table fits?

A. Somatic pain
B. Visceral pain
C. Neuropathic pain only
D. Psychogenic pain by definition
E. No pain category

Original table 93.1 | Nelson printed p. 678 | PDF p. 724

Table 93.1 Pain Categories and Characteristics

PAIN CATEGORY	DEFINITION	EXAMPLES	CHARACTERISTICS
Somatic	Pain resulting from injury to or inflammation of tissues (e.g., skin, muscle, tendons, bone, joints, fascia, vasculature)	Burns, lacerations, fractures, infections, inflammatory conditions	*In skin and superficial structures:* sharp, pulsatile, well localized *In deep somatic structures:* dull, aching, pulsatile, not well localized
Visceral	Pain resulting from injury to or inflammation of viscera	Angina, hepatic distention, bowel distention or hypermobility, pancreatitis	Aching and cramping; nonpulsatile; poorly localized (e.g., appendiceal pain perceived around umbilicus) or referred to distant locations (e.g., angina perceived in shoulder)
Neuropathic	Pain resulting from injury to, inflammation of, or dysfunction of the peripheral or central nervous system	Complex regional pain syndrome (CRPS), phantom limb pain, Guillain-Barré syndrome, sciatica	Spontaneous; burning; lancinating or shooting; dysesthesias (pins and needles, electrical sensations); **hyperalgesia** (amplification of noxious stimuli); **hyperpathia** (widespread pain in response to a discrete noxious stimulus); **allodynia** (pain in response to nonpainful stimulation); pain may be perceived distal or proximal to site of injury, often corresponding to innervation pathways (e.g., sciatica)

A verbal 11-year-old can reliably describe pain during a clinic visit. Which type of pain assessment approach in the table is appropriate for self-report?

A. A visual analog scale
B. A neonatal CRIES scale alone
C. Only heart rate without asking the child
D. Only parental guessing
E. A coma score

Original table 93.2 | Nelson printed p. 679 | PDF p. 725

Table 93.2 Pain Measurement Tools

NAME	FEATURES	AGE RANGE	ADVANTAGES	VALIDATION AND USES	LIMITATIONS
Visual Analog Scale (VAS)	Horizontal 10-cm line; subject marks a spot on the line between anchors of "no pain" and "most pain imaginable"	6-8 yr and older	Good psychometric properties; validated for research purposes	Acute pain Surgical pain Chronic pain	Cannot be used in younger children or in those with cognitive limitations Requires language skills and numerical processing; upper anchor of "most pain" requires an experiential reference point that is lacking in many children
Numerical Rating Scale (NRS)	Integers from 0 to 10, inclusive, corresponding to a range from no pain to most pain	6-8 yr and older	Good psychometric properties; validated for research purposes	Acute pain Surgical pain Chronic pain	Same as for VAS
Faces Scales (e.g., FACES-R, Wong-Baker, Oucher, Bieri, McGrath scales)	Subjects rate their pain by identifying with line drawings of faces or photos of children	3 yr and older	Can be used at younger ages than VAS and NRS	Acute pain Surgical pain	Choice of "no pain" face affects responses (neutral vs smiling); not culturally universal
Behavioral or combined behavioral-physiologic scales (e.g., FLACC, N-PASS, CHEOPS, OPS, FACS, NIPS)	Scoring of observed behaviors (e.g., facial expression, limb movement) ± heart rate and blood pressure	Some work for any ages; some work for specific age-groups, including preterm infants	May be used in both infants and nonverbal children	FLACC, N-PASS: Acute pain Surgical pain	Nonspecific; overrates pain in toddlers and preschool children; underrates persistent pain; some measures are convenient, but others require videotaping and complex processing; vital sign changes unrelated to pain can occur and may affect total score
Autonomic measures (e.g., heart rate, blood pressure, heart rate spectral analyses)	Scores changes in heart rate, blood pressure, or measures of heart rate variability (e.g., "vagal tone")	All ages	Can be used at all ages; useful for patients receiving mechanical ventilation		Nonspecific; vital sign changes unrelated to pain may occur and may artifactually increase or decrease score
Hormonal-metabolic measures	Plasma or salivary sampling of "stress" hormones (e.g., cortisol, epinephrine)	All ages	Can be used at all ages		Nonspecific; changes unrelated to pain can occur; inconvenient; cannot provide "real-time" information; standard normal values not available for every age bracket

VAS, visual analog scale; NRS, numerical rating scale; FLACC, face, legs, activity, cry, and consolability pain scale for preverbal/nonverbal patients; N-PASS, neonatal pain agitation

A preverbal infant has new grimacing, clenched fingers, tachycardia, and increased respiratory rate after a procedure. Which interpretation follows the table?

A. The findings may reflect pain and merit assessment
B. The infant cannot experience pain
C. Only spoken complaints can indicate pain
D. Tachycardia excludes pain
E. Facial expression is irrelevant

Original table 93.3 | Nelson printed p. 680 | PDF p. 726

Table 93.3 Signs and Symptoms of Pain in Infants and Young Children

PHYSIOLOGIC CHANGES	BEHAVIORAL CHANGES
• Increase in heart rate, respiratory rate, blood pressure, muscle tone • Oxygen desaturation • Sweating • Flushing • Pallor	• Change in facial expression (grimacing, furrowing of the brow, nasal flaring, deep nasolabial groove, curving of the tongue, quivering of the chin) • Finger clenching • Thrashing of limbs • Writhing • Back arching • Head banging • Poor feeding • Sleep disturbance • Pseudoparalysis

From Krauss BS, Calligaris L, Green SM, Barbi E. Current concepts in management of pain in children in the emergency department. *Lancet*. 2016;387:83–92.

A newborn after surgery has inconsolable crying, requires extra oxygen, shows raised vital signs, grimaces, and remains awake. Which tool in the table is designed to combine these domains?

A. CRIES neonatal pain scale
B. NEXUS
C. Gomez classification
D. Lake Louise score
E. Phoenix Sepsis Score

Original table 93.4 | Nelson printed p. 680 | PDF p. 726

Table 93.4 CRIES Neonatal Pain Assessment Scale

	0	1	2
Crying	No	High pitched but consolable	Inconsolable
Requires oxygen for saturation >95%	No	FiO_2 <30%	FiO_2 >30%
Increased vital signs	No	HR or BP <20%	HR or BP >20%
Expression	No	Grimace	Grimace and grunt
Sleepless	No	Wakes often	Constantly awake

Score <4 initiate nonpharmacologic measures
Score >4 initiate pharmacologic and nonpharmacologic measures
BP, Blood pressure; HR, heart rate

A child with severe cognitive impairment cannot give a standard pain self-report and shows individualized pain behaviors. Which table-listed observational tool is designed for this setting?

A. Revised FLACC scale
B. Adult visual analog self-report alone
C. NEXUS
D. AVPU as the only pain measure
E. Lake Louise score

Original table 93.5 | Nelson printed p. 680 | PDF p. 726

Table 93.5 Revised FLACC for Pain Assessment in the Cognitively Impaired*

	0	1	2
Face	No particular expression or smile	Occasional grimace/frown; withdrawn or disinterested (appears sad or worried)	Consistent grimace or frown; frequent/constant quivering chin, clenched jaw (distressed-looking face; expression of fright or panic)
Legs	Normal position or relaxed	Uneasy, restless, tense (occasional tremors)	Kicking or legs drawn up (marked increase in spasticity, constant tremors, or jerking)
Activity	Lying quietly, normal position, moves easily	Squirming, shifting back and forth, tense (mildly agitated [e.g., head back and forth, aggression]; shallow, splinting respirations, intermittent sighs)	Arched, rigid, or jerking (severe agitation, head banging; shivering [not rigors]; breath-holding, gasping or sharp intake of breath; severe splinting)
Cry	No cry (awake or asleep)	Moans or whimpers, occasional complaint (occasional verbal outburst or grunt)	Crying steadily, screams or sobs, frequent complaints (repeated outbursts, constant grunting)
Consolability	Content, relaxed	Reassured by occasional touching, hugging, or talking; distractible	Difficult to console or comfort (pushing away caregiver, resisting care or comfort measures)

*Revised descriptors for children with disabilities shown in brackets.
0= Relaxed/comfortable
1–3 = Mild discomfort

A child needs a nonopioid medication for inflammatory pain. Which drug class in the medication table provides antiinflammatory action?

A. Nonsteroidal antiinflammatory drugs
B. Opioid receptor antagonists alone
C. Anticholinergics alone
D. Thiazide diuretics
E. Antifungal agents

Original table 93.6 | Nelson printed p. 681 | PDF p. 727

Table 93.6 Commonly Used Nonopioid Medications (Antiinflammatory Medications)

MEDICATION	DOSAGE	COMMENT(S)
Acetaminophen	10-15 mg/kg PO q4h 10 mg/kg IV q4h 15 mg/kg IV q6h 10 mg/kg IV q6h (<2 yr) 20-30 mg/kg/PR q4h 40 mg/kg/PR q6-8h *Maximum daily dosing:* 75 mg/kg/24 hr (children) 60 mg/kg/24 hr (<2 yr) 30-45 mg/kg/24 hr (neonates)	Minimal antiinflammatory action; no antiplatelet or adverse gastric effects; overdosing can produce fulminant hepatic failure.
Ibuprofen	8-10 mg/kg PO q6h 10 mg/kg IV q4-6h to maximum of 400 mg *Maximum daily dose:* 2,400 mg	Antiinflammatory; transient antiplatelet effects; may cause gastritis; extensive pediatric safety experience.
Naproxen	5-7 mg/kg PO q8-12h *Maximum daily dose:* 1,000 mg	Antiinflammatory; transient antiplatelet effects; may cause gastritis; more prolonged duration than that of ibuprofen.
Ketorolac	Loading dose 0.3 mg/kg, then 0.25-0.3 mg/kg IV q6h to a maximum of 5 days; maximum single dose 15 mg for those < 50 kg and 30 mg for those ≥ 50 kg	Antiinflammatory; reversible antiplatelet effects; may cause gastritis; useful for short-term situations in which oral dosing is not feasible.
Diclofenac sodium	2-3 mg/kg/day divided in 2 or 3 doses *Maximum daily dose:* 150 mg	Antiinflammatory; reversible antiplatelet effects; lower risk of gastritis and ulceration compared with other NSAIDs.
Celecoxib	Only approved for children ≥2 yr; ≥10 kg to ≤25 kg: 50 mg PO bid >25 kg: 100 mg PO bid	Antiinflammatory; no or minimal antiplatelet or gastric effects; cross-reactivity with sulfa allergies.

A postoperative child given an opioid becomes hypoventilated and unresponsive. Which reversal medication is listed for opioid-induced respiratory depression?

A. Naloxone
B. Midodrine
C. Acetazolamide
D. Flumazenil
E. Atropine

Original table 93.8 | Nelson printed p. 684 | PDF p. 730

Table 93.8 Management of Opioid-Induced Adverse Effects

Respiratory depression	*Naloxone:* 0.01-0.02 mg/kg up to a full reversal dose of 0.1 mg/kg. May be given IV, IM, IN, SC, or via ETT. The full reversal dose should initially be used for apnea in opioid-naive patients. In opioid-tolerant patients, a reduced dose should be given and titrated up slowly to treat symptoms but prevent acute withdrawal. Ventilation may need to be supported during this process. Dose may be repeated every 2 min to a total of 10 mg. Adult maximum dose is 2 mg/dose. Give with caution to patients who are receiving long-term opioid therapy, as it may precipitate acute withdrawal. Duration of effect is 1-4 hr; therefore close observation for recurrent symptoms is essential.
Excessive sedation without evidence of respiratory depression	Change opioid or decrease the dose. In palliative patients or other special circumstances, can consider treating with stimulants. *Methylphenidate*:* 0.3 mg/kg per dose PO (typically 10-20 mg/dose to a teenager) before breakfast and lunch. Do not administer to patients receiving clonidine, because dysrhythmias may develop. *Dextroamphetamine*: 2.5-10 mg on awakening and at noon. Not for use in young children or in patients with cardiovascular disease or hypertension. *Modafinil:* Pediatric dose not established. May be useful in selected patients. Typical adult dose: 50-200 mg/day.
Nausea and vomiting	*Metoclopramide†*: 0.15 mg/kg IV up to 10 mg/dose q6-12h for 24 hr. *Trimethobenzamide:* if weight <15 kg, 100 mg PO or PR q6h; if >15 kg, 200 mg PO or PR q6h. (*Note:* Suppository contains benzocaine 2%.) Not for use in newborn infants or premature infants. 5-HT_3 receptor blockers: *Ondansetron:* 0.15 mg/kg up to 8 mg IV q6-8h not to exceed 32 mg/day (also available as a sublingual tablet). *Granisetron:* 10 to 20 µg/kg IV q12-24h. *Prochlorperazine*‡* (Compazine): >2 yr or >20 kg, 0.1 mg/kg per dose q8h IM or PO up to 10 mg/dose. Change opioid.
Pruritus	*Hydroxyzine*: 0.5 mg/kg PO q6h. *Nalbuphine:* 0.1 mg/kg IV q6h for pruritus caused by intraaxial opioids, especially fentanyl. Administer slowly over 15-20 min. May cause acute reversal of systemic µ-receptor effects and leave κ-agonism intact. *Naloxone:* 0.5-2 mcg/kg/hr IV infusion (titrate up to decrease pruritus and reduce infusion if pain increases). *Ondansetron:* 0.05-0.1 mg/kg IV or PO q8h. *Cyproheptadine†:* 0.1-0.2 mg/kg PO q8-12h. Maximum dose 12 mg. Change opioid.
Constipation	Encourage water consumption, high-fiber diet, and vegetable fiber. *Bulk laxatives:* Metamucil, Maltsupex. *Lubricants:* Mineral oil 15-30 mL PO daily as needed (not for use in infants because of aspiration risk). *Surfactants:* Sodium docusate (Colace): <3 yr: 10 mg PO q8h 3-6 yr: 15 mg PO q8h 6-12 yr: 50 mg PO q8h >12 yr: 100 mg PO q8h *Stimulants:* Bisacodyl suppository (Dulcolax): <2 yr: 5 mg PR qhs >2 yr: 10 mg PR qhs *Senna syrup* (218 mg/5 mL): >3 yr: 5 mL qhs *Enema:* Fleet hypertonic phosphate enema (older children; risk of hyperphosphatemia). *Electrolytic/osmotic:* Milk of magnesia; for severe impaction: polyethylene glycol (GoLYTELY, MiraLAX). Methylnaltrexone is an opioid antagonist that works in the colon and does not cross the blood-brain barrier to reverse analgesia; given as subcutaneous injection every day or every other day (0.15 mg/kg) and is effective in producing stool in 30-60 min in most patients.
Urinary retention	Straight catheterization, indwelling catheter. Decrease opioids, use naloxone drip.

*Avoid in patients taking monoamine oxidase inhibitors.
†May be associated with extrapyramidal side effects, which may be more often seen in children than in adults.

A child with severe renal failure needs an opioid. Which agent in the table is favored because it does not generate the active renally cleared metabolites of morphine?

A. Fentanyl
B. Morphine
C. Meperidine
D. Codeine
E. Propoxyphene

Original table 93.10 | Nelson printed p. 685 | PDF p. 731

Table 93.10 Opioid Use Guidelines in Hepatic and Renal Dysfunction

DRUG	PKA	PROTEIN BINDING (%)	PHASE 1 METABOLISM	PHASE 2 METABOLISM	ACTIVE METABOLITE	BILIARY EXCRETION[1] (%)	RENAL EXCRETION[2]	USE IN RENAL FAILURE
Morphine	8.0	30	None	Glucuronidation	M6G	10	Metabolites	Use with caution[a,c]
Fentanyl	8.4	80	CYP3A4	None	None		Norfentanyl	Preferred[b,e]
Hydromorphone	8.2	20	None	Glucuronidation	H6G		H3G & H6G	Use with caution[a,d]
Methadone	8.3	90	CYP2B6 CYP3A4, CYP2D6	None	None	20-40	Metabolites	Use with caution[b,e]
Codeine	8.2	25	CYP2D6	None	Morphine, Hydrocodone M6G		M6G	No[b,d]
Oxycodone	8.5	45	CYP3A4, CYP2D6	None	Oxymorphone		Noroxycodone	Use with caution[f]
Oxymorphone	8.2	10	CYP3A4	Glucuronidation	None		Noroxymorphone	Use with caution[a,c]
Remifentanil	7.1	70	Esterase	None	None		Metabolite	

[1]In the setting of hepatic dysfunction, all opioids should be used cautiously ("go low, go slow"). Meperidine (inactive metabolite associated with seizures) and codeine (cannot be metabolized into active metabolite, morphine) should not be used. Fentanyl may be the best opioid to use (in severe liver dysfunction, plasma cholinesterase may not be available

An infant with severe pain also receives a sedating medication. Which prescribing principle in the table is most appropriate?

A. Individualize and cautiously titrate opioid dosing with safety monitoring
B. Use one fixed adult dose regardless of weight
C. Escalate doses without reassessment
D. Ignore other sedatives
E. Assume all infants metabolize opioids identically

Original table 93.11 | Nelson printed p. 686 | PDF p. 732

Table 93.11 Practical Aspects of Prescribing Opioids

- Morphine, hydromorphone, or fentanyl is regarded as first choice for severe pain.
- Dosing should be titrated and individualized. There is no "right" dose for everyone.
- The right dose is the dose that relieves pain with a good margin of safety.
- Dosing should be more cautious in infants, in patients with coexisting diseases that increase risk or impair drug clearance, and with concomitant administration of sedatives.
- Hydromorphone is metabolized by CYP2D6 and fentanyl by CYP3A4 and to some extent 2D6; drugs that compete for 2D6 enzyme will raise blood levels and increase risk of respiratory depression.
- Morphine is metabolized by glucuronidation to an active metabolite, morphine-6-glucuronide, which accumulates and causes CNS toxicity in renal impairment.
- Anticipate and treat peripheral side effects, including constipation, nausea, and itching.
- Give doses at sufficient frequency to prevent the return of severe pain before the next dose.
- Use a drug delivery method, such as patient-controlled anesthesia or continuous infusions, that avoids the need for "prn" decision-making.
- With opioid dosing for >1 wk, taper gradually to avoid abstinence syndrome.
- When converting between parenteral and oral opioid doses, use appropriate potency ratios (see Table 93.9).
- *Tolerance* refers to decreasing drug effect with continued administration of a drug. Over time a patient will need higher dosing to achieve the same clinical effect; however, tolerance to sedation and respiratory depression develop more rapidly than tolerance to analgesia. Thus with higher doses, patients do not experience oversedation or respiratory depression.
- *Dependence* refers to the need for continued drug dosing to prevent abstinence syndrome when a drug is abruptly discontinued or its dose reduced. Abstinence syndrome is characterized by irritability, agitation, autonomic arousal, nasal congestion, piloerection, diarrhea, jitteriness, and yawning; it is produced by administration of potent opioids for >5-7 days.
- *Addiction,* a psychiatric pathology, refers to psychologic craving, compulsive drug-seeking behavior, and drug use despite medical harm. Addiction has strong genetic and environmental determinants. Opioid therapy will not lead to addiction in nonsusceptible individuals, and opioid underdosing does not prevent addiction; it may in fact increase drug-seeking behavior for relief of pain (e.g., watching the clock), referred to as "pseudoaddiction."

start IVs or provide superficial analgesia before a procedure (e.g.,

A 7-year-old needs treatment for postoperative pain. Which opioid in the FDA recommendations table is contraindicated for pain treatment in children under 12 years?

A. Codeine
B. Fentanyl
C. Morphine
D. Hydromorphone
E. Methadone

Original table 93.13 | Nelson printed p. 688 | PDF p. 734

Table 93.13 Summary of FDA Recommendations

- Use of codeine to treat pain or cough in children <12 yr old is contraindicated.
- Use of tramadol to treat pain in children <12 yr old is contraindicated.
- Use of tramadol for treatment of pain after tonsillectomy or adenoidectomy in patients <18 yr old is contraindicated. (Codeine was already contraindicated in such patients.)
- Use of codeine or tramadol in children 12-18 yr old who are obese or who have an increased risk of serious breathing problems, such as those with obstructive sleep apnea or severe lung disease, is not recommended.
- Use of codeine or tramadol in breastfeeding women should be avoided.

From FDA warns against use of codeine and tramadol in children and breastfeeding women. *Med Lett*. 2017;59(1521):86–88.

A child needs topical analgesia on intact skin before a planned needle procedure. Which table-listed combination may be applied under an occlusive dressing in advance?

A. Lidocaine-prilocaine cream
B. Oral amoxicillin
C. Intravenous furosemide
D. Saline alone
E. Topical silver sulfadiazine as the anesthetic

Original table 93.14 | Nelson printed p. 688 | PDF p. 734

Table 93.14 Topical Pharmacologic Management of Acute Pain in Children

DRUG	DOSE	NOTES
INTACT SKIN		
Lidocaine 2.5% and prilocaine 2.5% (EMLA cream)	<3 mo old or <5 kg: 1 g 3-12 mo and >5 kg: 2 g 1-6 yr and >10 kg: 10 g 7-12 yr and >20 kg: 20 g	60 min is needed to achieve maximum effect; cover cream with an occlusive dressing (Tegaderm)
Lidocaine, liposomal 5% (LMX4)	1-20 g as noted earlier	30-60 min needed to achieve maximum effect; cover with an occlusive dressing (Tegaderm)
Lidocaine 70 mg and tetracaine 70 mg (Synera patch)	Age ≥3 yr: apply patch	20-30 min needed to achieve maximum effect
Tetracaine 4% (Ametop)	>1 mo and <5 yr: apply 1 tube of gel (1 g) >5 yr: apply up to 5 tubes of gel (5 g)	30 min before venipuncture 45 min before intravenous cannulation
WOUNDS		
Lidocaine, epinephrine, tetracaine (LET) solution or gel*	Age ≥1 yr: apply to wound	20 min needed for maximum effect

*Also referred to as ALA on the basis of alternative names for the constituents: adrenaline, lignocaine, amethocaine. These mixtures are locally made by hospital formularies, with a common formula being lidocaine 4% plus epinephrine 0.1% plus tetracaine 0.5%. The cocaine-based formulation was historically avoided on wounds of digits, ears, penis, nose,

A child has chronic neuropathic pain despite treatment of the underlying cause. Which medication in the adjunctive-analgesic table is used for neuropathic pain?

A. Gabapentin
B. Amoxicillin
C. Hydrochlorothiazide
D. Ondansetron
E. Cetirizine

Original table 93.15 | Nelson printed p. 689 | PDF p. 735

Table 93.15 Commonly Used Adjunctive Analgesics

DRUG NAME (TRADE NAME)	SUGGESTED STARTING DOSE AND DOSING INTERVAL MAXIMUM DOSE PER DAY	ADVANTAGES (INDICATION FOR USE)	DISADVANTAGES (SIDE EFFECTS)
Gabapentin (Neurontin)	10-15 mg/kg per day divided bid or tid Max dose: 50 mg/kg per day (3 g/day)	Adjunct for the management of pediatric neuropathic pain, epilepsy	Drug reaction with eosinophilia and systemic symptoms (DRESS), anaphylaxis, somnolence, dizziness, peripheral edema, emotional lability, respiratory depression when combined with opioids
Pregabalin (Lyrica)	2.5 mg/kg per day divided bid or tid Max dose: 600 mg per day	Adjunct for the management of neuropathic pain associated with spinal cord injury, fibromyalgia, and epilepsy	Ataxia, blurred vision, visual field loss, constipation, drowsiness, headaches, peripheral edema, weight gain, tremor
Clonidine (Catapres)	5-25 mcg/kg per day divided every 4-8 hours if PO dosing Max dose: 2.4 mg/day	Used to treat hypertension and mitigate drug withdrawal symptoms; also used as a pain or peripheral nerve block additive	Drowsiness, dizziness, fatigue, headache, dry mouth, hypotension
Dexmedetomidine (Precedex)	Loading dose: 0.5-1 mcg/kg Infusion rate: 0.2-0.7 mcg/kg per hour titrated to effect Suggested max dose: 2.5 mcg/kg per hour	Sedative and analgesic properties; intraoperative bolus dose of 1 mcg/kg decreases postoperative morphine consumption and 2 mg/kg decreases emergence delirium	Bradycardia, hypotension
Tizanidine (Zanaflex)	Patients >18 yr: starting dose 2 mg q6-8h Max single dose: 16 mg Max daily dose: 36 mg	Antispasmodic agent	Dizziness, drowsiness, bradycardia, hypotension, fatigue, hallucinations, xerostomia
Diazepam (Valium)	PO: 0.1-0.8 mg/kg/day IV: 0.05-0.3 mg/kg/dose every 4-8 hr Max dose: 10 mg Use lowest needed dose; use lower dose when combined with opioids or other sedating medications	Antispasmodic, anxiolytic, sedative, seizure prophylaxis, promotes sleep	Somnolence, unsteady gait
Cyclobenzaprine (Flexeril)	Patients >15 yr: 5 mg PO bid-tid Max dose: 10 mg PO tid	Antispasmodic	Blurry vision, dizziness, drowsiness, lightheadedness, xerostomia
Ketamine	Loading dose: 0.25-0.5 mg/kg IV before incision Infusion rate: 0.1-1 mg/kg per hr intraoperatively 0.05-0.1 mg/kg per hr postoperatively Max parenteral dose 3,600 mg/day	Sedation, analgesic adjunct, especially beneficial for opioid-tolerant or chronic pain patients	Hallucinations, double/blurry vision, jerky muscle movements, drowsiness, loss of appetite, nausea
Lidocaine	Loading dose: 1-1.5 mg/kg IV Infusion rate: 1-2 mg/kg per hr intraoperatively Max dose: 4.5 mg/kg (not to exceed 300 mg in 2 hr)	Used during intraabdominal procedures to prevent severe postoperative pain	Cardiac arrhythmia, epilepsy/seizures, renal failure

Modified from Davis PJ, Cladis FP, eds. *Smith's Anesthesia for Infants and Children,* 10th ed. Philadelphia: Elsevier; 2022, Table 23.12, p. 510.

An adolescent is starting amitriptyline for chronic pain. Which pre-treatment assessment is specifically noted in the table?

A. A 12-lead ECG to assess QT interval
B. A routine brain biopsy
C. A daily chest radiograph
D. A serum lead concentration in every patient
E. A hearing screen before each dose

Original table 93.16 | Nelson printed p. 690 | PDF p. 736

Table 93.16 Medications for Pediatric Chronic Pain

MEDICATION	DOSING	COMMENTS
TRICYCLIC ANTIDEPRESSANTS		
Amitriptyline, nortriptyline	For patients ≥50 kg: Initial dose 5-10 mg PO qhs; titrate over 2-3 weeks to 25-50 mg PO qhs For patients 25-50 kg: Initial dose 0.1 mg/kg PO qhs. Titrate over 2-3 weeks to max dose of 0.5 mg/kg	Obtain 12-lead ECG for prolonged QT interval Side effects are related to anticholinergic effects, including tachycardia, dry mouth, urinary retention, and sedation Use with caution with other antidepressants because of risk of serotonin syndrome Concomitant use with CYP2D6 inhibitors may lead to increased serum concentration
SELECTIVE SEROTONIN-NOREPINEPHRINE REUPTAKE INHIBITORS		
Duloxetine (Cymbalta)	For patients > 13 yr: Dose 30-60 mg PO daily; max 600 mg/day	Review risk of suicidality
ANTICONVULSANTS		
Gabapentin (Neurontin)	For patients ≥50 kg: Initial dose 100-300 mg PO 1-2 times daily; titrate slowly to max dose of 1,800 mg/day divided tid; higher dosing possible in select patients For patients <50 kg: Initial dose 2-5 mg/kg PO daily; titrate slowly to max dose of 35 mg/day divided tid; higher dosing possible in select patients	Side effects include drowsiness, concentration and memory impairments, and peripheral edema (rare) Dose adjustment necessary with renal impairment
Pregabalin (Lyrica)	Patients >12 yr of age: Initial dose 25-75 mg PO 1-2 times daily; titrate up to max of 300 mg/day divided bid or tid	Side effects include drowsiness, headaches, peripheral edema (rare), and thrombocytopenia (rare)
Titrate all medications according to clinical benefit and side effects; use lowest effective dose. Antidepressants and anticonvulsants may increase the risk of suicidal thinking and behavior in children, adolescents, and young adults. Monitor closely for changes in mood or behavior.		

Modified from Davis PJ, Cladis FP, eds. *Smith's Anesthesia for Infants and Children*, 10th ed. Philadelphia: Elsevier; 2022, Table 25.2, p. 580.

After a wrist injury, a child has ongoing pain disproportionate to the injury, allodynia, swelling, temperature asymmetry, and restricted movement. Which diagnostic framework in the table applies?

A. Budapest criteria for complex regional pain syndrome
B. NEXUS cervical rule
C. CRIES neonatal score
D. Gomez malnutrition grade
E. Phoenix sepsis score

Original table 93.17 | Nelson printed p. 695 | PDF p. 741

Table 93.17 Budapest Criteria for Clinical Diagnosis of CRPS

1. **Pain** (ongoing and disproportionate to any inciting event)
2. **Symptoms (reported):** At least one symptom in three out of four of the following categories:
   - *Sensory* – Hyperesthesia and/or allodynia
   - *Vasomotor* – Temperature asymmetry and/or skin color changes and/or skin color asymmetry
   - *Sudomotor/Edema* – Edema and/or sweating changes and/or sweating asymmetry
   - *Motor/Trophic* – Decreased range of motion and/or motor dysfunction (weakness, tremor, dystonia) and/or trophic changes (hair, nail, skin)
3. **Signs (examined):** At least one sign in two out of four of the following categories:
   - *Sensory* – Hyperalgesia (to pinprick) and/or allodynia (to light touch and/or temperature sensation and/or deep somatic pressure and/or joint movement)
   - *Vasomotor* – Temperature asymmetry (>1°C) and/or skin color changes and/or asymmetry
   - *Sudomotor/Edema* – Edema and/or sweating changes and/or sweating asymmetry
   - *Motor/Trophic* – Decreased range of motion and/or motor dysfunction (weakness, tremor, dystonia) and/or trophic changes (hair, nail, skin)
4. **Diagnosis of exclusion:** No other diagnosis better explains the signs and symptoms.

CRPS, Complex regional pain syndrome
From Davis PJ, Cladis FP, eds. *Smith's Anesthesia for Infants and Children,* 10th ed.

A child develops persistent burning pain along a peripheral nerve distribution after surgery. Which category of pain syndrome is listed?

A. Posttraumatic neuropathic pain
B. Pure visceral pain
C. Normal bone growth
D. Reflex vasovagal syncope
E. Isolated seasonal allergy

Original table 93.18 | Nelson printed p. 695 | PDF p. 741

Table 93.18 Examples of Neuropathic Pain Syndromes

PERIPHERAL NERVOUS SYSTEM FOCAL AND MULTIFOCAL LESIONS

Postherpetic neuralgia
Cranial neuralgias (e.g., trigeminal neuralgia, glossopharyngeal neuralgia)
Diabetic mononeuropathy
Nerve entrapment syndromes
Plexopathy from malignancy or irradiation
Phantom limb pain
Posttraumatic neuralgia (e.g., nerve root compression, after thoracotomy)
Ischemic neuropathy
Complex regional pain syndrome types 1 and 2
Erythromelalgia

PERIPHERAL NERVOUS SYSTEM GENERALIZED POLYNEUROPATHIES

Metabolic/nutritional: Diabetes mellitus, pellagra, beriberi, multiple nutritional deficiency, hypothyroidism
Toxic: Alcohol-, platinum-, or taxane-based chemotherapy; isoniazid; antiretroviral drugs
Infective/autoimmune: HIV, acute inflammatory polyneuropathy (Guillain-Barré syndrome), neuroborreliosis (Bannwarth syndrome)
Hereditary: Fabry disease
Malignancy: Carcinomatosis
Others: Idiopathic small fiber neuropathy, erythromelalgia

CENTRAL NERVOUS SYSTEM LESIONS

Spinal cord injury
Prolapsed disc
Stroke (brain infarction, spinal infarction)
Multiple sclerosis
Surgical lesions (e.g., rhizotomy, cordotomy)
Complex neuropathic disorders
Complex regional pain syndrome types 1 and 2

Adapted from Freynhagen R, Bennett MI. Diagnosis and management of neuropathic pain. *BMJ*. 2009;339:b3002.

A child with cancer has severe pain despite lower-step therapy. Which analgesic category does the WHO ladder table assign to its highest step?

A. A strong opioid with appropriate adjuncts
B. No medication despite severe pain
C. Only a topical antihistamine
D. A diuretic without analgesia
E. An antibiotic regardless of infection

Original table 93.19 | Nelson printed p. 697 | PDF p. 743

Table 93.19 World Health Organization Analgesic Ladder for Cancer Pain

STEP 1
Patients who present with mild to moderate pain should be treated with a nonopioid.

STEP 2
Patients who present with moderate to severe pain or for whom the step 1 regimen fails should be treated with an oral opioid for moderate pain combined with a nonopioid analgesic.

STEP 3
Patients who present with very severe pain or for whom the step 2 regimen fails should be treated with an opioid used for severe pain, with or without a nonopioid analgesic.

A teenager has inherited episodes of burning red feet precipitated by warmth. Which channel gene in the table is associated with inherited erythromelalgia?

A. SCN9A
B. CFTR
C. FMR1
D. PAH
E. DMD

Original table 93.20 | Nelson printed p. 698 | PDF p. 744

Table 93.20 Clinical Features of Human Disorders Caused by Pathologic Variants in Ion-Channel Genes That Lead to Altered Pain Perception and Are Inherited in a Mendelian Manner

	AFFECTED GENE (PROTEIN)	TYPE AND EFFECT OF MUTATION	MAIN PHENOTYPE	ADDITIONAL FEATURES
Inherited erythromelalgia	*SCN9A* ($Na_v1.7$)	Heterozygous, activating	Onset by age 20 yr; episodic pain triggered by warmth; feet affected more frequently than hands	Erythema of feet
Paroxysmal extreme pain disorder	*SCN9A* ($Na_v1.7$)	Heterozygous, activating	Onset at birth; episodic pain; sacral region is affected most frequently, face is affected more often than the limbs; physical triggers include defecation	Erythema of the sacrum; tonic attacks
Small fiber neuropathy	*SCN9A* ($Na_v1.7$)	Heterozygous, activating	Onset at any age but more common in early adulthood; persistent burning pain; feet affected more frequently than hands	Could be autonomic features
Small fiber neuropathy	*SCN10A* ($Na_v1.8$)	Heterozygous, activating	Persistent burning pain	Could be autonomic features
Familial episodic pain syndrome type I	*TRPA1* (TRPA1)	Heterozygous, activating	Onset at birth or in infancy; episodic chest or arm pain; triggers are hunger and cold	—
Familial episodic pain syndrome type III	*SCN11A* ($Na_v1.9$)	Heterozygous, activating	Onset in first decade; episodic hand and foot pain; triggers are intercurrent illness or exercise	—

Na_v, Sodium ion channel.
Modified from Bennett DLH, Woods CG. Painful and painless channelopathies. *Lancet Neurol*. 2014;13:587–599, Table 1, p. 590.

A toddler ingests a small quantity of liquid lamp oil and then coughs persistently. Which principal toxicity is linked to aliphatic hydrocarbons in the table?

A. Acute lung injury
B. Congenital deafness
C. Primary retinal detachment
D. Hypothyroidism
E. Rickets

Original table 94.1 | Nelson printed p. 701 | PDF p. 747

Table 94.1 Common Agents Potentially Toxic to Young Children (<6 yr) in Small Doses*

SUBSTANCE	TOXICITY
Aliphatic hydrocarbons (e.g., gasoline, kerosene, lamp oil)	Acute lung injury
Antimalarials (chloroquine, quinine)	Seizures, dysrhythmias
Benzocaine	Methemoglobinemia
β-Adrenergic receptor blockers†	Bradycardia, hypotension
Calcium channel blockers	Bradycardia, hypotension, hyperglycemia
Camphor	Seizures
Caustics (pH <2 or >12)	Airway, esophageal and gastric burns
Clonidine	Lethargy, bradycardia, hypotension
Diphenoxylate and atropine (Lomotil)	CNS depression, respiratory depression
Ethylene glycol	Altered mental status, seizures
Hypoglycemics, oral (sulfonylureas and meglitinides)	Hypoglycemia, seizures
Imidazolines (oxymetazoline, tetrahydrozoline)	CNS depression, respiratory depression
Laundry detergent packets (pods)	Airway issues, respiratory distress, altered mental status
Lindane	Seizures
Marijuana (cannabis, THC)	Lethargy, seizures, coma
Monoamine oxidase inhibitors	Hypertension followed by delayed cardiovascular collapse
Methyl salicylate	Tachypnea, metabolic acidosis, seizures
Opioids (especially methadone, buprenorphine)	CNS depression, respiratory depression
Organophosphate pesticides	Cholinergic crisis
Phenothiazines (especially chlorpromazine, thioridazine)	Seizures, dysrhythmias
Sulfonylureas (glipizide, glyburide)	Hypoglycemia
Theophylline	Seizures, dysrhythmias
Tricyclic antidepressants	CNS depression, seizures, dysrhythmias, hypotension

*"Small dose" typically implies one to two pills or 5 mL.
†Lipid-soluble β blockers (e.g., propranolol) are more toxic than water-soluble β blockers (e.g., atenolol).

An unconscious child has pinpoint pupils after an unknown exposure. Which toxicant class does the selected-physical-findings table associate with miosis?

A. Opioids
B. Anticholinergics
C. Sympathomimetics
D. Atropine
E. Cocaine

Original table 94.2 | Nelson printed p. 702 | PDF p. 748

Table 94.2 Selected Historical and Physical Findings in Poisoning

SIGN	TOXIN
ODOR	
Bitter almonds	Cyanide
Acetone	Isopropyl alcohol, methanol, paraldehyde, salicylates
Rotten eggs	Hydrogen sulfide, sulfur dioxide, methyl mercaptans (additive to natural gas)
Wintergreen	Methyl salicylate
Garlic	Arsenic, thallium, organophosphates, selenium
Mothballs	Camphor, naphthalene
Freshly mowed hay	Phosgene
Carrots	Water hemlock
Gasoline	Petroleum distillates
OCULAR SIGNS	
Miosis	Opioids (except propoxyphene, meperidine, and pentazocine), organophosphates and other cholinergics, clonidine, phenothiazines (typical antipsychotics), sedative-hypnotics, olanzapine
Mydriasis	Anticholinergics (e.g., antihistamines, TCAs, atropine), sympathomimetics (cocaine, amphetamines, PCP), post–anoxic encephalopathy, opiate withdrawal, cathinones, MDMA
Nystagmus	Anticonvulsants, sedative-hypnotics, alcohols, PCP, ketamine, dextromethorphan
Lacrimation	Organophosphates, irritant gas or vapors
Retinal hyperemia	Methanol
CUTANEOUS SIGNS	
Diaphoresis	Cholinergics (organophosphates), sympathomimetics, salicylates, phencyclidine (PCP), withdrawal syndromes
Alopecia	Thallium, arsenic
Erythema	Boric acid, elemental mercury, cyanide, carbon monoxide, disulfiram, scombroid, anticholinergics, vancomycin
Cyanosis (unresponsive to oxygen)	Methemoglobinemia (e.g., benzocaine, dapsone, nitrites, phenazopyridine), amiodarone, silver
Bullae/blisters	Barbiturates, mustard gas, xylazine, snake, spiders
ORAL SIGNS	
Salivation	Organophosphates, salicylates, corrosives, ketamine, PCP, strychnine
Oral burns	Corrosives, oxalate-containing plants
Gum lines	Lead, mercury, arsenic, bismuth
GASTROINTESTINAL SIGNS	
Diarrhea	Antimicrobials, arsenic, iron, boric acid, cholinergics, colchicine, opioid withdrawal
Hematemesis	Arsenic, iron, caustics, NSAIDs, salicylates
Constipation	Lead
CARDIAC SIGNS	
Tachycardia	Sympathomimetics, anticholinergics, antidepressants, antipsychotics, methylxanthines (theophylline, caffeine), salicylates, cellular asphyxiants (cyanide, carbon monoxide, hydrogen sulfide), withdrawal (ethanol, sedatives, clonidine, opioids), serotonin syndrome, neuroleptic malignant syndrome, MDMA, cathinones
Bradycardia	β Blockers, calcium channel blockers, digoxin, clonidine, organophosphates, opioids, sedative-hypnotics xylazine
Hypertension	Sympathomimetics, anticholinergics, monoamine oxidase inhibitors, serotonin syndrome, nicotine, caffeine, neuroleptic malignant syndrome, clonidine withdrawal
Hypotension	β Blockers, calcium channel blockers, cyclic antidepressants, iron, antipsychotics, barbiturates, clonidine, opioids, arsenic, amatoxin mushrooms, cellular asphyxiants (cyanide, carbon monoxide, hydrogen sulfide), snake envenomation, xylazine
RESPIRATORY SIGNS	
Depressed respirations	Opioids, sedative-hypnotics, alcohol, clonidine, marijuana, barbiturates, xylazine
Tachypnea	Salicylates, sympathomimetics, caffeine, metabolic acidosis, carbon monoxide, hydrocarbon aspiration
CENTRAL NERVOUS SYSTEM SIGNS	
Ataxia	Alcohols, anticonvulsants, sedative-hypnotics, lithium, dextromethorphan, carbon monoxide, inhalants
Coma	Opioids, sedative-hypnotics, anticonvulsants, antidepressants, antipsychotics, ethanol, anticholinergics, clonidine, GHB, alcohols, salicylates, barbiturates, hypoglycemics, lead, arsenic, rohypnol, carbon monoxide
Seizures	Sympathomimetics, anticholinergics, antidepressants (especially TCAs, bupropion, venlafaxine), cholinergics (organophosphates), isoniazid, camphor, lindane, salicylates, lead, nicotine, tramadol, water hemlock, withdrawal (especially ethanol), strychnine, cocaine
Delirium/psychosis	Sympathomimetics, anticholinergics, LSD, PCP, hallucinogens, lithium, dextromethorphan, steroids, withdrawal, MDMA, cathinones
Peripheral neuropathy	Lead, arsenic, mercury, organophosphates, nicotine
Hypothermia	Carbon monoxide, opioids, oral hypoglycemics, liquor, sedative-hypnotics
Hyperthermia	Antihistamines, amphetamines, salicylates, antidepressants (TCAs), antipsychotics, serotonin syndrome, neuroleptic malignant syndrome, withdrawal (alcohol, baclofen)

GHB, γ-Hydroxybutyrate; LSD, lysergic acid diethylamide; MDMA, 3,4-methylenedioxymethamphetamine (ecstasy); NSAIDs, nonsteroidal antiinflammatory drugs; PCP, phencyclidine;

A toddler has somnolence, bradycardia, and pinpoint pupils after a possible household medication exposure. Which agent in the alpha-2 agonist mini-toxidrome is a likely cause?

A. Clonidine
B. Atropine
C. Albuterol
D. Diphenhydramine
E. Cocaine

Original table 94.4 | Nelson printed p. 704 | PDF p. 750

Table 94.4 Mini-Toxidromes

TOXIDROME	SYMPTOMS AND SIGNS	EXAMPLES
α_1-Adrenergic receptor antagonists	CNS depression, tachycardia, miosis	Chlorpromazine, quetiapine, clozapine, olanzapine, risperidone
α_2-Adrenergic receptor agonist	CNS depression, bradycardia, hypertension (early), hypotension (late), miosis	Clonidine, oxymetazoline, tetrahydrozoline, tizanidine, dexmedetomidine
Clonus/myoclonus	CNS depression, myoclonic jerks, clonus, hyperreflexia	Carisoprodol, lithium, serotonergic agents, bismuth, organic lead, organic mercury, serotonin or neuroleptic malignant syndrome
Sodium channel blockers	CNS toxicity, wide QRS	Cyclic antidepressants and structurally related agents, propoxyphene, quinidine/quinine, amantadine, antihistamines, bupropion, cocaine
Potassium channel blockers	CNS toxicity, long QT interval	Antipsychotics, methadone, phenothiazines
Cathinones, synthetic cannabinoids	Hyperthermia, tachycardia, delirium, agitation, mydriases	See Chapter 157.

CNS, Central nervous system.
From Ruha AM, Levine M. Central nervous system toxicity. *Emerg Med Clin North Am*. 2015;32(1):205–221, p. 208.

A child is bradycardic and hypotensive after an unknown ingestion. Which drug class in the vital-sign table should be considered?

A. Calcium channel blockers
B. Amphetamines
C. Cocaine
D. Anticholinergics
E. Caffeine

Original table 94.5 | Nelson printed p. 704 | PDF p. 750

Table 94.5 Predicting Toxicity from Vital Signs

BRADYCARDIA (PACED)
Propranolol (β blockers), poppies (opioids), propoxyphene, physostigmine
Anticholinesterase drugs, antiarrhythmics
Clonidine, calcium channel blockers
Ethanol or other alcohols
Digoxin, digitalis

TACHYCARDIA (FAST)
Free base or other forms of cocaine, Freon
Anticholinergics, antihistamines, antipsychotics amphetamines, alcohol withdrawal
Sympathomimetics (cocaine, caffeine, amphetamines, phencyclidine [PCP]), solvent abuse, strychnine
Theophylline, tricyclic antidepressants (TCAs), thyroid hormones

HYPOTHERMIA (COOLS)
Carbon monoxide
Opioids
Oral hypoglycemics, insulin
Liquor (alcohols)
Sedative-hypnotics

HYPERTHERMIA (NASA)
Neuroleptic malignant syndrome (NMS), nicotine
Antihistamines, alcohol withdrawal
Salicylates, sympathomimetics, serotonin syndrome
Anticholinergics, antidepressants, antipsychotics

HYPOTENSION (CRASH)
Clonidine, calcium channel blockers
Rodenticides (containing arsenic, cyanide)
Antidepressants, aminophylline, antihypertensives
Sedative-hypnotics (xylazine)
Heroin or other opioids

HYPERTENSION (CT SCAN)
Cocaine
Thyroid supplements
Sympathomimetics
Caffeine
Anticholinergics, amphetamines
Nicotine

RAPID RESPIRATION (PANT)
PCP, paraquat, pneumonitis, phosgene
Acetylsalicylic acid (ASA) and other salicylates
Noncardiogenic pulmonary edema, nerve agents
Toxin-induced metabolic acidosis

SLOW RESPIRATION (SLOW)
Sedative-hypnotics (barbiturates, benzodiazepines, xylazine)
Liquor (alcohols)
Opioids
Weed (marijuana)

From Meehan TJ. Approach to the poisoned patient. In: Walls RM, Hockberger RS, Gausche-Hill M, et al., eds. *Rosen's Emergency Medicine,* 9th ed. Philadelphia: Elsevier; 2018, Box 139.6, p. 1816.

A child with suspected poisoning has a high anion-gap metabolic acidosis and elevated osmolar gap. Which listed toxic alcohol should be considered?

A. Ethylene glycol
B. Plain ethanol-free water
C. Iron-free multivitamins
D. Topical petrolatum
E. Dietary calcium

Original table 94.6 | Nelson printed p. 705 | PDF p. 751

Table 94.6 Laboratory Clues in Toxicologic Diagnosis

ANION GAP METABOLIC ACIDOSIS (MNEMONIC = MUDPILES CAT)
Methanol, metformin
Uremia
Diabetic ketoacidosis
Propylene glycol
Isoniazid, iron, massive ibuprofen
Lactic acidosis
Ethylene glycol
Salicylates
Cellular asphyxiants (cyanide, carbon monoxide, hydrogen sulfide)
Alcoholic ketoacidosis
Tylenol (clinical significance depends upon presence or absence of liver injury), toluene

ELEVATED OSMOLAR GAP
Alcohols: ethanol, isopropyl, methanol, ethylene glycol

HYPOGLYCEMIA (MNEMONIC = HOBBIES)
Hypoglycemics, oral: sulfonylureas, meglitinides
Other: quinine, unripe ackee fruit
Beta **B**lockers
Insulin
Ethanol
Salicylates (late)

HYPERGLYCEMIA
Salicylates (early)
Calcium channel blockers
Caffeine

HYPOCALCEMIA
Ethylene glycol
Fluoride

RHABDOMYOLYSIS
Neuroleptic malignant syndrome, serotonin syndrome
Statins
Mushrooms (Tricholoma equestre)
Any toxin causing prolonged immobilization (e.g., opioids, antipsychotics) or excessive muscle activity or seizures (e.g., sympathomimetics)

RADIOPAQUE SUBSTANCE ON KUB (MNEMONIC = CHIPPED)
Chloral hydrate, calcium carbonate
Heavy metals (lead, zinc, barium, arsenic, lithium, bismuth)
Iron
Phenothiazines
Play-Doh, potassium chloride
Enteric-coated pills
Dental amalgam, drug packets

KUB, Kidney-ureter-bladder radiograph.

An adolescent overdoses on a tricyclic antidepressant and develops widening of the QRS complex. Which ECG effect from the table does this illustrate?

A. Sodium-channel blockade associated QRS prolongation
B. Isolated PR shortening
C. An obligatory normal ECG
D. Purely sinus respiratory variation
E. A structural atrial septal defect

Original table 94.7 | Nelson printed p. 706 | PDF p. 752

Table 94.7 Electrocardiographic Findings in Poisoning

PR INTERVAL PROLONGATION
Digoxin
Lithium
Calcium channel antagonists
β-Antagonists
QRS PROLONGATION
Tricyclic antidepressants
Diphenhydramine
Carbamazepine
Cardiac glycosides
Chloroquine, hydroxychloroquine
Cocaine
Lamotrigine
Quinidine, quinine, procainamide, disopyramide
Phenothiazines
Propoxyphene
Propranolol
Bupropion, venlafaxine (rare)
QTc PROLONGATION*
Amiodarone
Antipsychotics (typical and atypical)
Arsenic
Cisapride
Citalopram
Clarithromycin, erythromycin
Disopyramide, dofetilide, ibutilide
Fluconazole, ketoconazole, itraconazole
Methadone
Pentamidine
Phenothiazines
Sotalol

*This is a select list of important toxins; other medications are also associated with QTc prolongation.

A child develops a severe toxic reaction to a local anesthetic with cardiovascular compromise. Which rescue therapy is listed among other antidotes?

A. Intravenous lipid emulsion
B. Oral iron supplementation
C. Intramuscular vitamin K alone
D. Topical bacitracin
E. Enteral cornstarch

Original table 94.9 | Nelson printed p. 708 | PDF p. 754

Table 94.9 Other Antidotes

ANTIDOTES	TOXIN OR POISON
Latrodectus antivenin	Black widow spider
Botulinum antitoxin	Botulinum toxin
Diphenhydramine and/or benztropine	Dystonic reactions
Calcium salts	Fluoride, calcium channel blockers
Intravenous lipid emulsion (ILE)	Local anesthetics; consider for bupropion, calcium channel blockers, β blockers, and type I antidysrhythmics
Protamine	Heparin
Folinic acid	Methotrexate, trimethoprim, pyrimethamine, methanol
Crotalidae-specific Fab antibodies	Rattlesnake envenomation
Sodium bicarbonate	Sodium channel blockade (tricyclic antidepressants, type 1 antiarrhythmics)

A pesticide spills over a child's skin, followed by signs of systemic cholinergic poisoning. Which listed exposure type explains systemic toxicity without ingestion?

A. Dermal absorption of organophosphate insecticide
B. Intact-skin exposure to plain water
C. A hearing-aid fitting
D. A routine bandage change
E. An isolated sunlight exposure

Original table 94.10 | Nelson printed p. 708 | PDF p. 754

Table 94.10 Toxins Associated with Systemic Toxicity After Dermal Absorption

Aniline dyes
Camphor
Dinitrophenol
Hexachlorophene
Hydrofluoric acid
Lindane (γ-benzene hydrochloride)
Organophosphate insecticide
Nerve agents
Nitrobenzene
Organic mercury
Phenol
Thallium

From Shannon MW. Emergency management of poisoning. In: Shannon MW, Borron SW, Burns MJ, eds. *Haddad and Winchester's Clinical Management of Poisoning and*

A child ingests an iron supplement. Which property in the activated-charcoal table matters when planning decontamination?

A. Iron is poorly adsorbed by activated charcoal
B. Iron binds charcoal completely
C. Charcoal reliably neutralizes all metals
D. The substance is a hydrocarbon
E. Iron is a sedative-hypnotic

Original table 94.11 | Nelson printed p. 709 | PDF p. 755

Table 94.11 Substances Poorly Adsorbed by Activated Charcoal

Alcohols
Caustics: alkalis and acids
Cyanide
Heavy metals (e.g., lead)
Hydrocarbons
Iron
Lithium

After acetaminophen overdose, a child feels briefly better but develops right-upper-quadrant tenderness and elevated transaminases the following day. Which phase in the table fits?

A. Stage II, about 24-48 hours
B. Stage I only, immediate symptoms
C. Stage IV after several weeks
D. No recognized phase
E. A chronic allergic reaction

Original table 94.12 | Nelson printed p. 710 | PDF p. 756

Table 94.12 Classic Stages in Clinical Course of Acetaminophen Toxicity

STAGE	TIME AFTER INGESTION	CHARACTERISTICS
I	0-24 hr	Anorexia, vomiting, malaise Laboratory tests typically normal, except for acetaminophen level
II	24-48 hr	Resolution of earlier symptoms; right upper quadrant abdominal pain and tenderness; elevated hepatic transaminases (aspartate > alanine), INR
III	3-5 days	Peak transaminase elevations; development of liver failure, multiorgan system failure, death *or* recovery begins
IV	4 days to 2 wk	Resolution of liver function abnormalities Clinical recovery precedes histologic recovery

An adolescent takes an unknown prescription opioid and the ECG shows QT widening. Which opioid in the clinical-properties table is associated with that effect?

A. Methadone
B. Hydrocodone only
C. Morphine only
D. Fentanyl only
E. Naloxone

Original table 94.13 | Nelson printed p. 713 | PDF p. 759

Table 94.13 Clinical Properties of Select Prescription Opioids

CLINICAL EFFECT	OPIOID
QRS widening, sodium channel blockade	Propoxyphene
QT widening, potassium channel blockade	Methadone
Seizures	Propoxyphene, meperidine
Serotonin syndrome	Meperidine, methadone, tramadol
Hearing loss, ototoxicity	Methadone, hydrocodone

Modified from Nikolaides JK, Thompson TM. Opioids. In: Walls RM, Hockberger RS, Gausche-Hill M, et al., eds. *Rosen's Emergency Medicine,* 9th ed. Philadelphia: Elsevier;

A toddler vomits after acute iron ingestion, then appears briefly improved before developing acidosis and circulatory collapse. Which course does the table describe?

A. Latent interval followed by systemic toxicity
B. A single benign self-limited episode
C. Immediate recovery proving no danger
D. A chronic allergic syndrome
E. Isolated vitamin deficiency

Original table 94.15 | Nelson printed p. 715 | PDF p. 761

Table 94.15 Clinical Manifestations of Iron Toxicity After Acute Overdose

PHASE	CLINICAL FEATURES
1. Gastrointestinal (6 hr)	Vomiting Diarrhea Hematemesis Hematochezia
2. Latent (6-24 hr)	Resolution of GI symptoms Tachycardia Acidosis Depressed mental status
3. Systemic (12-24 hr)	Return of GI symptoms Acidosis Leukocytosis Coagulopathy Renal failure Lethargy or coma Cardiovascular collapse
4. Hepatic (2-5 days)	Fulminant liver failure Coagulopathy
5. Obstructive (3-6 wk)	Pyloric or bowel scarring Obstruction

GI, Gastrointestinal.
Modified from Theobald JL, Mycyk MB. Iron and heavy metals. In: Walls RM,

A teen taking sertraline starts tramadol and then develops agitation and clonus. Which medication interaction in the table increases concern for serotonin toxicity?

A. SSRI plus a serotonergic analgesic
B. SSRI plus plain saline
C. An isolated topical emollient
D. A low-calcium diet
E. An antihistamine eye drop alone

Original table 94.16 | Nelson printed p. 717 | PDF p. 763

Table 94.16 Drugs Associated with Serotonin Syndrome

DRUG TYPE	DRUGS
Selective serotonin reuptake inhibitors	Sertraline, fluoxetine, fluvoxamine, paroxetine, citalopram, escitalopram
Antidepressant drugs	Trazodone, nefazodone, buspirone, clomipramine, venlafaxine, amitriptyline, nortriptyline
Monoamine oxidase inhibitors	Phenelzine, moclobemide, clorgyline, isocarboxazid
Anticonvulsants	Valproate
Analgesics	Meperidine, fentanyl, tramadol, pentazocine
Antiemetic agents	Ondansetron, granisetron, metoclopramide
Antimigraine drugs	Sumatriptan
Bariatric medications	Sibutramine
Antibiotics	Linezolid (a monoamine oxidase inhibitor), ritonavir (through inhibition of cytochrome P450 enzyme isoform 3A4)
Nonprescription cough and cold remedies	Dextromethorphan
Drugs of abuse	Methylenedioxymethamphetamine (MDMA, "ecstasy"), lysergic acid diethylamide (LSD), 5-methoxydiisopropyltryptamine ("foxy methoxy"), Syrian rue (contains harmine and harmaline, both monoamine oxidase inhibitors)
Dietary supplements and herbal products	Tryptophan, *Hypericum perforatum* (St. John's wort), *Panax ginseng* (ginseng)
Other	Lithium

From Boyer EW, Shannon M. The serotonin syndrome. *N Engl J Med*. 2005;352:1112

A child with serotonergic drug exposure has spontaneous clonus, agitation, and fever. Which severity-associated syndrome in the table is suggested?

A. Serotonin toxicity with neuromuscular excitation
B. Isolated opioid respiratory depression
C. Classic organophosphate poisoning
D. Hypothermic bradycardia
E. Pure iron deficiency

Original table 94.17 | Nelson printed p. 718 | PDF p. 764

Table 94.17 Spectrum of Symptoms of Serotonergic Toxicity

SEVERITY	NEUROMUSCULAR EXCITATION	ALTERED MENTAL STATUS	AUTONOMIC DYSFUNCTION
Mild	Hyperreflexia Tremor Myoclonus	Anxiety Restlessness Insomnia	Diaphoresis Mydriasis Tachycardia
Moderate	Opsoclonus Spontaneous or inducible clonus	Agitation	Hypertension Hyperthermia (<40°C [<104°F]) Hyperactive bowel sounds Diarrhea, nausea, vomiting
Severe	Rigidity Respiratory failure Tonic-clonic seizure	Coma Delirium Confusion	Severe hyperthermia (≥40°C [≥104°F]) Dynamic blood pressure

Adapted from Wang RZ, Vashistha V, Kaur S, Houchens NW. Serotonin syndrome: Preventing, recognizing, and treating it. *Clev Clinic J Med*. 2016;83(11):810–817, Table 2, p. 812.

A patient becomes acutely hyperthermic and develops clonus within hours of serotonergic medication exposure. Which syndrome is favored over neuroleptic malignant syndrome in the comparison table?

A. Serotonin syndrome
B. Neuroleptic malignant syndrome
C. Malignant hyperthermia from anesthetics
D. Uncomplicated fever
E. Myasthenia gravis

Original table 94.18 | Nelson printed p. 718 | PDF p. 764

Table 94.18 Signs and Symptoms of Neuroleptic Malignant Syndrome (NMS)/Serotonin Syndrome/Malignant Hyperthermia

CLINICAL FEATURES	NMS	SEROTONIN SYNDROME	MALIGNANT HYPERTHERMIA
Triggering agent	Neuroleptic	Proserotonergic agent	Succinylcholine or inhaled anesthetic
Onset	Slow (hours to days)	Fast (minutes to hours)	Very fast to fast (minutes to hours)
Duration	Long (days to weeks)	Short (1-2 days)	Short (1-3 days)
Agitation	Sometimes	Yes	No
Confusion	Yes	Sometimes	Unusual
Hyperactivity	No	Yes	No
Bradykinesia/stupor	Yes	No	Unusual
Myoclonus	No	Yes	No
Shivering	No	Yes/sometimes	No
Tremor	Sometimes	Yes	No
Pupils	Mid-sized	Large	Not specific
Hyperreflexia	No	Yes (especially lower extremities)	No
Rigidity	Severe	Sometimes	Severe
Rigidity type	Extrapyramidal (lead pipe)	Pyramidal (clasp-knife)	Generalized
Hyperpyrexia	Yes	Yes	Severe
Tachypnea	Yes	Yes	Yes
Tachycardia	Yes	Yes	Yes (severe)
Hypertension	Sometimes	Yes	Sometimes
Leukocytosis	Yes	Uncommon	Not typical
Elevated creatine phosphokinase	Severe	Mild	Severe

Adapted from Gillman PK. The serotonin syndrome and its treatment. *J Psychopharmacol* 1999;13:100–109; Gillman K; Serotonin toxicity www.psychotropical.com/serotonin-toxicity; and Wappler F, Fiege M, Schulte am Esch J. Pathophysiological role of the serotonin system in malignant hyperthermia. *Br J Anaesth*. 2001;87(5):794–798.

A toddler eats autumn crocus and develops vomiting followed by progressive systemic illness. Which delayed complication in the toxic-plant table is particularly concerning?

A. Bone marrow failure
B. Isolated speech delay
C. Congenital heart defect
D. Transient myopia
E. Vitamin D deficiency

Original table 94.19 | Nelson printed p. 722 | PDF p. 768

Table 94.19 Commonly Ingested Plants with Significant Toxic Potential

PLANT	SYMPTOMS	MANAGEMENT
Autumn crocus (Colchicum autumnale)	Vomiting Diarrhea Initial leukocytosis followed by bone marrow failure Multisystem organ failure	Activated charcoal decontamination Aggressive fluid resuscitation and supportive care
Belladonna alkaloids: jimsonweed (Datura stramonium) Belladonna ("deadly nightshade"; Atropa belladonna)	Anticholinergic toxidrome Seizures	Supportive care, benzodiazepines Consider physostigmine; only use if no conduction delays on ECG
Cardiac glycoside–containing plants (e.g., foxglove, lily of the valley, oleander, yellow oleander)	Nausea Vomiting Bradycardia Dysrhythmias (AV block, ventricular ectopy) Hyperkalemia	Digoxin-specific Fab fragments
Jequirity bean and other abrin-containing species (e.g., rosary pea, precatory bean)	Oral pain Vomiting Diarrhea Shock Hemolysis Renal failure	Supportive care, including aggressive volume resuscitation and correction of electrolyte abnormalities
Monkshood (Aconitum species)	Numbness and tingling of lips/tongue Vomiting Bradycardia	Atropine for bradycardia Supportive care
Oxalate-containing plants: Philodendron, Dieffenbachia, Colocasia ("elephant ear")	Local tissue injury Oral pain Vomiting	Supportive care, pain control
Poison hemlock (Conium maculatum)	Vomiting Agitation followed by CNS depression Paralysis Respiratory failure	Supportive care
Pokeweed	Hemorrhagic gastroenteritis Burning of mouth and throat	Supportive care
Rhododendron	Vomiting Diarrhea Bradycardia	Atropine for symptomatic bradycardia Supportive care
Tobacco	Vomiting Agitation Diaphoresis Fasciculations Seizures	Supportive care
Water hemlock (Cicuta species)	Abdominal pain Vomiting Delirium Seizures	Supportive care, including benzodiazepines for seizures
Yew (Taxus species)	GI symptoms QRS widening Hypotension CV collapse	Supportive care Atropine for bradycardia Sodium bicarbonate does not appear to be effective

AV, Atrioventricular; CNS, central nervous system; CV, cardiovascular; ECG, electrocardiogram; Fab, fragment, antigen binding; GI, gastrointestinal.

A child ingests aconite-containing herbal material and develops palpitations. Which toxicity in the herb table should be anticipated?

A. Cardiac arrhythmia
B. Only constipation
C. Rickets
D. Hypothyroidism
E. A benign blue-gray skin patch

Original table 94.20 | Nelson printed p. 723 | PDF p. 769

Table 94.20 Clinical Toxicity of Selected Herbs

COMMON NAME	BOTANICAL NAME	THERAPEUTIC USES	POTENTIAL TOXICITY
Aconite (monkshood, wolfsbane)	*Aconitum* spp.	Sedative, analgesic, antihypertensive	Cardiac arrhythmias
Aloe	*Aloe* spp.	Burns, skin diseases	Nephritis, GI upset
Betel nut	*Areca catechu*	Mood elevation	Bronchoconstriction, oral cancers
Bloodroot	*Sanguinaria canadensis*	Emetic, cathartic, eczema	GI upset, vertigo, visual disturbances
Chaparral (greasewood)	*Larrea tridentata*	Aging, free radical scavenging	Hepatitis
Compound Q	*Trichosanthes kirilowii*	Anthelmintic, cathartic	Diarrhea, hypoglycemia, CNS toxicity
Dandelion	*Taraxacum officinale*	Diuretic, heartburn remedy	Anaphylaxis
Figwort (xuan shen)	*Scrophularia* spp.	Antiinflammatory, antibacterial	Cardiac stimulation
Ginseng	*Panax quinquefolium*	Antihypertensive, aphrodisiac, stimulant, mood elevation, digestive aid	Ginseng abuse syndrome
Goldenseal	*Hydrastis canadensis*	Digestive aid, mucolytic, antiinfective	Uterine, cardiac stimulation; GI upset, leukopenia
Hellebore	*Veratrum* spp.	Antihypertensive	Vomiting, bradycardia, hypotension
Hyssop	*Hyssopus officinalis*	Asthma, mucolytic	Seizures
Juniper	*Juniperus communis*	Hallucinogen	GI upset, seizures, renal injury, hypotension, bradycardia
Kava	*Piper methysticum*	Sedative	Inebriation
Kombucha		Stimulant	Metabolic acidosis, hepatotoxicity, death
Licorice	*Glycyrrhiza* spp.	Indigestion	Mineralocorticoid effects
Lily of the valley	*Convallaria* spp.	Cardiotonic	GI (nausea, vomiting), cardiac arrhythmias
Linn (willow)	*Salix caprea*	Purgative	Hemolysis with glucose-6-phosphate dehydrogenase deficiency
Lobelia (Indian tobacco)	*Lobelia* spp.	Stimulant	Nicotine intoxication
Ma Huang	*Ephedra sinica*	Stimulant	Sympathetic crisis, especially with monoamine oxidase inhibitors
Mandrake	*Mandragora officinarum*	Hallucinogen	Anticholinergic syndrome
Mormon tea	*Ephedra nevadensis*	Stimulant, asthma, antipyretic	Hypertension, sympathomimetic
Nutmeg	*Myristica fragrans*	Hallucinogen, abortifacient	Hallucinations, GI upset
Oleander	*Nerium oleander*	Cardiac stimulant	Cardiac arrhythmias
Passionflower	*Passiflora caeruliea*	Hallucinogen	Hallucinations, seizures, hypotension
Periwinkle	*Vinca* spp.	Antiinflammatory, diabetes	Alopecia, seizures, hepatotoxicity
Pokeweed	*Phytolacca* spp.	Arthritis, chronic pain	GI upset, seizures, death
Sabah	*Sauropus androgynus*	Weight loss, vision	Pulmonary injury
Sage	*Salvia* spp.	CNS stimulant	Seizures
Snakeroot	*Rauwolfia serpentina*	Sedative, antihypertensive	Bradycardia, coma
Squill	*Urginea maritima*	Arthritis, cardiac stimulant	Seizures, arrhythmias, death
Thorn apple (jimsonweed)	*Datura stramonium*	Hallucinations	Anticholinergic
Tonka bean	*Dipteryx odorata*	Anticoagulant	Bleeding diathesis
Valerian root	*Valeriana* spp.	Sedative	Sedation, obtundation
Wild (squirting) cucumber	*Ecballium elaterium*	Constipation, antiinflammatory, rheumatic disease	Airway obstruction
Wormwood (mugwort)	*Artemisia* spp.	Stimulant, hallucinogen	Hallucinations, seizures, uterine stimulation
Yohimbine	*Corynanthe yohimbe*	Aphrodisiac, stimulant	Hypertension, sympathetic crisis

CNS, Central nervous system; GI, gastrointestinal.

A child has a highly distinctive phenotype known to result from pathogenic variants in one gene. Which genetic-testing strategy in the table is most focused?

A. Single-gene testing
B. A broad untargeted genome analysis as the first and only possible option
C. Karyotyping for all single-base substitutions
D. Only a newborn hearing screen
E. No genetic test because features are distinctive

Original table 95.2 | Nelson printed p. 727 | PDF p. 773

Table 95.2 Indications for Single Gene, Gene Panel, Exome, and Genome Sequencing

INDICATIONS	EXAMPLES
SINGLE GENE	
Minimal locus heterogeneity (only one or a small number of genes known to cause the condition)	*CFTR* for cystic fibrosis
Distinctive clinical findings that clearly point to specific gene	*PAH* for phenylketonuria
GENE PANEL	
Locus heterogeneity (multiple genes are known to cause the same or similar conditions)	Muscular dystrophy panel
Disorders with overlapping phenotypes	Cardiomyopathy panel
Disorders that share one manifestation but can have very different presentations	Epilepsy panel
Disorders associated with genes from a common pathway or structure	*RAS*opathy panel
EXOME	
Extreme heterogeneity and de novo mutations common	Autism, intellectual disability
Two or more unrelated phenotypes in one patient	Oculocutaneous albinism and neutropenia
No distinctive phenotypic feature present	Kabuki syndrome
Phenotype indistinct and underlying cause not clear	Congenital diarrhea, Zellweger syndrome
GENOME	
As above for Exome, plus:	
Noncoding variation is suspected as a cause	Hypertrophic cardiomyopathy
Structural variation is suspected as a cause	DiGeorge syndrome
Exome sequencing already performed and was nondiagnostic	Undiagnosed Diseases Network
Rapid generation of sequencing data needed for patients who are critically ill	Neonates and children in intensive care
Suspected mitochondrial disorder: multisystem (heart, brain, muscle, liver) disorder	Whole genome and/or mitochondrial DNA (tissue) sequencing

From Manolio TA, Rowley R, Williams MS, et al. Opportunities, resources, and techniques for implementing genomics in clinical care. *Lancet*. 2019;394:511–520. Table 2

A child with developmental delay may have a pathogenic microdeletion or duplication. Which test in the comparison table detects copy-number changes across the genome?

A. Chromosomal microarray
B. Conventional visual acuity testing
C. A stool culture
D. Pulse oximetry
E. A routine EEG alone

Original table 98.1 | Nelson printed p. 749 | PDF p. 795

Table 98.1 Approaches for Genetic Testing

TYPE OF TESTING	RESOLUTION	ADVANTAGES	DISADVANTAGES	SAMPLE REQUIREMENTS
Linkage analysis	Depends on location of polymorphic markers near putative disease gene	Possible when specific disease-causing genetic pathogenic variant is not identifiable or found	Can give only diagnostic probability based on likelihood of genetic recombination between presumed DNA pathogenic variant and polymorphic markers	Requires multiple family members with documented Mendelian pattern of inheritance within family
Chromosome microarray (CMA)	Several hundred base pairs to several hundreds of kilobases	Able to detect small deletion or duplications within one or more genes	Can miss small deletions or insertions depending on the resolution of the array used	Single patient sample sufficient, but having sample from biological parents can help with interpretation
Direct DNA-based testing (e.g., DNA sequencing)	Single–base-pair changes	High specificity if previously described deleterious pathogenic variant is found	Can miss deletion or duplication of a segment of gene	Single patient sample sufficient, but having sample from biological parents and siblings (affected or unaffected) can help with interpretation

A genomic test reveals an unexpected pathogenic variant that could lead to a preventable condition beginning in childhood. How is this incidental finding categorized in the table?

A. Childhood onset, medically actionable
B. Childhood onset, not medically actionable
C. Adult onset, medically actionable
D. Adult onset, not medically actionable
E. A laboratory artifact by definition

Original table 98.2 | Nelson printed p. 751 | PDF p. 797

Table 98.2 Variants That Are Incidental Findings Are Assigned to One of Four Categories

Childhood onset	Medically actionable*
Childhood onset	Not medically actionable†
Adult onset	Medically actionable*
Adult onset	Not medically actionable†

*"Medically actionable" refers to a variant in a gene in which knowledge of the particular variant will affect medical decision-making, such as initiation of a treatment or family planning

An adolescent remains paralyzed longer than expected after succinylcholine. Which gene in the pharmacogenomic table is associated with this response?

A. BCHE
B. FMR1
C. CFTR
D. PAH
E. DMD

Original table 98.3 | Nelson printed p. 754 | PDF p. 800

Table 98.3 Examples of Effects of Gene Polymorphisms on Drug Response

GENE	ENZYME/TARGET	DRUG	CLINICAL RESPONSE
BCHE	Butyrylcholinesterase	Succinylcholine	Prolonged paralysis
CYP2C9	Cytochrome P450 2C9	Warfarin	Individuals having ≥1 reduced function alleles require lower doses of warfarin for optimal anticoagulation, especially initial anticoagulant control.
CYP2C19	Cytochrome P450 2C19	Clopidogrel	Individuals having ≥1 loss-of-function alleles have reduced capacity to form pharmacologically active metabolite of clopidogrel and reduced antiplatelet effect.
CYP2D6	Cytochrome P450 2D6	Codeine	Poor metabolizers (individuals with two loss-of-function alleles) do not metabolize codeine to morphine and thus experience no analgesic effect. Ultrarapid metabolizers (individuals with ≥3 functional alleles) may experience morphine toxicity.
G6PD	Glucose-6-phosphate dehydrogenase	Primaquine (others)	Hemolysis
*HLA-A*3101*	Human leukocyte antigen A31	Carbamazepine	Carriers of *HLA-A*3101* allele have increased risk of SJS and TEN from carbamazepine.
*HLA-B*1502*	Human leukocyte antigen B15	Allopurinol	Han Chinese carriers of *HLA-B*1502* allele have increased risk of SJS and TEN from carbamazepine.
*HLA-B*5701*	Human leukocyte antigen B57	Abacavir Flucloxacillin	Carriers of *HLA-B*5701* allele have increased risk of hypersensitivity reactions to abacavir- and flucloxacillin-induced liver injury.
*HLA-B*5801*	Human leukocyte antigen B58	Allopurinol	Carriers of *HLA-B*5801* allele have increased risk of severe cutaneous adverse reactions to allopurinol, including hypersensitivity reactions, SJS, and TEN.
NAT2	*N*-Acetyltransferase 2	Isoniazid, hydralazine	Individuals homozygous for "slow acetylation" polymorphisms are more susceptible to isoniazid toxicity, or hydralazine-induced systemic lupus erythematosus.
SLCO1B1	Organic anion–transporting protein (OATP) 1B1	Simvastatin	Carriers of the *SLCO1B1*5* allele are at increased risk for musculoskeletal side effects from simvastatin.
TPMT	Thiopurine *S*-methyltransferase	Azathioprine 6-Mercaptopurine	Individuals homozygous for an inactivating pathogenic variant have severe toxicity if treated with standard doses of azathioprine or 6-mercaptopurine; rapid metabolism causes undertreatment.
UGT1A1	Uridine diphospho-glucuronosyltransferase 1A1	Irinotecan	*UGT1A1*28* allele is associated with decreased glucuronidation of SN-38, the active metabolite of irinotecan, and increased risk of neutropenia.
VKORC1	Vitamin K oxidoreductase complex 1	Warfarin	Individuals with a haplotype associated with reduced expression of VKORC1 protein (therapeutic target of warfarin) require lower doses of the drug for stable anticoagulation.

SJS, Stevens-Johnson syndrome; TEN, toxic epidermal necrolysis.

A couple with consanguinity previously had a child with an unexplained metabolic disorder. Which referral is specifically supported by the table?

A. Genetic counseling
B. Only routine dental assessment
C. Only a vision check
D. No additional family assessment
E. An automatic diagnosis without testing

Original table 98.4 | Nelson printed p. 756 | PDF p. 802

Table 98.4 Indications for Genetic Counseling

Advanced parental age
- Maternal age ≥35 years
- Paternal age ≥40 years

Previous child with or family history of:
- Congenital abnormality
- Dysmorphology
- Intellectual disability
- Isolated birth defect
- Metabolic disorder
- Chromosome abnormality
- Single-gene disorder

Adult-onset genetic disease (presymptomatic testing)
- Cancer
- Huntington disease

Pharmacogenomics

Consanguinity

Teratogen exposure (occupational, abuse)

Repeated pregnancy loss or infertility

Pregnancy screening abnormality
- Maternal serum α-fetoprotein

Maternal first-trimester screen
- Maternal triple or quad screen or variant of this test
- Fetal ultrasonography

Noninvasive prenatal testing (NIPT)
- Fetal karyotype

Heterozygote screening based on ethnic risk
- Sickle cell anemia
- Tay-Sachs, Canavan, and Gaucher diseases
- Thalassemias

Universal carrier screening panels

Follow-up to abnormal neonatal genetic testing

Prior to whole genome or exome sequencing

Prior to preimplantation genetic testing

A child's karyotype is reported as 46,XY,del(5p). What does the abbreviation del signify?

A. Deletion
B. Duplication
C. Inversion
D. Translocation
E. Triploidy

Original table 99.2 | Nelson printed p. 763 | PDF p. 809

Table 99.2 Some Abbreviations Used for Description of Chromosomes and Their Abnormalities

ABBREVIATION	MEANING	EXAMPLE	CONDITION
XX	Female	46,XX	Normal female karyotype
XY	Male	46,XY	Normal male karyotype
[##]	Number [#] of cells	46,XY[12]/47,XXY[10]	Number of cells in each clone, typically inside brackets Mosaicism in Klinefelter syndrome with 12 normal cells and 10 cells with an extra X chromosome
cen	Centromere		
del	Deletion	46,XY,del(5p)	Male with deletion of chromosome 5 short arm
der	Derivative	46,XX,der(2),t(2p12;7q13)	Female with a structurally rearranged chromosome 2 that resulted from a translocation between chromosomes 2 (short arm) and 7 (long arm)
dup	Duplication	46,XY,dup(15)(q11-q13)	Male with interstitial duplication in the long arm of chromosome 15 in the Prader-Willi/Angelman syndrome region
ins	Insertion	46,XY,ins(3)(p13q21q26)	Male with an insertion within chromosome 3 A piece between q21 and q26 has reinserted on p13
inv	Inversion	46,XY,inv(2)(p21q31)	Male with pericentric inversion of chromosome 2 with breakpoints at bands p21 and q31
ish	Metaphase FISH	46,XX.ish del(7)(q11.23q11.23)	Female with deletion in the Williams syndrome region detected by in situ hybridization
nuc ish	Interphase FISH	nuc ish(DXZ1 × 3)	Interphase in situ hybridization showing three signals for the X chromosome centromeric region
mar	Marker	47,XY,+mar	Male with extra, unidentified chromosome material
mos	Mosaic	mos 45,X[14]/46,XX[16]	Turner syndrome mosaicism (analysis of 30 cells showed that 14 cells were 45,X and 16 cells were 46,XX)
p	Short arm	46,XY,del(5)(p12)	Male with a deletion on the short arm of chromosome 5, band p12 (short nomenclature)
q	Long arm	46,XY,del(5)(q14)	Male with a deletion on the long arm of chromosome 5, band 14
r	Ring chromosome	46,X,r(X)(p21q27)	Female with one normal X chromosome and a ring X chromosome
t	Translocation	t(2;8)(q33;q24.1)	Interchange of material between chromosomes 2 and 8 with breakpoints at bands 2q33 and 8q24.1
ter	Terminal	46,XY,del(5)(p12-pter)	Male with a deletion of chromosome 5 between p12 and the end of the short arm (long nomenclature)
/	Slash	45,X/46,XY	Separate lines or clones Mosaicism for monosomy X and a male cell line
+	Gain of	47,XX,+21	Female with trisomy 21
−	Loss of	45,XY,−21	Male with monosomy 21

FISH, Fluorescence in situ hybridization.

A newborn has midline cleft lip, polydactyly, and holoprosencephaly. Which chromosomal trisomy from the comparison table best fits?

A. Trisomy 13
B. Trisomy 18
C. Trisomy 21
D. Trisomy X
E. Turner syndrome

Original table 99.3 | Nelson printed p. 766 | PDF p. 812

Table 99.3 Chromosomal Trisomies and Their Clinical Findings*

SYNDROME	INCIDENCE	CLINICAL MANIFESTATIONS
Trisomy 13, Patau syndrome	1/10,000 births	Cleft lip often midline; flexed fingers with postaxial polydactyly; ocular hypotelorism, bulbous nose; low-set, malformed ears; microcephaly; cerebral malformation, especially holoprosencephaly; microphthalmia, cardiac malformations; scalp defects; hypoplastic or absent ribs; visceral and genital anomalies Early lethality in most cases, with a median survival of 12 days; ~80% die by 1 year; 10-year survival ~13%; survivors have significant neurodevelopmental delay
Trisomy 18, Edwards syndrome	1/6,000 births	Low birthweight, closed fists with index finger overlapping the third digit and the fifth digit overlapping the fourth, narrow hips with limited abduction, short sternum, rocker-bottom feet, microcephaly, prominent occiput, micrognathia, cardiac and renal malformations, intellectual disability ~88% of children die in the first year; 10-year survival ~10%; survivors have significant neurodevelopmental delay
Trisomy 8, mosaicism	1/20,000 births	Long face; high, prominent forehead; wide, upturned nose; thick, everted lower lip; microretrognathia; low-set ears; high-arched, sometimes cleft, palate; osteoarticular anomalies common (camptodactyly of second through fifth digits, small patella); deep plantar and palmar creases; moderate intellectual disability

*For trisomy 21, see Chapter 57.

A child has a 4p deletion, marked growth delay, and a characteristic “Greek helmet” facial appearance. Which syndrome is listed?

A. Wolf-Hirschhorn syndrome
B. Williams syndrome
C. Prader-Willi syndrome
D. Angelman syndrome
E. Klinefelter syndrome

Original table 99.4 | Nelson printed p. 767 | PDF p. 813

Table 99.4 Common Deletions and Their Clinical Manifestations

DELETION	CLINICAL ABNORMALITIES
4p–	Wolf-Hirschhorn syndrome. The main features are a typical “Greek helmet” facies secondary to ocular hypertelorism, prominent glabella, frontal bossing, microcephaly, dolichocephaly, hypoplasia of the orbits, ptosis, strabismus, nystagmus, bilateral epicanthic folds, cleft lip and palate, beaked nose with prominent bridge, hypospadias, cardiac malformations, and intellectual disability.
5p–	Cri du chat syndrome. The main features are hypotonia, short stature, characteristic shrill cry in the first few weeks of life (also called cat’s cry syndrome), microcephaly with protruding metopic suture, hypertelorism, bilateral epicanthic folds, high arched palate, wide and flat nasal bridge, and intellectual disability.
9p–	The main features are craniofacial dysmorphic features with trigonocephaly, slanted palpebral fissures, discrete exophthalmos secondary to supraorbital hypoplasia, arched eyebrows, flat and wide nasal bridge, short neck with low hairline, genital anomalies, long fingers and toes with extra flexion creases, cardiac malformations, and intellectual disability.
13q–	The main features are low birthweight, failure to thrive, microcephaly, and severe intellectual disability. Facial features include high, wide nasal bridge; hypertelorism; ptosis; and micrognathia. Ocular malformations are common (retinoblastoma). The hands have hypoplastic or absent thumbs and syndactyly.
18p–	A few patients (15%) are severely affected and have cephalic and ocular malformations: holoprosencephaly, cleft lip and palate, ptosis, epicanthal folds, and varying degrees of intellectual disability. Most (80%) have only minor malformations and mild intellectual disability.
18q–	The main features are growth deficiency and hypotonia with a “froglike” position with the legs flexed, externally rotated, and in hyperabduction. The face is characteristic, with depressed midface and apparent protrusion of the mandible, deep-set eyes, short upper lip, and everted lower lip (“carplike” mouth); antihelix of the ears is very prominent. Varying degrees of intellectual disability and belligerent personality are present. Myelination abnormalities occur in the central nervous system.

A child with developmental delay and autistic features has a 7q11.23 duplication. Which category of genomic change in the table describes this finding?

A. Microduplication
B. Balanced reciprocal translocation
C. Monosomy X
D. Whole-chromosome trisomy 13
E. Mitochondrial point variant

Original table 99.6 | Nelson printed p. 769 | PDF p. 815

Table 99.6 Microduplications and Their Clinical Manifestations

DUPLICATION CHROMOSOME REGION	DISEASE REGION	CLINICAL FEATURES
1q21.1		Macrocephaly, DD, learning disabilities
3q29		Mild to moderate DD, ID, microcephaly
7q11.23	Williams syndrome	DD and severe expressive language disorder, autistic features, subtle dysmorphisms
15q13.3	Prader-Willi/Angelman syndrome	DD, ID, autistic features in duplications of maternal origin
15q24		Growth restriction, DD, microcephaly, digital anomalies, hypospadias, connective tissue abnormalities
16p11.2		FTT, severe DD, short stature, GH deficiency, dysmorphic features
17p11.2	Potocki-Lupski syndrome	Hypotonia, cardiovascular anomalies, FTT, DD, verbal apraxia, autism, anxiety
17q21.31		Severe DD, microcephaly, short and broad digits, dysmorphic features
22q11.2	Velocardiofacial-DiGeorge syndrome	Cardiovascular defects, velopharyngeal insufficiency
Xq28	*MECP2* gene (Rett syndrome)	In males: infantile hypotonia, immune deficiency, dysmorphic features, DD, speech delay, autistic behavior, regression in childhood

DD, Developmental delay; FTT, failure to thrive; GH, growth hormone; ID, intellectual disability.

An adolescent boy with tall stature and small testes has a karyotype of 47,XXY. Which sex-chromosome disorder does the table identify?

A. Klinefelter syndrome
B. Turner syndrome
C. Trisomy X
D. XYY syndrome
E. Trisomy 18

Original table 99.7 | Nelson printed p. 770 | PDF p. 816

Table 99.7 Sex Chromosome Abnormalities

DISORDER	KARYOTYPE	APPROXIMATE INCIDENCE
Klinefelter syndrome	47,XXY	1/580 males
	48,XXXY	1/50,000-1/80,000 male births
	Other (48,XXYY; 49,XXXYY; mosaics)	
XYY syndrome	47,XYY	1/800-1,000 males
Other X or Y chromosome abnormalities		1/1,500 males
XX males	46,XX	1/20,000 males
Turner syndrome	45,X	1/2,500-1/5,000 females
	Variants and mosaics	
Trisomy X	47,XXX	1/1,000 females
	48,XXXX and 49,XXXXX	Rare
Other X chromosome abnormalities		1/3,000 females
XY females	46,XY	1/20,000 females

A girl with short stature, congenital lymphedema, and a wide chest is evaluated for Turner syndrome. Which cardiovascular lesion in the table should be assessed?

A. Coarctation of the aorta
B. Tetralogy of Fallot in every case
C. Isolated coronary atherosclerosis
D. Primary pulmonary embolism
E. Tricuspid atresia as a defining requirement

Original table 99.8 | Nelson printed p. 771 | PDF p. 817

Table 99.8 Signs Associated with Turner Syndrome

Short stature
Congenital lymphedema
Horseshoe kidneys
Patella dislocation
Increased carrying angle of elbow (cubitus valgus)
Madelung deformity (chondrodysplasia of distal radial epiphysis)
Congenital hip dislocation
Scoliosis
Widespread nipples
Shield chest
Redundant nuchal skin (in utero cystic hygroma)
Low posterior hairline
Coarctation of aorta
Bicuspid aortic valve
Cardiac conduction abnormalities
Hypoplastic left heart syndrome and other left-sided heart abnormalities
Gonadal dysgenesis (infertility, primary amenorrhea)
Gonadoblastoma (increased risk if Y chromosome material is present)
Learning disabilities (nonverbal perceptual motor and visuospatial skills) (in 70%)
Developmental delay (in 10%)
Social awkwardness
Hypothyroidism (acquired in 15–30%)
Type 2 diabetes mellitus (insulin resistance)
Strabismus
Cataracts
Red-green color blindness (as in males)
Recurrent otitis media
Sensorineural hearing loss
Inflammatory bowel disease
Celiac disease (increased incidence)

A child has a radial-ray thumb anomaly, short stature, and progressive pancytopenia. Which chromosome-instability syndrome matches the table?

A. Fanconi anemia
B. Turner syndrome
C. Prader-Willi syndrome
D. Noonan syndrome
E. Phenylketonuria

Original table 99.10 | Nelson printed p. 774 | PDF p. 820

Table 99.10 Chromosome Instability Syndromes

SYNDROME	LABORATORY FINDINGS AND GENES INVOLVED	CLINICAL FINDINGS
Fanconi anemia (FA)	Chromosome breakage induced by diepoxybutane and mitomycin C There are least 21 FA genes, most are autosomal recessive, only one is X linked	Short stature, microcephaly in 1/3 of cases, radial ray defects including thumb anomalies, pancytopenia, skeletal anomalies, renal anomalies, café-au-lait macules, ear abnormalities and hearing loss
Ataxia telangiectasia	Chromosome instability with rearrangements between chromosomes 7 and 14 in lymphocytes often involving the T-cell receptors in those chromosomes Decreased IgA levels Pathogenic variants in the *ATM* gene. Autosomal recessive	Progressive cerebellar ataxia with later development of conjunctival telangiectasias, choreoathetosis, and dystonia Sinopulmonary infections Predisposition to malignancies like B-cell lymphomas, T-cell leukemias and solid tumors
Nijmegen syndrome	Translocations involving chromosomes 7 and 14 in up to 50% of cells Pathogenic variants in the *NBN* gene (autosomal recessive)	IUGR, short stature, progressive microcephaly, and intellectual disability, recurrent sinopulmonary infections Susceptibility to malignancies before age 20 years like T- and B-cell lymphomas, medulloblastomas, gliomas, rhabdomyosarcoma
ICF (immunodeficiency, centromere instability, facial anomalies) syndrome, types I and II	Pericentromeric chromosomal instability on PHA-stimulated metaphases in chromosomes 1, 9, and 16 Decrease of IgG and IgE in type I, IgM and IgE in type II Low T cells, like NK cells. Pathogenic variants in *DNMT3B* and ZBTB24 genes in types I and II, respectively Autosomal recessive	Immunodeficiency, recurrent infections, intellectual disability, facial dysmorphic features
Roberts-SC phocomelia syndrome	Premature chromosome separation with chromatid/centromere repulsion in prophase or early metaphase easily detected using C-banding Pathogenic variants in *ESCO2* gene Autosomal recessive	Prenatal growth deficiency, absent or hypoplastic arms typically symmetric with reduction of digits' length including thumbs that are usually more affected than lower extremities, bilateral cleft lip and palate, dysmorphic features, cardiac anomalies, renal anomalies, and intellectual disability
Bloom syndrome	Marked chromosomal increase of sister chromatid exchange in the presence of BrdU and increased spontaneous chromosome breakage Decreased IgG, IgA, IgM Pathogenic variants in the *RECQL3* gene. Autosomal recessive	Severe prenatal and postnatal growth deficiency, microcephaly (average intelligence), sensitivity to sunlight (butterfly distribution over the face), cafe-au-lait macules, insulin resistance, predisposition to malignancies: lymphomas, leukemias, squamous cell carcinoma and solid tumors Hypersensitivity to chemotherapy
Werner syndrome	"Variegated translocation mosaicism": chromosomal aberrations, including translocations, inversions, and deletions Telomere loss Pathogenic variants in *RECQL2* Autosomal recessive	Short stature, premature aging appearance, and predisposition to malignancies Loss and graying of hair, hoarseness, scleroderma-like changes in the 20s Cataracts, type II diabetes, osteoporosis, hypogonadism in the 30s Neoplasms in >40% of cases including sarcomas, melanomas, and thyroid cancer Myocardial infarction and malignancies are cause of early death

IUGR, Intrauterine growth restriction; PHA, phytohemagglutinin; NK, natural killer.

An infant has profound hypotonia and poor feeding, followed by hyperphagia and excessive weight gain in early childhood. Which syndrome fits the diagnostic-features table?

A. Prader-Willi syndrome
B. Angelman syndrome
C. Klinefelter syndrome
D. Cystic fibrosis
E. Fragile X premutation only

Original table 99.11 | Nelson printed p. 776 | PDF p. 822

Table 99.11 Consensus Diagnostic Criteria for Prader-Willi Syndrome

	MAJOR CRITERIA (1 POINT EACH)	MINOR CRITERIA (1/2 POINT EACH)
1	Neonatal/infantile hypotonia	Decreased fetal movement and infantile lethargy
2	Feeding problems and failure to thrive as an infant	Typical behavior problems
3	Weight gain at 1-6 years; obesity; hyperphagia	Sleep apnea
4	Characteristic dysmorphic facial features	Short stature for family by 15 years
5	Small genitalia; pubertal delay and insufficiency	Hypopigmentation for the family
6	Developmental delay/intellectual disability	Small hands and feet for height
7		Narrow hands, straight ulnar border
8		Esotropia, myopia
9		Thick, viscous saliva
10		Speech articulation defects
11		Skin picking

From Cassidy SB, Schwartz S, Miller JL, Driscoll DJ. Prader-Willi syndrome. *Genet Med*. 2012;14(1):15. Table 2.

A young infant with Prader-Willi syndrome has hypotonia and struggles to feed, rather than overeating. Which concept from the nutritional-phase table explains this?

A. Early nutritional phases feature poor feeding before later hyperphagia
B. Hyperphagia is obligatory immediately after birth
C. Poor feeding excludes the diagnosis
D. Prader-Willi syndrome never alters appetite
E. Only adults develop nutritional phases

Original table 99.12 | Nelson printed p. 777 | PDF p. 823

Table 99.12 Nutritional Phases in Prader-Willi Syndrome

PHASE	MEDIAN AGES	CLINICAL CHARACTERISTICS
0	Prenatal to birth	Decreased fetal movements and lower birthweight than siblings
1a	0-9 mo	Hypotonia with difficulty feeding and decreased appetite
1b	9-25 mo	Improved feeding and appetite and growing appropriately
2a	2.1-4.5 yr	Weight increasing without appetite increase or excess calories
2b	4.5-8 yr	Increased appetite and calories, but can feel full
3	8 yr to adulthood	Hyperphagic, rarely feels full
4	Adulthood	Appetite is no longer insatiable

Modified from Miller JL, Lynn CH, Driscoll DC, et al. Nutritional phases in Prader-Willi syndrome. *Am J Med Genet A*. 2011;155A:1040–1049.

A child has a deletion at 15q11-q13 affecting the paternally inherited copy. Which syndrome is associated with this parent-of-origin effect?

A. Prader-Willi syndrome
B. Angelman syndrome
C. Turner syndrome
D. Noonan syndrome
E. Trisomy 13

Original table 99.13 | Nelson printed p. 777 | PDF p. 823

Table 99.13 Molecular Mechanisms Causing Prader-Willi and Angelman Syndromes

	PRADER-WILLI SYNDROME	ANGELMAN SYNDROME
15q11-q13 deletion	~70% (paternal)	~70% (maternal)
Uniparental disomy	~30% (maternal)	~5% (paternal)
Single-gene pathogenic variants	None detected	*UBE3A* gene encoding the E6-AP ubiquitin-protein ligase (11% of total but mostly in familial cases)
Imprinting center pathogenic variants	5%	1%
Unidentified	<1%	10–15%

Data from Nicholls RD, Knepper JL. Genome organization, function and imprinting in Prader-Willi and Angelman syndromes. *Annu Rev Genomics Hum Genet*. 2001;2:153–175; and Horsthemke B, Buiting K. Imprinting defects on human chromosome 15. *Cytogenet Genome Res*. 2006;113:292–299.

A child has micrognathia leading to posterior displacement of the tongue and a secondary cleft palate. Which dysmorphology term in the table describes this chain of events?

A. Sequence
B. Association
C. Independent chromosomal trisomy
D. Simple isolated variant
E. Acquired neoplasm

Original table 100.1 | Nelson printed p. 778 | PDF p. 824

Table 100.1 Mechanisms, Terminology, and Definitions of Dysmorphology

TERMINOLOGY	DEFINITION	EXAMPLE
Sequence	Single error in morphogenesis that results in a series of subsequent defects	Pierre-Robin sequence, in which a small jaw results in glossoptosis and cleft palate 22q11 deletion sequence of primary fourth brachial arch and third and fourth pharyngeal pouch defects, leading to aplasia or hypoplasia of the thymus and parathyroid glands, aortic arch anomalies, and micrognathia
22q11 deletion	Mechanical (uterine) force that alters structure of intrinsically normal tissue	Oligohydramnios produces deformations by in utero compression of limbs (e.g., dislocated hips, equinovarus foot deformity), crumpled ears, or small thorax
Disruption sequence	In utero tissue destruction after a period of normal morphogenesis	Amnionic membrane rupture sequence, leading to amputation of fingers/toes, tissue fibrosis, and tissue bands
Dysplasia sequence	Atypical organization of cells into tissues or organs	Neurocutaneous melanosis sequence, with atypical migration of melanocyte precursor cells from the neural crest to the periphery, manifesting as melanocytic hamartomas of skin and meninges
Malformation syndrome	Appearance of multiple malformations in unrelated tissues that have a known, unifying cause	Trisomy 21 Teratogens Numerous multiple congenital anomaly syndromes as described above

From Kliegman RM, Greenbaum LA, Lye PS, eds. *Practical Strategies in Pediatric Diagnosis and Therapy*. 2nd ed. Philadelphia: Elsevier, 2004.

A child has abnormal vertebral and rib segmentation due to a pathogenic variant involving DLL3. Which listed disorder best fits?

A. Spondylocostal dysostosis
B. Turner syndrome
C. Prader-Willi syndrome
D. Cystic fibrosis
E. Fanconi anemia

Original table 100.2 | Nelson printed p. 780 | PDF p. 826

Table 100.2 Examples of Malformations with Distinct Causes, Clinical Features, and Pathogenesis

DISORDER	CAUSE/INHERITANCE	SELECTED CLINICAL FEATURES	PATHOGENESIS
Spondylocostal dysostosis syndrome	Mendelian; autosomal recessive	Abnormal vertebral and rib segmentation	Deleterious sequence variants in *DLL3* and other genes
Rubinstein-Taybi syndrome	Autosomal dominant	Intellectual disability Broad thumbs and halluces; valgus deviation of these digits Hypoplastic maxillae Prominent nose and columella Congenital heart disease	Deleterious sequence variants in *CBP* and *EP300*
X-linked lissencephaly	X-linked	Male: severe intellectual disability, seizures Female: variable	Deleterious sequence variants in *DCX*
Aniridia	Autosomal dominant	Absent iris or iris/foveal hypoplasia	Deleterious sequence variants in *PAX6*
Waardenburg syndrome, type I	Autosomal dominant	Deafness White forelock Wide-spaced eyes Iris heterochromia and/or pale skin pigmentation	Deleterious sequence variants in *PAX3*
Holoprosencephaly	Loss of function or haploinsufficiency for multiple genes	Microcephaly Cyclopia Single central incisor	*SHH*, multiple other genes
Velocardiofacial syndrome	Microdeletion 22q11.2	Congenital heart disease, including conotruncal defects Cleft palate T-cell defects Facial anomalies	*TBX1* haploinsufficiency/ pathogenic variants; haploinsufficiency for other genes in the deleted interval also contributes to the phenotype
Down syndrome	Additional copy of chromosome 21 (trisomy 21)	Intellectual disability Characteristic facial anomalies Congenital heart disease Increased risk of leukemia Alzheimer disease	Increase in dosage of an estimated 250 genes on chromosome 21
Neural tube defects	Multifactorial	Meningomyelocele	Defects in folate sensitive enzymes or folic acid uptake
Fetal alcohol syndrome	Teratogenic	Microcephaly Developmental delay Facial anomalies Behavioral abnormalities	Ethanol toxicity to developing brain
Retinoic acid embryopathy	Teratogenic	Microtia Congenital heart disease	Isotretinoin effects on neural crest and branchial arch development

anal atresia, tracheoesophageal fistula (TEF) with esophageal atresia, mouse models with defective Hedgehog and/or ciliary signaling mani-

A newborn has multiple malformations following a documented maternal viral illness during pregnancy. Which etiologic category from the table should be assessed?

A. Maternal infection
B. Postnatal iron deficiency only
C. Simple traumatic fracture
D. An isolated circadian sleep disorder
E. Childhood-onset tic disorder

Original table 100.3 | Nelson printed p. 781 | PDF p. 827

Table 100.3 Causes of Congenital Malformations

MONOGENIC
X-linked hydrocephalus
Achondroplasia
Ectodermal dysplasia
Apert syndrome
Treacher Collins syndrome
CHROMOSOMAL ABERRATIONS AND COPY NUMBER VARIANTS
Trisomy 21, 18, 13
XO, XXY
Deletions 4p−, 5p−, 7q−, 13q−, 18p−, 18q−, 22q−
Prader-Willi syndrome (70% of affected patients have deletion of chromosome 15q11.2-q13)
MATERNAL INFECTION
Intrauterine infections (e.g., herpes simplex virus, cytomegalovirus, varicella-zoster virus, rubella virus, Zika virus, toxoplasmosis)
MATERNAL ILLNESS
Diabetes mellitus
Phenylketonuria
Hyperthermia
UTERINE ENVIRONMENT
Deformation
Uterine pressure, oligohydramnios: clubfoot, torticollis, congenital hip dislocation, pulmonary hypoplasia, seventh nerve palsy
Disruption
Amniotic bands, congenital amputations, gastroschisis, porencephaly, intestinal atresia
Twinning
ENVIRONMENTAL AGENTS
Polychlorinated biphenyls
Herbicides
Mercury
Alcohol
MEDICATIONS
Thalidomide
Diethylstilbestrol
Phenytoin
Warfarin
Cytotoxic drugs
Paroxetine
Angiotensin-converting enzyme inhibitors
Isotretinoin (vitamin A)
D-Penicillamine
Valproic acid
Mycophenolate mofetil
UNKNOWN ETIOLOGIES
Neural tube defects, such as anencephaly and spina bifida
Cleft lip/palate
Pyloric stenosis
SPORADIC SEQUENCE COMPLEXES
VATER/VACTERL sequence (vertebral defects, anal atresia, cardiac defects, tracheoesophageal fistula with esophageal atresia, radial and renal anomalies)
Pierre-Robin sequence
NUTRITIONAL
Neural tube defects due to low folic acid

From Behrman RE, Kliegman RM, eds. *Nelson's Essentials of Pediatrics*, 4th ed. Philadelphia: Saunders; 2002.

A dysmorphology note describes brachydactyly. What finding does the terminology table mean?

A. Short digits
B. Permanent flexion of a finger
C. Widely spaced eyes
D. White iris flecks
E. Small head circumference

Original table 100.4 | Nelson printed p. 784 | PDF p. 830

Table 100.4 Definitions of Common Clinical Signs of Syndromes with Facial Anomalies

SIGN	DEFINITION
Brachycephaly	A condition in which head shape is shortened from front to back along the sagittal plane; typically the back of the skull (occiput) and face are flatter than normal.
Brachydactyly	Short digits.
Brushfield spots	Speckled white spots or rings about two-thirds of the distance to the periphery of the iris of the eye.
Camptodactyly	Permanent flexion of one or more fingers that can be associated with missing interphalangeal creases.
Clinodactyly	A medial or lateral curving of the fingers or toes; usually refers to incurving of the fifth finger.
Hypoplastic or small nail	A small nail on a digit.
Low-set ears	This designation is made when the helix meets the cranium at a level below a horizontal plane that is an extension of a line through both inner canthi.
Melia	A suffix meaning "limb" (e.g., amelia, missing limb; brachymelia, short limb).
Wide-set eyes	Increased distance between the center of the pupils of the two eyes; can be measured as an *increased interpupillary distance* (IPD).
Plagiocephaly	A condition in which head shape is asymmetric in the sagittal or coronal plane; can result from asymmetry in cranial suture closure, asymmetry of brain growth, or deformation of the skull.
Posterior hair whorl	A single hair whorl occurs to the right or left of midline and is within 2 cm anterior to the posterior fontanel in 95% of cases.
Postaxial polydactyly	Extra finger or toe present on the lateral side of the hand or foot.
Preaxial polydactyly	Extra finger or toe present on the medial side of the hand or foot.
Prominent lateral palatine ridges	Relative overgrowth of the lateral palatine ridges that can be caused by a deficit of tongue thrust into the hard palate.
Scaphocephaly	A condition in which the head is elongated from front to back in the sagittal plane; most normal skulls are scaphocephalic; also termed *dolichocephaly*.
Shawl scrotum	The scrotal skin joins around the superior aspect of the penis and represents a mild deficit in full migration of the labial-scrotal folds.
Short palpebral fissures	Decreased horizontal distance of the eyelid folds based on measurements from the inner canthus to the outer canthus.
Syndactyly	Incomplete separation of the fingers or toes. It most commonly occurs between the third and fourth fingers and between the second and third toes.
Synophrys	Eyebrows that meet in the midline.
Telecanthus	Lateral displacement of the inner canthi. The inner canthal distance (ICD) is increased, but the IPD is normal.
Widow's peak	V-shaped midline, downward projection of the scalp hair in the frontal region. It represents an upper forehead intersection of the bilateral fields of periocular hair growth suppression. A widow's peak can occur together with wide-spaced eyes.

A newborn has an omphalocele. How is this finding classified in the table of congenital anomalies?

A. Major abdominal-wall malformation
B. Minor ear anomaly
C. Normal variant of the iris
D. Isolated behavioral finding
E. Acquired childhood injury

Original table 100.5 | Nelson printed p. 785 | PDF p. 831

Table 100.5 Major Malformations*

NEUROLOGIC
Severe hydrocephalus
Lissencephaly
Schizencephaly
Megalencephaly
Neural tube defect
Meningomyelocele
Encephalocele

CARDIOVASCULAR
Various congenital heart malformations
Cardiomyopathy
Genetic arrhythmia syndromes

GENITOURINARY
Ambiguous genitalia
Kidney malformations
Urachal defects

RESPIRATORY
Congenital pulmonary airway malformation
Tracheoesophageal fistula

ABDOMINAL WALL
Gastroschisis
Omphalocele

CRANIOFACIAL
Craniosynostosis
Facial cleft
Cleft lip and palate
Structural eye defect
Coloboma
Aniridia
Structural ear defects
Microtia
Aplasia of the auditory canal

LIMB
Amelia
Split/hand foot malformation

*Not an inclusive list.
From Basel D. Dysmorphology in a genomic era. *Clin Perinatol*. 2020;47:15–23. Table 1.

A neonate has a small isolated preauricular skin tag but otherwise normal examination. Which category includes this physical finding?

A. Minor ear malformation
B. Major cardiac defect
C. Major abdominal-wall defect
D. Central nervous-system malformation
E. Inherited metabolic crisis

Original table 100.6 | Nelson printed p. 785 | PDF p. 831

Table 100.6 Minor Malformations*

CRANIOFACIAL
Large fontanel
Flat or low nasal bridge
Saddle nose, upturned nose
Micrognathia
Cutis aplasia of the scalp

EYE
Palpebral fissures
  Telecanthus or epicanthus
  Up or down slanting
Hypertelorism
Brushfield spots

EAR
Posteriorly rotated pinna
Lack of helical fold
Preauricular with or without auricular skin tags
Small pinna
Auricular (preauricular) pit or sinus
Folding of helix
Darwinian tubercle
Crushed (crinkled) ear
Asymmetric ear sizes
Low-set ears

SKIN
Dimpling over the bones
Capillary hemangioma (face/posterior neck)
Dermal melanosis (African, Asian)
Sacral dimple
Pigmented nevi
Redundant skin folds
Cutis marmorata
Café-au-lait macules

HAND
Simian crease
Bridged upper palmar creases
Fifth finger clinodactyly
Joint hypermobility (hyperextension of thumb)
Cutaneous syndactyly
Polydactyly
Short, broad thumb
Narrow or hyperconvex nails
Hypoplastic nails
Camptodactyly
Short fourth metacarpal

FOOT
Syndactyly of second/third toe
Asymmetric toe length
Clinodactyly of second toe
Overlapping toes
Nail hypoplasia
Wide gap between hallux and second toe
Deep plantar crease between hallux and second toe

OTHER
Mild calcaneovalgus
Hydrocele
Shawl scrotum
Hypospadias
Hypoplasia of labia majora
Supernumerary nipples
Undescended testes
Tongue tie

*Not an inclusive list.
From Basel D. Dysmorphology in a genomic era. *Clin Perinatol*. 2020;47:15–23. Table 2.

A child has a friendly social style, supravalvular aortic stenosis, and stellate iris pattern. Which deletion syndrome fits the table?

A. Williams syndrome
B. WAGR syndrome
C. Prader-Willi syndrome
D. Wolf-Hirschhorn syndrome
E. Cri-du-chat syndrome

Original table 100.7 | Nelson printed p. 786 | PDF p. 832

Table 100.7 Chromosomal Deletion Syndromes

CONDITION	BRIEF DESCRIPTION	PROBE
Williams syndrome	Proportionate short stature, mild-moderate to severe intellectual disability, friendly personality, stellate pattern of iris pigmentation, supravalvular aortic stenosis, wide mouth with full lips	7q11
WAGR syndrome	Wilms tumor, aniridia, growth delay, intellectual disability, and genitourinary anomalies	11p13
Prader-Willi syndrome Angelman syndrome	Distinct syndromes with common or overlapping areas of deletion; phenotype depends on gender of the parent of origin of the deletion Prader-Willi syndrome: hypotonia in infancy, short stature, obesity, mild-moderate and occasionally severe intellectual disability, small hands and feet (caused by paternal deletion of 15q11-13 or maternal uniparental disomy for chromosome 15) Angelman syndrome: severe intellectual disability, absence of speech, ataxia, tremulous movements, large mouth, frequent drooling (caused by maternal deletion of chromosome 15q11-13 or paternal uniparental disomy)	15q11
Smith-Magenis syndrome	Brachycephaly, prognathism, self-destructive behavior, wrist biting, pulling out nails, head banging, indifference to pain, intellectual disability, hyperactivity	17p11.2
Miller-Dieker syndrome	Microcephaly, narrow temples, hypotonia/hypertonia, abnormal posturing, seizures, severe to profound intellectual disability, poor growth, lissencephaly and other brain abnormalities on CT or MRI	17p13
22q11 deletion syndrome	Cleft palate, congenital heart disease, learning/behavior problems, long face, prominent nose, limb hypotonia, slender hands with tapering fingers, T-cell deficiency, immunoglobulin deficiency	22q11

WAGR, Wilms tumor, aniridia, genitourinary anomalies, and mental retardation.
From Kliegman RM, Lye PS, et al., eds. *Nelson Pediatric Symptom-Based Diagnosis,* Philadelphia: Elsevier; 2018: Table 25-10.

A child with Noonan syndrome has a pathogenic variant in PTPN11. Which signaling pathway in the table connects this gene to the phenotype?

A. RAS/MAPK pathway
B. Mitochondrial electron transport chain only
C. Complement cascade
D. Coagulation intrinsic pathway
E. Urea cycle

Original table 101.1 | Nelson printed p. 788 | PDF p. 834

Table 101.1 Genes and Features of the RAS/MAPK Pathway

SYNDROME	RAS/MAPK PATHWAY GENE	PROTEIN	PROTEIN FUNCTION	CLINICAL PHENOTYPE
Noonan syndrome	*PTPN11* *SOS1* *RAF1* *KRAS* *NRAS* *SHOC2* *CBL* *RIT1*	SHP2 SOS1 CRAF KRAS NRAS SHOC2 CBL RIT1	Phosphatase RasGEF Kinase GTPase GTPase Scaffolding E3 ubiquitin ligase GTPase	Craniofacial dysmorphic features, including a broad forehead, hypertelorism, down-slanting palpebral fissures, ptosis, a high-arched palate, and low-set, posteriorly rotated ears; congenital heart defects; short stature; undescended testicles; ophthalmologic abnormalities; bleeding disorders; normal neurocognitive function or mild impairment; predisposition to cancer
Noonan syndrome with multiple lentigines	*PTPN11* *RAF1*	SHP2 RAF1/CRAF	Phosphatase Kinase	Same as Noonan syndrome, but with possible development of multiple skin lentigines as individuals age; unclear predisposition to cancer
Capillary malformation–arteriovenous malformation	*RASA1*	p120-RasGAP	RasGAP	Multifocal capillary malformations, which may be associated with arteriovenous malformations and fistulae; unclear predisposition to cancer
Costello syndrome	*HRAS*	HRAS	GTPase	Craniofacial features similar to those of Noonan syndrome but potentially more coarse; congenital heart defects; failure to thrive; short stature; ophthalmologic abnormalities; multiple skin manifestations, including papilloma; normal neurocognitive function or mild impairment; hypotonia; predisposition to cancer
Cardiofaciocutaneous syndrome	*BRAF* *MAP2K1* *MAP2K2* *KRAS*	BRAF MEK1 MEK2 KRAS	Kinase Kinase Kinase GTPase	Craniofacial features similar to those of Noonan syndrome; congenital heart defects; failure to thrive; short stature; ophthalmologic abnormalities; multiple skin manifestations, including progressive formation of nevi; normal neurocognitive function or mild impairment; hypotonia; unclear predisposition to cancer
Neurofibromatosis type 1	*NF1*	Neurofibromin	RasGAP	Café-au-lait maculae; intertriginous freckling; neurofibromas and plexiform neurofibromas; iris Lisch nodules; osseous dysplasia; optic pathway glioma; normal neurocognitive function or mild impairment; predisposition to other cancers
Legius syndrome	*SPRED1*	SPRED1	SPROUTY-related, EVH1 domain–containing protein 1	Café-au-lait maculae; intertriginous freckling; macrocephaly; normal neurocognitive function or mild impairment; no apparent predisposition to cancer

Modified from Rauen KA. The RASopathies. *Annu Rev Genom Hum Genet*. 2013;14:355–369. Table 3.

A child has short stature, ptosis, widely spaced eyes, low posterior hairline, and a pectus deformity. Which syndrome matches the listed clinical features?

A. Noonan syndrome
B. Classic galactosemia
C. Angelman syndrome
D. Isolated phenylketonuria
E. Duchenne muscular dystrophy

Original table 101.2 | Nelson printed p. 789 | PDF p. 835

Table 101.2 Clinical Findings Associated with Noonan Syndrome

Short stature
Failure to thrive (use of specific Noonan syndrome growth curves is recommended)
Tall forehead
Epicanthal folds
Ptosis
Blue-green irides
Wide-spaced eyes
Low nasal bridge, upturned nose
Down-slanting palpebral fissures
Low-set and posteriorly rotated ears
Dental malocclusion
Low posterior hairline
Pectus excavatum
Pectus carinatum superiorly
Scoliosis
Pigmented villonodular synovitis (polyarticular)
Cubitus valgus
Pulmonary valve stenosis (dysplastic valve)
Hypertrophic cardiomyopathy
Atrial septal defect, ventricular septal defect
Lymphedema
Nevi, lentigines, café-au-lait spots
Cryptorchidism
Small penis
Delayed puberty
Bleeding disorders, including thrombocytopenia and coagulation factor deficiencies
Leukemia, myeloproliferative disorders, other malignancies
Cognitive delay

A child has a new diagnosis of Noonan syndrome. Which care component is included at diagnosis in the management table?

A. Medical genetics evaluation and systematic physical examination
B. No baseline examination
C. Automatic discharge from follow-up
D. Only an annual dental radiograph
E. Delay all counseling until adulthood

Original table 101.3 | Nelson printed p. 790 | PDF p. 836

Table 101.3 Management of Noonan Syndrome

	AT DIAGNOSIS	AFTER DIAGNOSIS	IF SYMPTOMATIC
General	Complete physical and neurologic examination; medical genetics consultation to confirm diagnosis, consider molecular genetic testing and genetic counseling	Yearly complete physical and neurologic examination; return to geneticist if genotype negative or for multisystem assessment; genetic counseling at adolescence or when a young adult	Orchiopexy by age 1 year for cryptorchidism; if lymphoedema, refer to specialty clinic; brain and cervical spine MRI if intracranial pressure increases; electroencephalogram and referral to neurologist if seizures suspected
Developmental	Multidisciplinary developmental assessment	Developmental screening yearly for children age 5-18 years	Neuropsychologist testing if screening abnormal; referral to early intervention if delays detected before age 3 years; individual education plan for children age 5-18 years with delays
Dental	First dental assessment between age 1 year and 2 years	Yearly dental assessment	—
Growth and feeding	Plot growth on curves for Noonan syndrome	Plot growth on curves for Noonan syndrome 3 times per year until age 3 years, then yearly	Refer to gastroenterologist for feeding problems or recurrent vomiting, or if evidence of growth failure without comorbid cause exists; thyroid function tests if signs or symptoms of hypothyroidism
Cardiovascular	Cardiac examination, electrocardiogram, echocardiogram	Follow up on the basis of initial findings. If initial assessment normal, repeat every 5 years	—
Ophthalmologic	Baseline eye examination Baseline audiology examination	Repeat every 2 years, sooner if indicated	—
Audiologic	Baseline audiology examination	Repeat if recurrent otitis media or speech delay	Refer to ear, nose, and throat specialist for recurrent otitis media or serous otitis; hearing aids or classroom interventions for hearing loss
Hematologic	Complete blood cell count with differential, and prothrombin time or activated partial thromboplastin time	Repeat complete blood cell count with differential and prothrombin time or activated partial thromboplastin time if age 6-12 months at initial screen Preoperatively: complete blood cell count with differential and prothrombin time or activated partial thromboplastin time, second tier (in consultation with hematologist) factor IX, XI, and XII concentrations, von Willebrand factor, platelet aggregation	Prothrombin time or activated partial thromboplastin time if bleeding abnormal or persistent, refer to hematologist; complete blood cell count with differential for splenomegaly; complete blood cell count with differential and liver function studies for hepatosplenomegaly
Renal	Kidney ultrasound	—	—
Skeletal	Clinical assessment of spine with radiology if indicated by examination	Repeat spinal examination yearly through adolescence; radiology and referral to orthopaedic specialist if abnormal	—

From Roberts AE, Allanson JE, Tartaglia M, Gelb BD. Noonan syndrome. *Lancet*. 2013;381:333–342.

A child has chronic otitis media, recurrent respiratory symptoms, and organ laterality abnormalities. Which motile-cilia disorder in the table best explains this combination?

A. Primary ciliary dyskinesia
B. Nephronophthisis alone
C. Isolated familial hypercholesterolemia
D. Phenylketonuria
E. Turner syndrome

Original table 101.4 | Nelson printed p. 792 | PDF p. 838

Table 101.4 Childhood Diseases and Syndromes Associated with Motile and Primary/Sensory Ciliopathies

PEDIATRIC CILIOPATHY	CLINICAL MANIFESTATIONS	SELECTED GENE(S)
MOTOR		
Primary ciliary dyskinesia	Chronic bronchitis, rhinosinusitis, otitis media, laterality defects, infertility, CHD	*DNAI1, DNAH5, DNAH11, DNAI2, KTU, TXNDC3, LRRC50, RSPH9, RSPH4A, CCDC40, CCDC39*
PRIMARY/SENSORY		
Autosomal recessive polycystic kidney disease	RFD, CHF	*PKHD1*
Nephronophthisis	RFD, interstitial nephritis, CHF, RP	*NPHP1-8, ALMS1, CEP290*
Bardet-Biedl syndrome	Obesity, polydactyly, ID, RP, renal anomalies, anosmia, CHD	*BBS1-12, MKS1, MKS3, CEP290*
Meckel-Gruber syndrome	RFD, polydactyly, ID, CNS anomalies, CHD, cleft lip, cleft palate	*MKS1-6, CC2D2A, CEP290, TMEM216*
Joubert syndrome	CNS anomalies, ID, ataxia, RP, polydactyly, cleft lip, cleft palate	*NPHP1, JBTS1, JBTS3, JBTS4, CORS2, AHI1, CEP290, TMEM216*
Alström syndrome	Obesity, RP, DM, hypothyroidism, hypogonadism, skeletal dysplasia, cardiomyopathy, pulmonary fibrosis	*ALMS1*
Orofaciodigital syndrome type I	Polydactyly, syndactyly, cleft lip, cleft palate, CNS anomalies, ID, RFD	*OFD1*
Ellis van Creveld syndrome	Chondrodystrophy, polydactyly, ectodermal dysplasia, CHD	*EVC, EVC2*
Jeune asphyxiating thoracic dystrophy	Narrow thorax, RFD, RP, dwarfism, polydactyly	*IFT80*
Sensenbrenner syndrome	Dolichocephaly, ectodermal dysplasia, dental dysplasia, narrow thorax, RFD, CHD	*IFT122, IFT43, WDR35*
Short rib–polydactyly syndromes	Narrow thorax, short limb dwarfism, polydactyly, renal dysplasia	*WDR35, DYNC2H1, NEK1*

CHD, Congenital heart disease; CHF, congenital hepatic fibrosis; CNS, central nervous system; DM, diabetes mellitus; ID, intellectual disabilities; RFD, renal fibrocystic disease; RP, retinitis pigmentosa.
From Farkol TW, Leigh MW. Ciliopathies: the central role of cilia in a spectrum of pediatric disorders. *J Pediatr*. 2012;160:366–371.

A child has long palpebral fissures with everted lower lids, arched eyebrows sparse laterally, and abnormal dentition. Which phenotype-scoring list in the table is relevant?

A. Kabuki syndrome phenotype score
B. NEXUS
C. Glasgow Coma Scale
D. Phoenix sepsis score
E. CRIES neonatal pain score

Original table 102.1 | Nelson printed p. 797 | PDF p. 843

Table 102.1 Kabuki Phenotype Scoring List

CLINICAL FEATURES	POSSIBLE SCORE	FEATURES
Facial features	0-5 points (0-3 features = 1 point; 4-6 = 2 point; 7-9 = 3 point; 10-12 = 4 point; 13-15 = 5 point)	Long palpebral fissures; everted lower eyelids; large dysplastic ears; arched eyebrows, sparse lateral one third; flat nasal tip; abnormal dentition; high/cleft palate; strabismus; blue sclera; micrognathia; ptosis; broad nasal root; oligodontia; thin upper and full lower lip; lip nodules
Limb/extremity features	Up to 1 point (0-1 features = 0 point; 2-4 = 1 point)	Persistent fetal pads; brachy- or clinodactyly; lax joints; hip dislocation
Microcephaly	1 point	
Short stature	1 point	
Heart	1 point	
Kidney	1 point	
Sum	0-10	

From Wang YR, Xu NX, Wang J, Wang XM. Kabuki syndrome: review of the clinical features, diagnosis and epigenetic mechanisms. *World J Pediatr*. 2019;15:528–535. Table 1.

A neonate develops recurrent fasting hypoglycemia with concern for an inherited defect of energy metabolism. Which disease category is listed in the metabolic differential?

A. Fatty acid oxidation disorders
B. Isolated dyslexia
C. Simple congenital myopia
D. Primary oppositional behavior
E. Transient tic disorder

Original table 104.4 | Nelson printed p. 806 | PDF p. 852

Table 104.4 Select Inborn Errors of Metabolism Associated with Neonatal Hypoglycemia

CATEGORY OF DISORDERS	DISORDERS
Fatty acid oxidation disorders	Carnitine-acylcarnitine translocase deficiency Carnitine palmitoyltransferase Ia deficiency Carnitine palmitoyltransferase II deficiency Long-chain 3-hydroxyacyl-CoA dehydrogenase deficiency/trifunctional protein deficiency Medium-chain acyl-CoA dehydrogenase deficiency Very-long-chain acyl-CoA dehydrogenase deficiency Multiple acyl-CoA dehydrogenase deficiency
Disorders of gluconeogenesis	Fructose-1,6-diphosphatase deficiency Phosphoenolpyruvate carboxykinase deficiency
Disorders of fructose and galactose metabolism	Hereditary fructose intolerance Classic galactosemia
Glycogen storage diseases (GSD)	GSD type Ia (glucose-6-phosphatase deficiency) GSD type Ib (impaired glucose-6-phosphate exchanger) GSD type III (glycogen debrancher enzyme deficiency) GSD type VI (liver glycogen phosphorylase deficiency) GSD type IX (phosphorylase kinase deficiencies)
Disorders of ketone metabolism	3-Hydroxy-3-methylglutaryl-CoA lyase deficiency Mitochondrial 3-hydroxy-3-methylglutaryl-CoA synthase deficiency Succinyl-CoA:3-oxoacid-CoA transferase (SCOT) deficiency β-Ketothiolase deficiency
Disorders of amino acid metabolism	Maple syrup urine disease
Organic acidemias	Propionic acidemia Methylmalonic acidemia Isovaleric acidemia Multiple carboxylase deficiency (holocarboxylase synthetase deficiency and biotinidase deficiency)
Hyperinsulinemic hypoglycemia	*HADH*-related disorder (3-alpha-hydroxyacyl-CoA dehydrogenase deficiency) *GLUD1*-related disorder (hyperammonemia-hyperinsulinism syndrome [HIHA])
Other	Mitochondrial respiratory chain defects Neonatal intrahepatic cholestasis caused by citrin deficiency Pyruvate carboxylase deficiency Carbonic anhydrase VA deficiency

Modified from Zinn AB. Inborn errors of metabolism. In: Martin RJ, Fanaroff AA, Walsh MC, eds. *Fanaroff & Martin's Neonatal-Perinatal Medicine: Diseases of the Fetus and Infant,* 10th ed. Philadelphia: Elsevier; 2015: Table 99.17, p. 1605.

A neonate with unexplained encephalopathy has marked hyperammonemia and no primary liver failure. Which inborn-error category is central in the table's differential?

A. Urea-cycle defects
B. Isolated speech sound disorder
C. Turner syndrome
D. Uncomplicated iron deficiency
E. Primary vasovagal syncope

Original table 104.5 | Nelson printed p. 807 | PDF p. 853

Table 104.5 Differential Diagnosis of Hyperammonemia

INBORN ERRORS OF METABOLISM
Urea Cycle Enzyme Defects
N-acetylglutamate synthase (NAGS) deficiency
Carbamoyl phosphate synthetase one (CPS1) deficiency
Ornithine transcarbamylase (OTC) deficiency
Argininosuccinate synthetase (ASS) deficiency (citrullinemia type 1)
Argininosuccinate lyase (ASL) deficiency (argininosuccinic aciduria)
Arginase 1 deficiency
Transport and Synthesis Defects of Urea Cycle Intermediates
Hyperornithinemia-hyperammonemia-homocitrullinemia (HHH syndrome)
Citrullinemia type 2 caused by citrin deficiency
Lysinuric protein intolerance
Ornithine aminotransferase deficiency
Carbonic anhydrase VA deficiency
Organic Acidemias
Propionic acidemia
MMUT-related methylmalonic acidemia and cobalamin metabolism disorders
Isovaleric acidemia
Fatty Acid Oxidation Disorders
Long-chain fatty acid oxidation defects
Systemic primary carnitine deficiency
Other
Pyruvate carboxylase deficiency
GLUD1-related hyperinsulinemic hypoglycemia
Neonatal iron overload disorders (e.g., hereditary hemochromatoses)

ACQUIRED DISORDERS
Transient Hyperammonemia of the Newborn
Diseases of the Liver and Biliary Tract
Liver failure
Biliary atresia
Severe Systemic Neonatal Illness
Neonates sepsis
Heart failure
Medications
Valproic acid
Cyclophosphamide
5-Pentanoic acid
Asparaginase
Other
Reye syndrome

ANATOMIC VARIANTS
Vascular bypass of the liver (e.g., a portosystemic anastomosis)

TECHNICAL
Inappropriate sample collection (e.g., capillary blood or prolonged placement of a tourniquet)
Sample not immediately analyzed

Modified from El-Hattab AW. Inborn errors of metabolism. *Clin Perinatol*. 2015;42:413–439, Box 8.

A critically ill newborn's urine has a sweet odor resembling maple syrup. Which amino-acid metabolic disorder in the table should be considered?

A. Maple syrup urine disease
B. Isovaleric acidemia
C. Phenylketonuria
D. Trimethylaminuria
E. Primary ciliary dyskinesia

Original table 104.11 | Nelson printed p. 810 | PDF p. 856

Table 104.11 Inborn Errors of Amino Acid Metabolism Associated with Peculiar Odor

INBORN ERROR OF METABOLISM	URINE ODOR
Isovaleric acidemia Glutaric acidemia (type II)	"Sweaty feet," acrid
Maple syrup urine disease	Maple syrup, burnt sugar
Multiple carboxylase deficiency 3-Methylcrotonyl-CoA carboxylase deficiency 3-Hydroxy-3-methylglutaric aciduria	Cat urine
Phenylketonuria	Mousey or musty
Trimethylaminuria Dimethylglycine dehydrogenase deficiency	Rotten fish
Tyrosinemia type 1	Boiled cabbage, rancid butter
Hypermethioninemia	Boiled cabbage
Cystinuria Tyrosinemia type I	Sulfur
Hawkinsinuria	"Swimming pool"
Oasthouse urine disease	Hopslike

A newborn has a sepsis-like illness and a previous sibling died from a similar unexplained neonatal episode. Which diagnostic direction does the clinical-clues table support?

A. Urgent evaluation for an inherited metabolic disorder
B. Assume the family history is irrelevant
C. Postpone all investigation until school age
D. Diagnose an isolated speech disorder
E. Exclude metabolic disease because infection is possible

Original table 104.12 | Nelson printed p. 811 | PDF p. 857

Table 104.12 Clinical Findings That Should Prompt a Metabolic Workup

Family history	Sibling(s) who died from unexplained causes or exhibit overlapping symptoms Ethnic groups with a high prevalence of metabolic disorders Consanguinity
Perinatal history	Intrauterine growth restriction, sepsis-like presentation in the neonatal period, nonimmune fetal hydrops
Growth	Postnatal failure to thrive, microcephaly, macrocephaly, short stature
Central and peripheral nervous systems	Progressive encephalopathy, lethargy, coma, intractable seizures, developmental delay, developmental regression, intellectual disability, autism spectrum disorder, hypotonia, spasticity, dystonia, strokes, ataxia, psychosis, intracranial calcifications, white matter disease, peripheral neuropathy
Respiratory system	Hyperventilation, apnea
Cardiovascular system	Cardiac failure with or without cardiomyopathy, arrhythmia
Musculoskeletal system	Rhabdomyolysis, myopathy Osteopenia, early-onset osteoporosis, skeletal dysplasia, epiphyseal abnormalities, bone crises
Eye	Retinitis pigmentosa, macular dystrophy, cataracts, corneal opacities, nystagmus, cherry-red spot
Hearing	Sensorineural hearing loss
Gastrointestinal system	Hepatomegaly, hepatic adenoma, splenomegaly, liver failure, Reye syndrome, cholestasis, cirrhosis, chronic diarrhea, vomiting, acute pancreatitis
Kidney	Renal dysfunction, renal Fanconi syndrome, renal stones
Hematologic system	Anemia, leukopenia, thrombocytopenia, pancytopenia, hemolytic-uremic syndrome
Skin	Hair abnormality, alopecia, lipodystrophy, recalcitrant eczema

A lethargic infant has unexplained hyperammonemia, hypoglycemia, and metabolic acidosis. What does the laboratory-clues table suggest?

A. Prompt metabolic evaluation
B. Routine vision screening only
C. A benign isolated behavioral problem
D. No need for urgent testing
E. Uncomplicated pubertal change

Original table 104.13 | Nelson printed p. 811 | PDF p. 857

Table 104.13 Laboratory Findings That Should Prompt a Metabolic Workup

Hyperammonemia	Hypoglycemia
Metabolic acidosis	Liver dysfunction
Lactic acidosis	Pancytopenia
Ketosis	

A newborn has profound hyperammonemia, low citrulline, and elevated glutamine. Which category in the enzyme table should be considered?

A. Proximal urea-cycle disorder
B. Isolated glycogen storage disease
C. Classic lactose intolerance
D. Phenylketonuria alone
E. Primary hypothyroidism

Original table 105.4 | Nelson printed p. 849 | PDF p. 895

Table 105.4 The Urea Cycle Disorders

ENZYME OR TRANSPORTER DEFICIENCY	GENE (INHERITANCE)	INCIDENCE	CLINICAL MANIFESTATIONS	AMINO ACIDS (PLASMA, UNLESS OTHERWISE INDICATED)	URINE ORGANIC ACIDS
N-Acetylglutamate synthetase MIM 237310	*NAGS* (AR)	<1:2,000,000	Acute episodic hyperammonemia Late-onset presentations	↓ Citrulline ↓ Arginine ↑ Glutamine	Unremarkable
Carbamyl phosphate synthetase I MIM 237300	*CPS1* (AR)	1:1,300,000	Acute episodic hyperammonemia Late-onset presentations	↓ Citrulline ↓ Arginine ↑ Glutamine	Unremarkable
Ornithine transcarbamylase MIM 311250	*OTC* (XL)	1:56,500	Acute episodic hyperammonemia Late-onset presentations	↓ Citrulline ↓ Arginine ↑ Glutamine	↑↑ Orotic acid
Argininosuccinate synthetase MIM 215700	*ASS1* (AR)	1:250,000	Acute episodic hyperammonemia Late-onset presentations	↑↑ Citrulline ↑ Glutamine ↓ Arginine	*N*-to-↑ orotic acid
Argininosuccinate lyase MIM 207900	*ASL* (AR)	1:218,750	Acute episodic hyperammonemia Late-onset presentations ↑ Neurodevelopmental issues Chronic liver disease Trichorrhexis nodosa	↑ Argininosuccinate and anhydrides ↑ Glutamine ↑ Citrulline ↓ Arginine	*N*-to-↑ orotic acid
Arginase MIM 207800	*ARG1* (AR)	1:950,000	Progressive spasticity (LL > UL) Usually mild ID Hyperammonemia (rare)	↑ Arginine	*N*-to-↑ orotic acid
Citrin MIM 605814, 603471	*SLC25A13* (AR)	<1:2,000,000	*NICCD* Intrahepatic cholestasis Poor growth Spontaneous improvement by 1 yr of age *FTTDCD* Failure to thrive Dyslipidemia Chronic liver disease *Citrullinemia type II* Acute episodic hyperammonemia Neuropsychologic manifestations	↑ Citrulline ↑ Arginine ↑ Methionine ↑ Threonine	Unremarkable
Ornithine transporter MIM 238970	*SLC25A15* (AR)	<1:2,000,000	Acute episodic hyperammonemia Liver failure (with or without hyperammonemia) Recurrent vomiting Neurologic presentation (e.g., DD, spasticity) Recurrent	↑ Ornithine ↑ Glutamine ↔-to-↓ citrulline ↑ Urine homocitrulline	*N*-to-↑ orotic acid

AR, Autosomal recessive; DD, developmental delay; FTTDCD, failure to thrive and dyslipidemia caused by citrin deficiency; IV, intravenous; LL, lower limb; NICCD, neonatal intrahepatic cholestasis caused by citrin deficiency; UL, upper limb; XL, X-linked.

A neonate has severe hyperammonemia with metabolic acidosis and ketosis. Which non-urea-cycle category in the table deserves assessment?

A. Organic acidemia
B. Simple vasovagal syncope
C. Isolated speech disorder
D. Uncomplicated vitamin A deficiency
E. Allergic rhinitis

Original table 105.5 | Nelson printed p. 850 | PDF p. 896

Table 105.5 Inborn Errors of Metabolism Causing Hyperammonemia

DEFICIENCIES OF THE UREA CYCLIC ENZYMES

Carbamyl phosphate synthetase 1
Ornithine transcarbamylase
Argininosuccinate synthetase
Argininosuccinate lyase
Arginase 1
N-acetylglutamate synthetase

ORGANIC ACIDEMIA

Propionic acidemia
Methylmalonic acidemia
Isovaleric acidemia
β-Ketothiolase deficiency
Multiple carboxylase deficiencies
Medium-chain fatty acid acyl-CoA dehydrogenase deficiency
Glutaric acidemia type I
3-Hydroxy-3-methylglutaric aciduria

OTHERS

Lysinuric protein intolerance
Hyperammonemia-hyperornithinemia-homocitrullinemia syndrome
Transient hyperammonemia of the newborn
Congenital hyperinsulinism with hyperammonemia
Carbonic anhydrase VA deficiency

acid, or arginine, respectively. The combination of hyperammonemia

A critically ill infant has an acute hyperammonemic crisis. Which immediate metabolic strategy is included in the table?

A. Provide intravenous calories while suppressing catabolism and initiate ammonia-removal therapy
B. Prolong fasting to reduce substrate supply
C. Provide unrestricted protein alone
D. Delay treatment until genetic sequencing returns
E. Use no fluid or electrolyte support

Original table 105.6 | Nelson printed p. 850 | PDF p. 896

Table 105.6 Treatment of Acute Hyperammonemia in an Infant

1. Provide adequate calories, fluid, and electrolytes intravenously (10% glucose, NaCl* and intravenous lipids 1 g/kg/day). Add minimal amounts of protein, preferably as a mixture of essential amino acids (0.25 g/kg/day) during the first 24 hr of therapy.
2. Give priming doses of the following compounds (to be added to 20 mL/kg of 10% glucose and infused within 1-2 hr):
   - Sodium benzoate 250 mg/kg†
   - Sodium phenylacetate 250 mg/kg†
   - Arginine hydrochloride 200-600 mg/kg as a 10% solution
3. Continue infusion of sodium benzoate† (250-500 mg/kg/day), sodium phenylacetate† (250-500 mg/kg/day), and arginine (200-600 mg/kg/day‡) following the above priming doses. These compounds should be added to the daily intravenous fluid.
4. Initiate peritoneal dialysis or hemodialysis if above treatment fails to produce an appreciable decrease in plasma ammonia.

*The concentration of sodium chloride should be calculated to be 0.45–0.9%, including the amount of the sodium in the drugs.
†Sodium from these drugs should be included as part of the daily sodium requirement

A neonate has a suspected Zellweger spectrum disorder. Which gene group in the peroxisomal classification table is involved in peroxisome biogenesis?

A. PEX genes
B. FMR1 only
C. CFTR only
D. HBB only
E. DMD only

Original table 106.2 | Nelson printed p. 866 | PDF p. 912

Table 106.2 Peroxisomal Disorder Classification, Disorders, and Genes

DISORDERS	GENES
PEROXISOMAL BIOGENESIS	
Peroxisome biogenesis disorder–Zellweger spectrum disorders (PBD-ZSD) Zellweger syndrome (severe PBD-ZSD) Neonatal adrenoleukodystrophy (intermediate PBD-ZSD) Infantile Refsum disease (mild PBD-ZSD)	*PEX1*, *PEX2*, *PEX3*, *PEX5*, *PEX6*, *PEX10*, *PEX11B*, *PEX12*, *PEX13*, *PEX14*, *PEX16*, *PEX19*, *PEX26*
Rhizomelic chondrodysplasia punctata, types 1 and 5 (RCDP1 and RCDP5)	*PEX7* and *PEX5*, respectively
SINGLE-ENZYME DEFECTS	
X-linked adrenoleukodystrophy	*ABCD1*
Acyl-CoA oxidase deficiency	*ACOX1*
D-Bifunctional protein deficiency	*HSD17B4*
2-Methylacyl-CoA racemase deficiency	*AMACR*
Rhizomelic chondrodysplasia punctata, types 2 and 3 (RCDP2 and RCDP3)	*AGPS, GNPAT*
Adult Refsum disease	*PHYH*

and branched-chain fatty acid metabolism. The peroxisome biogenesis

A child with suspected Zellweger spectrum disorder undergoes biochemical testing. Which abnormality from the table is most characteristic?

A. Accumulation of very-long-chain fatty acids
B. Marked depletion of all serum sodium in every case
C. Excess phenylalanine alone
D. Low blood lead alone
E. Isolated low serum urate

Original table 106.3 | Nelson printed p. 866 | PDF p. 912

Table 106.3 Abnormal Laboratory Findings Common to Zellweger Spectrum Disorders

Defective oxidation and abnormal accumulation of very long chain fatty acids
Peroxisomes absent to reduced in number
Catalase in cytosol
Deficient synthesis and reduced tissue levels of plasmalogens
Deficient oxidation and age-dependent accumulation of phytanic acid
Defects in certain steps of bile acid formation and accumulation of bile acid intermediates
Defects in oxidation and accumulation of L-pipecolic acid
Increased urinary excretion of dicarboxylic acids

common, but rarer *PEX5* pathogenic variants are seen. The pattern

A child has elevated very-long-chain fatty acids and reduced plasmalogens. Which category in the comparison table best matches the combined pattern?

A. Zellweger spectrum peroxisomal biogenesis disorder
B. Isolated X-linked adrenoleukodystrophy
C. A normal biochemical profile
D. Classic type 1 diabetes
E. Simple iron deficiency

Original table 106.5 | Nelson printed p. 869 | PDF p. 915

Table 106.5 Diagnostic Biochemical Abnormalities in Peroxisomal Disorders

DISORDER	VLCFA	PHYTANIC ACID	PRISTANIC ACID	PLASMALOGENS
PBD-ZSD	↑↑	↑*	↑*	↓
RCDP	Nl	↑	Nl	↓↓
ALD	↑	Nl	Nl	Nl
ACoX	↑	Nl	Nl	Nl
Bifunctional enzyme deficiency	↑	↑	↑	Nl
AMACR	Nl	↑	↑	Nl
Refsum disease	Nl	↑	↑	Nl

*Phytanic acid and pristanic acid accumulation is age dependent, and normal (Nl) levels may be seen in infants and young children.
VLCFA, Very long chain fatty acids; ZSD, Zellweger spectrum disorder; RCDP, rhizomelic chondroplasia punctata; ALD, adrenoleukodystrophy; ACoX, acyl-CoA oxidase deficiency; AMACR, 2-methylacyl-CoA racemase deficiency

A laboratory identifies a large triglyceride-rich particle formed in the intestine with apolipoprotein B-48. Which lipoprotein is this?

A. Chylomicron
B. LDL
C. HDL
D. Lipoprotein(a)
E. IDL

Original table 106.6 | Nelson printed p. 874 | PDF p. 920

Table 106.6 Characteristics of the Major Lipoproteins

LIPOPROTEIN	SOURCE	SIZE (nm)	DENSITY (g/mL)	COMPOSITION		
				PROTEIN (%)	LIPID (%)	APOLIPOPROTEINS
Chylomicrons	Intestine	80-1,200	<0.95	1-2	98-99	C-I, C-II, C-III, E, A-I, A-II, A-IV, B-48
Chylomicron remnants	Chylomicrons	40-150	<1.0006	6-8	92-94	B-48, E
VLDL	Liver, intestine	30-80	0.95-1.006	7-10	90-93	B-100, C-I, C-II, C-III
IDL	VLDL	25-35	1.006-1.019	11	89	B-100, E
LDL	VLDL	18-25	1.019-1.063	21	79	B-100
HDL	Liver, intestine VLDL, chylomicrons	5-20	1.125-1.210	32-57	43-68	A-I, A-II, A-IV C-I, C-II, C-III D, E

HDL, High-density lipoproteins; IDL, intermediate-density lipoproteins; LDL, low-density lipoproteins; VLDL, very low-density lipoproteins.

A teenager has elevated LDL, tendon xanthomas, and family coronary disease. Which listed inherited lipid disorder is most likely?

A. Familial hypercholesterolemia
B. Primary chylomicronemia
C. Abetalipoproteinemia
D. Simple transient postmeal lipemia
E. Isolated HDL deficiency

Original table 106.7 | Nelson printed p. 875 | PDF p. 921

Table 106.7 Hyperlipoproteinemias

DISORDER	LIPOPROTEINS ELEVATED	CLINICAL FINDINGS	GENETICS	ESTIMATED INCIDENCE
Familial hypercholesterolemia	LDL	Tendon xanthomas, CHD	AD	1 in 500
Familial defective ApoB-100	LDL	Tendon xanthomas, CHD	AD	1 in 1,000
Autosomal recessive hypercholesterolemia	LDL	Tendon xanthomas, CHD	AR	<1 in 1,000,000
Sitosterolemia	LDL	Tendon xanthomas, CHD	AR	<1 in 1,000,000
Polygenic hypercholesterolemia	LDL	CHD		1 in 30?
Familial combined hyperlipidemia	LDL, TG	CHD	AD	1 in 200
Familial dysbetalipoproteinemia	LDL, TG	Tuberoeruptive xanthomas, peripheral vascular disease	AD	1 in 10,000
Familial chylomicronemia (Frederickson type I)	TG ⇑⇑	Eruptive xanthomas, hepatosplenomegaly, pancreatitis	AR	1 in 1,000,000
Familial hypertriglyceridemia (Frederickson type IV)	TG ↑	±CHD	AD	1 in 500
Familial hypertriglyceridemia (Frederickson type V)	TG ⇑⇑	Xanthomas ± CHD	AD	—
Familial hepatic lipase deficiency	VLDL	CHD	AR	<1 in 1,000,000

AD, Autosomal dominant; AR, autosomal recessive; CHD, coronary heart disease; LDL, low-density lipoproteins, TG, triglycerides; VLDL, very low-density lipoproteins.

A child has newly detected hypercholesterolemia and symptoms of thyroid deficiency. Which secondary cause in the table warrants evaluation?

A. Hypothyroidism
B. Isolated seasonal allergies
C. Postural dizziness
D. Primary speech delay
E. Uncomplicated dental caries

Original table 106.10 | Nelson printed p. 880 | PDF p. 926

Table 106.10 Secondary Causes of Hyperlipidemia

HYPERCHOLESTEROLEMIA
Hypothyroidism
Nephrotic syndrome
Cholestasis
Anorexia nervosa
Drugs: progesterone, thiazides, carbamazepine (Tegretol), cyclosporine
HYPERTRIGLYCERIDEMIA
Glycogen storage disease type 1
Obesity
Type 2 diabetes
Alcohol
Renal failure
Sepsis
Stress
Cushing syndrome
Pregnancy
Hepatitis
AIDS, protease inhibitors
Drugs: anabolic steroids, β blockers, estrogen, thiazides, Accutane
REDUCED HIGH-DENSITY LIPOPROTEIN
Smoking
Obesity
Type 2 diabetes
Malnutrition
Drugs: β blockers, anabolic steroids

A child has microcephaly, toe II-III syndactyly, and genital anomalies. Which syndrome in the table fits the constellation?

A. Smith-Lemli-Opitz syndrome
B. Turner syndrome
C. Marfan syndrome
D. Phelan-McDermid syndrome
E. Classic galactosemia

Original table 106.11 | Nelson printed p. 881 | PDF p. 927

Table 106.11 Major Clinical Characteristics of Smith-Lemli-Opitz Syndrome: Frequent Anomalies (>50% of Patients)

CRANIOFACIAL
Microcephaly
Blepharoptosis
Anteverted nares
Retromicrognathia
Low-set, posteriorly rotated ears
Midline cleft palate
Broad maxillary alveolar ridges
Cataracts (<50%)
SKELETAL ANOMALIES
Syndactyly of toes II/III
Postaxial polydactyly (<50%)
Equinovarus deformity (<50%)
GENITAL ANOMALIES
Hypospadias
Cryptorchidism
Sexual ambiguity (<50%) or XY sex reversal
DEVELOPMENT
Prenatal and postnatal growth retardation
Feeding problems
Intellectual disability
Behavioral abnormalities

From Haas D, Kelley RI, Hoffmann GF. Inherited disorders of cholesterol biosynthesis. *Neuropediatrics*. 2001;32:113–122.

A severely affected infant with Smith-Lemli-Opitz syndrome is found to have renal hypoplasia. Which organ category in the table includes this anomaly?

A. Urinary tract
B. Skin appendages
C. Pulmonary alveoli only
D. Peripheral blood leukocytes
E. Auditory ossicles

Original table 106.12 | Nelson printed p. 882 | PDF p. 928

Table 106.12 Characteristic Malformations of Internal Organs in Severely Affected Smith-Lemli-Opitz Patients

CENTRAL NERVOUS SYSTEM
Frontal lobe hypoplasia
Enlarged ventricles
Agenesis of corpus callosum
Cerebellar hypoplasia
Holoprosencephaly
CARDIOVASCULAR
Atrioventricular canal
Secundum atrial septal defect
Patent ductus arteriosus
Membranous ventricular septal defect
URINARY TRACT
Renal hypoplasia or aplasia
Renal cortical cysts
Hydronephrosis
Ureteral duplication
GASTROINTESTINAL
Hirschsprung disease
Pyloric stenosis
Refractory dysmotility
Cholestatic and noncholestatic progressive liver disease
PULMONARY
Pulmonary hypoplasia
Abnormal lobation
ENDOCRINE
Adrenal insufficiency

From Haas D, Kelley RI, Hoffmann GF. Inherited disorders of cholesterol biosynthesis. *Neuropediatrics*. 2001;32:113–122.

A teen with markedly elevated LDL needs drug therapy after specialist assessment. Which class in the lipid-treatment table decreases cholesterol synthesis and increases hepatic LDL receptors?

A. Statins
B. Fibrinolytics
C. Benzodiazepines
D. Opioids
E. Macrolide antibiotics

Original table 106.13 | Nelson printed p. 883 | PDF p. 929

Table 106.13 Drugs Used for the Treatment of Hyperlipidemia

DRUG	MECHANISM OF ACTION	INDICATION	STARTING DOSE
HMG-CoA reductase inhibitors (statins)	↓ Cholesterol and VLDL synthesis ↑ Hepatic LDL receptors	Elevated LDL	5-80 mg every night at bedtime
Bile acid sequestrants: Cholestyramine Colestipol	↑ Bile and excretion	Elevated LDL	 4-32 g daily 5-40 g daily
Nicotinic acid	↓ Hepatic VLDL synthesis	Elevated LDL Elevated TG	100-2,000 mg three times daily
Fibric acid derivatives: Gemfibrozil	↑ LPL ↓ VLDL	Elevated TG	600 mg twice daily
Fish oils	↓ VLDL production	Elevated TG	3-10 g daily
Cholesterol absorption inhibitors:			
Ezetimibe	↓ Intestinal absorption cholesterol	Elevated LDL	10 mg daily
PCSK-9 inhibitor Evolocumab	Upregulation of hepatic LDL receptors to enhance removal of LDL from circulation	Refractory or intolerant to statin	140 mg every 2 weeks or 420 mg subcutaneous injection monthly

LDL, Low-density lipoprotein(s); LPL, lipoprotein lipase; TG, triglycerides; VLDL, very-low-density lipoprotein.

A teenager receiving statin treatment reports new muscle pain and weakness. Which recognized adverse effect in the table should be evaluated?

A. Myopathy or myositis
B. Acute cataract in every case
C. Obligatory hypoglycemia
D. Isolated tooth eruption
E. Primary hyperammonemia

Original table 106.14 | Nelson printed p. 883 | PDF p. 929

Table 106.14 Adverse Effects of Cholesterol-Lowering Drugs

STATINS	Myalgia, myositis, transaminase elevations, hepatic dysfunction, increased risk of diabetes mellitus Rare: Rhabdomyolysis, hemorrhagic stroke
EZETIMIBE	Diarrhea, arthralgia, rhabdomyolysis, hepatitis, pancreatitis, thrombocytopenia
PCSK9 INHIBITORS	Nasopharyngitis, upper respiratory tract infection, influenza, back pain, injection site reactions, rash, allergic skin reactions, cognitive effects, antidrug antibodies
BILE ACID SEQUESTRANTS	Constipation, heartburn, nausea, eructation, bloating Adverse effects are more common with colestipol and cholestyramine and may diminish over time.
FIBRIC ACID DERIVATIVES	Gastrointestinal (GI) disturbances, cholelithiasis, hepatitis, myositis
NIACIN	Skin flushing, pruritus, GI disturbances, blurred vision, fatigue, glucose intolerance, hyperuricemia, hepatic toxicity, exacerbation of peptic ulcers Adverse effects, especially flushing, occur more frequently with immediate-release products. Rare: Dry eyes, hyperpigmentation
FISH OIL	Eructation, dyspepsia, unpleasant aftertaste

From The Medical Letter. Lipid-lowering drugs. *Med Lett*. 2016;58:133–140, Table 2, p. 136.

A child has progressive neurodegeneration, and testing supports GM1 gangliosidosis. Which clinical feature is present across the infantile, late-infantile, and juvenile forms in the comparison table?

A. Cognitive decline
B. Coarse facial features in every form
C. Cherry-red spot in every form
D. Congenital heart block in every form
E. Normal cognition in every form

Original table 106.17 | Nelson printed p. 893 | PDF p. 939

Table 106.17 Symptoms and Biochemical Signs in Three Clinical Forms of GM_1 Gangliosidosis

SYMPTOMS AND SIGNS	INFANTILE FORM	LATE-INFANTILE FORM	JUVENILE FORM
CLINICAL SYMPTOMS			
Coarse facial features	+	–	–
Cherry red macula spot	–/+	–	–
Cardiomyopathy	–/+	–/+	–
Hepatosplenomegaly	–/+	–	–
Cognitive decline	+	+	+
Dystonia	–/+	–/+	–/+
Ataxia	–/+	–/+	–/+
Pyramidal signs	+	+	–
LABORATORY SIGNS			
Increased oligosaccharides	+	–/+	–/+
Increased ASAT	–/+	–/+	–
Increased chitotriosidase activity	>1,000	>100–1,000	na

na, Not applicable.
From Arash-Kaps L, Komlosi K, Seegräber M, et al. The clinical and molecular spectrum of GM1 gangliosidosis. *J Pediatr.* 2019;215:152–157, Table II.

A young child with a family history of Fabry disease has gastrointestinal discomfort and episodic distal extremity pain. Which interpretation does the pediatric table support?

A. Fabry symptoms can occur in early childhood
B. Symptoms only begin in late adulthood
C. All young carriers are asymptomatic
D. Fabry disease causes only isolated visual loss
E. Symptoms exclude a metabolic disorder

Original table 106.18 | Nelson printed p. 894 | PDF p. 940

Table 106.18 Summary of Reported Clinical Manifestations in Fabry Patients (Newborn to 4 Yr)

FABRY-RELATED SIGNS AND SYMPTOMS	EARLIEST REPORT OF SYMPTOM
Storage of globotriaosylceramide found in organs on biopsy	Prenatal
Corneal whorls/verticillata	Prenatal/newborn
Gastrointestinal problems, including nausea, vomiting, diarrhea, constipation, and abdominal pain	1.0 yr
Slow growth in boys (mean height/weight <50th percentile)	2.0 yr
Intermittent acroparesthesia/neuropathic pain triggered by stress, heat, fatigue, or exercise	2.0 yr
Hypohidrosis or anhidrosis	2.5 yr
Fabry crises of agonizing neuropathic pain typically begin in the hands and feet and may radiate proximally	2.5 yr
Heat, cold, and/or exercise intolerance	3.5 yr
Retinal vascular tortuosity	4.0 yr
Tinnitus/vertigo	4.0 yr
Low glomerular filtration rate	4.0 yr
T-wave inversion on electrocardiogram	4.0 yr
Trivial cardiac valve disease	4.0 yr
Angiokeratoma	4.4 yr

From Laney DA, Peck DS, Atherton AM, et al. Fabry disease in infancy and early childhood: A systematic literature review. *Genetics Med.* 2015;17(5):323–330, Table 2.

An adolescent with Fabry disease has burning distal pain and is initially labeled as having a rheumatologic pain syndrome. Which point from the misdiagnoses table is relevant?

A. Fabry disease may mimic inflammatory or neuropathic conditions
B. A rheumatologic label definitively excludes Fabry disease
C. Fabry disease never affects peripheral nerves
D. Only a skin biopsy can identify any symptom
E. Family history is always irrelevant

Original table 106.19 | Nelson printed p. 895 | PDF p. 941

Table 106.19 Common Misdiagnoses for Fabry Disease

INFLAMMATORY
Systemic lupus erythematous
Rheumatic fever
Fibromyalgia
Dermatomyositis
Raynaud phenomenon
Raynaud syndrome
C1 esterase deficiency
TNF receptor–associated periodic syndrome (TRAPS)
Joint and recurrent fever syndromes (juvenile idiopathic arthritis, familial Mediterranean fever)
Erythromelalgia
NEUROLOGIC
Porphyria
Guillain-Barre syndrome
Hereditary neuropathies
Nutritional neuropathies
Uremic neuropathy
Diabetic neuropathy
Polyneuropathy
Meniere disease
Complex regional pain syndromes
Multiple sclerosis
Mitochondrial disorders
Migraine
MELAS
CADASIL
GASTROINTESTINAL/NUTRITION
Irritable bowel syndrome
Appendicitis
Metabolic bone disease (rickets, uremia, scurvy)
Crohn disease
Celiac disease
Peptic ulcer disease
OTHER
Growing pains
Chronic overlapping pain syndrome
Malingering
Coronary heart disease
Osler-Weber-Rendu disease
Cardiomyopathy
Gaucher disease

MELAS, Mitochondrial encephalopathy lactic acidosis, strokelike symptoms; CADASIL, cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy.

A child receiving a beta-adrenergic agonist has elevated lactate without evidence of tissue hypoxia. Which type B lactic-acidosis category in the table includes this exposure?

A. Drug-associated type B2
B. Hypoxic type A only
C. Isolated respiratory alkalosis
D. Normal lactate physiology
E. Inherited type B3 by definition

Original table 107.2 | Nelson printed p. 914 | PDF p. 960

Table 107.2 Causes of Type B Lactic Acidosis

TYPE B1—UNDERLYING DISEASES
Renal failure
Hepatic failure
Diabetes mellitus
Malignancy
Systemic inflammatory response syndrome
Human immunodeficiency virus
TYPE B2—DRUGS AND TOXINS
Acetaminophen
Alcohols: ethanol, methanol, diethylene glycol, isopropanol, and propylene glycol
Antiretroviral nucleoside analogs—zidovudine, didanosine, and lamivudine
β-Adrenergic agonists: epinephrine, ritodrine, and terbutaline
Biguanides: phenformin and metformin
Cocaine, methamphetamine
Cyanogenic compounds: cyanide, aliphatic nitriles, and nitroprusside
Diethyl ether
Fluorouracil
Halothane
Iron
Isoniazid
Linezolid
Nalidixic acid
Niacin
Propofol
Salicylates
Strychnine
Sugars and sugar alcohols: fructose, sorbitol, and xylitol
Sulfasalazine
Total parenteral nutrition
Valproic acid
Vitamin deficiencies: thiamine and biotin
TYPE B3—INBORN ERRORS OF METABOLISM
Glucose-6-phosphatase deficiency (von Gierke disease)
Fructose-1,6-diphosphatase deficiency
Phosphoenolpyruvate carboxykinase deficiency
Pyruvate carboxylase deficiency
Pyruvate dehydrogenase complex (PDHC) deficiency
Krebs cycle defects
Methylmalonic aciduria and other organic acidemias
Kearns-Sayre syndrome
Pearson syndrome
Barth syndrome
Mitochondrial DNA depletion syndromes
Nuclear DNA respiratory chain defects
Mitochondrial DNA respiratory defects
Mitochondrial encephalomyopathy, lactic acidosis, and strokelike episodes (MELAS)
Myoclonic epilepsy with ragged red fibers (MERRF)

Adapted from Vernon C, LeTourneau JL. Lactic acidosis: recognition, kinetics, and associated prognosis. *Crit Care Clin*. 2010;26:255–283, Box 1.

A child with suspected mitochondrial disease has developmental delay, exercise intolerance, multisystem findings, and elevated lactate. Which bedside tool in the table combines clinical, metabolic, and morphologic evidence?

A. Simplified mitochondrial disease criteria
B. NEXUS
C. A neonatal pain scale
D. Gomez malnutrition grading
E. A single ECG rhythm strip

Original table 107.4 | Nelson printed p. 919 | PDF p. 965

Table 107.4 Mitochondrial Disease Criteria (Simplified Version for Bedside Use)*

I. CLINICAL SIGNS AND SYMPTOMS, 1 POINT/SYMPTOM (max. 4 points)				
A. MUSCULAR PRESENTATION (max. 2 points)	**B. CNS PRESENTATION (max. 2 points)**	**C. MULTISYSTEM DISEASE (max. 3 points)**	**II. METABOLIC/IMAGING STUDIES (max. 4 points)**	**III. MORPHOLOGY (max. 4 points)**
Ophthalmoplegia†	Developmental delay	Hematology	Elevated lactate†	Ragged red/blue fibers‡
Facies myopathica	Loss of skills	GI tract	Elevated L/P ratio	COX-negative fibers‡
Exercise intolerance	Stroke-like episode	Endocrine/growth	Elevated alanine†	Reduced COX staining‡
Muscle weakness	Migraine	Heart	Elevated CSF lactate†	Reduced SDH staining
Rhabdomyolysis	Seizures	Kidney	Elevated CSF protein	SDH positive blood vessels†
Abnormal EMG	Myoclonus	Vision	Elevated CSF alanine†	Abnormal mitochondria/EM†
	Cortical blindness	Hearing	Urinary TA excretion†	
	Pyramidal signs	Neuropathy	Ethylmalonic aciduria	
	Extrapyramidal signs	Recurrent/familial	Strokelike picture/MRI	
	Brainstem involvement		Leigh syndrome/MRI†	
			Elevated lactate/MRS	

*Score 1: unlikely mitochondrial disorder; score 2-4: possible mitochondrial disorder; score 5-7: probable mitochondrial disorder; score ≥8: definite mitochondrial disorder.
†This specific symptom scores 2 points.
‡This symptom in a higher percentage scores 4 points.

A child has recurrent strokelike episodes whose MRI lesions do not follow vascular territories, along with a lactate peak on MR spectroscopy. Which diagnostic category in the table is suggested?

A. Mitochondrial disease
B. Uncomplicated migraine in every case
C. Isolated refractive error
D. Vasovagal syncope alone
E. Provisional tic disorder

Original table 107.5 | Nelson printed p. 920 | PDF p. 966

Table 107.5 Clues to the Diagnosis of Mitochondrial Disease

NEUROLOGIC
Cerebral strokelike lesions in a nonvascular pattern
Basal ganglia disease
Encephalopathy, recurrent or with low/moderate dosing of valproate
Neurodegeneration
Epilepsia partialis continua
Myoclonus
Ataxia
MRI findings consistent with Leigh syndrome
Characteristic MRS peaks
Lactate peak at 1.3 ppm TE (time to echo) at 35 and 135
Succinate peak at 2.4 ppm
CARDIOVASCULAR
Hypertrophic cardiomyopathy with rhythm disturbance
Unexplained heart block in a child
Cardiomyopathy with lactic acidosis (>5 mM)
Dilated cardiomyopathy with muscle weakness
Wolff-Parkinson-White arrhythmia
OPHTHALMOLOGIC
Retinal degeneration with signs of night blindness, color vision deficits, decreased visual acuity, or pigmentary retinopathy
Ophthalmoplegia/paresis
Fluctuating, dysconjugate eye movements
Ptosis
Sudden- or insidious-onset optic neuropathy/atrophy
GASTROENTEROLOGIC
Unexplained or valproate-induced liver failure
Severe dysmotility
Pseudoobstructive episodes
OTHER
A newborn, infant, or young child with unexplained hypotonia, weakness, failure to thrive, and a metabolic acidosis (particularly lactic acidosis)
Exercise intolerance that is not in proportion to weakness
Hypersensitivity to general anesthesia
Episodes of acute rhabdomyolysis
Elevated GDF-15 level

MRI, Magnetic resonance imaging, MRS, magnetic resonance spectroscopy; GDF, growth and differentiation factor.
From Haas RH, Parikh S, Falk MJ, et al. Mitochondrial disease: a practical approach for

An infant with hypotonia, strabismus, and cerebellar hypoplasia has an abnormal transferrin isoform profile. Which group of disorders in the table is relevant?

A. Congenital disorders of glycosylation
B. Isolated speech sound disorders
C. Primary vasovagal syncope
D. Simple lactose intolerance
E. Acquired myopia

Original table 107.6 | Nelson printed p. 924 | PDF p. 970

Table 107.6 Clinical and Laboratory Features in Common Congenital Disorders of Glycosylation (CDGs), with Clinically Recognizable Phenotype and Abnormal Glycosylation, Detectable by Serum Transferrin Isoform Analysis (TIEF)

DEFECTIVE GENE	MOST FREQUENT CLINICAL FEATURES	SUGGESTIVE FEATURES	LABORATORY ABNORMALITIES	OTHER BIOCHEMICAL ANOMALIES
PMM2	Strabismus, nystagmus, smooth philtrum, large ears, vomiting, diarrhea, FTT, axial hypotonia, cerebellar vermis hypoplasia, ataxia, psychomotor disability, seizures, spasticity, neuropathy, pigmentary retinitis	Inverted nipples and/or abnormal fat pads, strokelike episodes	Elevated serum transaminases; hypoalbuminemia, decreased factor IX, XI, and AT activity; low serum ceruloplasmin and TBG levels	Type 1 serum TIEF, decreased PMM activity in leukocytes and fibroblasts
MPI	Cholestasis, hepatomegaly, feeding difficulties, recurrent vomiting, chronic diarrhea, ascites, recurrent thrombosis, gastrointestinal bleeding	Hyperinsulinism, protein-losing enteropathy Normal intelligence and absence of neurologic features	Elevated transaminases; hypoalbuminemia; hypoglycemia; decreased factor IX, XI, and AT-III activity	Type 1 serum TIEF, decreased PMI activity in leukocytes and fibroblasts
ALG6	Hypotonia, muscle weakness, seizures, ataxia, intellectual disability, behavioral abnormalities	Distal limb malformations	Elevated serum transaminases; hypoalbuminemia; decreased factor IX, XI, and AT activity; low serum IgG level	Type 1 serum TIEF, abnormal LLO results in fibroblasts
DPAGT1	Microcephaly, brain malformations, hypotonia, severe psychomotor disability, seizures, spasticity, proximal weakness, failure to thrive, joint contractures	Congenital myasthenia phenotype In multisystem phenotype: cataract	Decreased AT, protein C, and protein S activity; increased creatine kinase; hypoalbuminemia; normal creatine kinase in myasthenia	Type 1 serum TIEF
SRD5A3	Developmental delay, hypotonia, ataxia, cerebellar vermis hypoplasia, intellectual disability, speech delay, visual loss	Congenital cataract, retinal and iridic coloboma, glaucoma, optic nerve dysplasia, ichthyosis	Low anticoagulation factors (AT, protein C, and protein S activity), increased serum transaminases	Type 1 serum TIEF but reported false-negative TIEF
ATP6V0A2	Generalized cutis laxa, hypotonia, strabismus, characteristic facial features, joint laxity, seizures, motor and language developmental delay, spontaneous improvement of cutis laxa by aging	Cobblestone-like brain dysgenesis	Mild coagulation abnormalities, increased serum transaminase levels	Type 2 serum TIEF but reported false-negative TIEF
ATP6V1A and *ATP6V1E1*		Cardiovascular anomalies	Mild coagulation abnormalities and increased serum transaminase levels, hypercholesterolemia	Abnormal apoC-III IEF, characteristic MALDI TOF profile (Note abnormal skin histology)
PGM1	Pierre Robin sequence, cholestasis, short stature, dilated cardiomyopathy	Cleft palate, hyperinsulinism, normal intelligence	Hypoglycemia, increased serum transaminase levels, decreased AT	Mixed type 1/ serum TIEF, decreased fibroblast PGM1 activity
MAN1B1	Developmental delay, speech delay, intellectual disability, muscle weakness	Obesity, autistic features, inverted nipples, characteristic face	Increased serum transaminase levels, low AT	Type 2 serum TIEF, abnormal apoC-III IEF, diagnostic MALDI TOF profile
TMEM199 *CCDC115* *ATP6AP1* and *ATP6AP2*	Cholestasis, hepatomegaly, liver steatosis, liver fibrosis, liver failure, spontaneous bleedings, motor developmental delay	Normal intelligence Hepatomegaly Immune deficiency	Decreased serum ceruloplasmin, increased serum transaminase levels, hypercholesterolemia, high AP	Type 2 serum TIEF, abnormal apoC-III IEF, characteristic MALDI TOF profile
SLC39A8	Seizures, hypsarrhythmia, hypotonia, developmental and speech delay, FTT	Dwarfism, craniosynostosis, rhizomelia, Leigh disease	Decreased serum manganese, high serum transaminases, abnormal coagulation	Type 2 serum TIEF, abnormal apoC-III, characteristic MALDI TOF profile

AP, Alkaline phosphatase; AT, antithrombin; apoC-III: apolipoprotein C-III; FTT, failure to thrive; LLO, lipid-linked oligosaccharides; MALDI-TOF, matrix-assisted laser desorption/ionization time of flight; TBG, thyroxine-binding globulin; TIEF, transferrin isoelectric focusing.

A child with confirmed MPI-CDG has gastrointestinal symptoms, coagulopathy, and hypoglycemia. Which targeted nutrient therapy is listed?

A. Oral mannose
B. Elimination of all carbohydrate
C. Unrestricted alcohol
D. High-dose iron as the only treatment
E. Oral potassium iodide

Original table 107.7 | Nelson printed p. 927 | PDF p. 973

Table 107.7 Effective Therapies in CDG

CDG	TREATMENT	RECOMMENDED DOSE	CLINICAL EFFECTS	SIDE EFFECTS
MPI-CDG	Mannose	600-1200 mg/kg BW/day in 4-6 oral doses	Improvement of digestive symptoms (13/14), coagulopathy (12/12), and hypoglycemia (9/9); no long-term effect on liver symptoms	Abdominal pain and diarrhea (5/10; responding to dose adjustment)
PGM1-CDG	Galactose	1 g/kg/day (500-2500 mg/kg/day; max 50 g/day), divided in up to 6 oral doses per day	Improvement of hepatopathy (15/18), muscle symptoms (14/14), coagulopathy (10/12), hypoglycemia (10/13), and pubertal delay (2/2); minimal effect on growth (1/8), ID (0/2), and cardiologic symptoms (0/2)	Not reported
SLC35C2-CDG	Galactose	1.5 g/kg/day (up to 3 g/kg/day), divided in up to 5 oral doses per day	Improvement of psychomotor development (5/10), growth (n.s.), gastrointestinal symptoms (n.s.), and seizures (3/5)	Not reported
SLC35C1-CDG	Fucose	400 mg/kg/day (up to 1.2 g/kg/day in severe cases), divided into 2-3 oral doses per day	Normalization of neutrophil count (5/5), decreased incidence of severe infections (3/3), improvement of psychomotor development (1/5), no effect on adult form of the disease (ID, ataxia, epilepsy, autism)	Autoimmune neutropenia and hemolysis (responding to dose adjustment)
CAD-CDG	Uridine	100 mg/kg/day in 4 oral doses	Cessation of pharmacoresistant seizures (3/3), significant developmental progress (3/3), resolution of anemia (2/2), and anisopoikilocytosis (3/3)	Not reported
SLC39A8-CDG	Manganese	15-20 mg $MnSO_4$/kg BW/day in 5 oral doses	Improvement of glycosylation (2/2), motor abilities (2/2), epilepsy (1/1), ataxia (1/1), and hearing (1/1)	Not reported, risk of manganism
	Galactose	500-3750 mg/kg BW/day in 5 oral doses	Improvement of glycosylation (2/2), no clinical improvement reported	Not reported
TMEM165-CDG	Galactose	1000 mg/kg/day orally	Improvement of glycosylation (2/2), hepatopathy (2/2), coagulopathy (2/2), and IGF1 levels (2/2) (clinical improvement not mentioned)	Not reported
GFPT1-CDG	Pyridostigmine (cholinesterase inhibitors)	2.5-15 mg/kg/day in 3 oral doses	Improvement of muscle weakness (52/56)	Muscle twitching, depression, and anxiety (2/56)
ALG2-CDG	Pyridostigmine (cholinesterase inhibitors)	Oral, dose n.s.	Improvement of muscle weakness (1/1)	Not reported
ALG14-CDG	Pyridostigmine (cholinesterase inhibitors)	5-8 mg/kg/day in 2-6 oral doses	Improvement of muscle weakness (4/4, in 1 patient the effect was only temporary)	Not reported
PIGM-CDG	Sodium butyrate	60-90 mg/kg/day in 3 oral doses	Effect on seizures (3/3), developmental delay (2/2), and increase in the expression of GPI-linked blood cell surface markers (2/4)	Not reported
PMM2-CDG	Acetazolamide	7-17 mg/kg/day in 2 oral doses	Effect on cerebellar symptoms (20/23), speech (20/23), anxiety (20/23), some coagulation parameters (20/23), stereotypic movements (5/5), and SLE (1/1). No improvement of ID and non-neurologic symptoms.	Acidosis with significant decrease of serum bicarbonate (9/23), asthenia (4/23), and paresthesia (2/23) responding to dose adjustments; risk of urolithiasis, osteopenia

BW, Body weight; GPI, glycosylphosphatidylinositol; ID, intellectual disability; IGF1, insulin-like growth factor 1; n.s., not specified; SLE, strokelike episodes.
Modified from Ondruskova N, Cechova A, Hansikova H, et al. Congenital disorders of glycosylation: still "hot" in 2020. *Biochim Biophys Acta Gen Subj*. 2021;1865(1):129751, Table 2.

A child with possible mitochondrial disease has myopathy, dystonia, growth failure, and hearing impairment. Which feature of the criteria table explains the diagnostic approach?

A. Evidence is assessed across muscular, neurologic, and multisystem domains
B. Only a single serum sodium value is scored
C. Normal hearing is obligatory
D. Every diagnosis requires a malformation at birth
E. Only one organ system may be affected

Original table 108.2 | Nelson printed p. 934 | PDF p. 980

Table 108.2 Mitochondrial Disease Criteria

FEATURES		
Muscular	Myopathy Abnormal EMG Motor developmental delay Exercise intolerance	Maximal score for muscle is 2
Neurologic	Developmental delay or ID Speech delay Dystonia Ataxia Spasticity Neuropathy Seizures or encephalopathy	Maximal score for neurologic is 2
Multisystem	Any gastrointestinal tract disease Growth delay or failure to thrive Endocrine Immune Eye (vision) or hearing Renal tubular acidosis Cardiomyopathy	Maximal score for multisystem is 3
Total clinical		**Total maximal clinical score is 4**
Metabolic	Lactate high at least 2×: (score 2) Alanine high at least 2× Krebs cycle intermediates[a] Ethyl malonic and methyl malonic acid 3 methyl glutaconic acid CSF lactate, alanine	
Imaging/other	Leigh disease (score 2) Strokelike episodes (score 2) Lactate peak on MRS Leukoencephalopathy with brainstem and spinal cord involvement[b] Cavitating leukoencephalopathy[b] Leukoencephalopathy with thalamus involvement[b] Deep cerebral white matter involvement and corpus callosum agenesis[b]	Total metabolic and MRI maximal score is 4
Total MDC score (clinical, metabolic, imaging)		**Total maximal score is 8**

[a]Krebs cycle intermediates: alpha-ketoglutarate, succinate, fumarate.
[b]Numerous MRI patterns characteristic of mitochondrial disease have been described in addition to Leigh syndrome and basal ganglia with brainstem involvement. We

A child with dystonia is evaluated for suspected mitochondrial disease. Which treatable mimic in the differential table should be considered?

A. Biotinidase deficiency
B. Simple seasonal allergic rhinitis
C. Primary dental caries
D. Uncomplicated myopia
E. Isolated circumcision status

Original table 108.3 | Nelson printed p. 935 | PDF p. 981

Table 108.3 Differential Diagnosis of Selected Phenotypes Commonly Associated with Mitochondrial Disease

PHENOTYPE	MITOCHONDRIAL CAUSE	LIMITED DIFFERENTIAL DIAGNOSIS
Dystonia	Leigh syndrome, deafness-dystonia syndrome, other mitochondrial encephalomyopathies	Biotinidase deficiency, thiamine transporter deficiency 2, *ADAR* pathogenic variants (Aicardi-Goutières syndrome 6), organic acidemias (especially glutaric aciduria type I), NBIA, acute (viral) necrotizing encephalopathy, pathogenic variants in *NUP62*, *RANBP2*, and *PDE8B*, primary genetic dystonias
Epileptic encephalopathy	Alpers-Huttenlocher syndrome, many other mitochondrial disorders	Many genetic epileptic encephalopathies, including Dravet syndrome and *KCNQ2* pathogenic variants, pyridoxine-dependent epilepsies (antiquitin deficiency, PNPO deficiency), viral encephalitis
Progressive myoclonic epilepsy	MERRF	Ramsay Hunt syndrome, Unverricht-Lundborg disease, Lafora body disease, sialidosis, *PRICKLE1* pathogenic variants
Leukoencephalopathy	Complex I deficiency, complex II deficiency, SURF1 deficiency (rarely), disorders of mitochondrial translation and Fe-S cluster assembly	Vanishing white matter disease, lysosomal storage disorders, Canavan disease, Alexander disease, Pelizaeus-Merzbacher(-like), hypo/dysmyelination
Ataxia	*ADCK3* pathogenic variants, ataxia-neuropathy syndromes, for example, SCAE, MIRAS, MERRF, NARP, disorders of coenzyme Q_{10} biosynthesis	Spinocerebellar ataxias, CAPOS syndrome
Demyelination	MNGIE	ADEM, multiple sclerosis
Peripheral neuropathy	Pathogenic variants in *POLG, MPV17, KARS,* and *SURF1*; part of multisystem disease in many mitochondrial disorders, for example, MNGIE	Other nonmitochondrial genetic causes of Charcot-Marie-Tooth syndromes, riboflavin transporter deficiency, toxic neuropathies, critical illness
Ptosis and ophthalmoplegia	PEO, KSS, MNGIE, MELAS	Some congenital myopathies, pseudo-upgaze impairment in *OPMD,* horizontal gaze palsy and scoliosis (*ROBO3* pathogenic variant)
Optic neuropathy	LHON, ADOA, Leigh syndrome	Toxic optic neuropathy (e.g., methanol, cyanide, tobacco)
Hypertrophic cardiomyopathy with lactic acidosis	Complex I deficiency, *TMEM70* pathogenic variants, Sengers syndrome (AGK deficiency), disorders of mitochondrial translation	Viral infection
Dilated cardiomyopathy with lactic acidosis	Barth syndrome, disorders of mitochondrial phospholipid remodeling, other mitochondrial cardiomyopathies	Viral infection
Exocrine pancreatic insufficiency	Pearson syndrome	Cystic fibrosis
Diabetes and deafness	MIDD, other mtDNA pathogenic variants	Type 2 diabetes mellitus with incidental nonsyndromic deafness
Sideroblastic anemia	Pearson syndrome, MLASA, TRNT1 deficiency, *PUS1* or *YARS2* pathogenic variants	Blackfan-Diamond syndrome, Schwachman-Diamond syndrome, X-linked sideroblastic anemia
B-cell immune deficiency	TRNT1 deficiency	Primary immunodeficiency disorder
Liver failure	Mitochondrial DNA (mtDNA) depletion syndromes	NBAS, LARS, and IARS deficiencies, viral infection, lysosomal storage disorders, other syndromic genetic conditions
Renal tubulopathy/failure	Pearson and Kearns-Sayre syndromes, *RMND1*-related disease	Gitelman syndrome, Fanconi Bickel (*SLC2A2* pathogenic variants) syndrome, other syndromic genetic conditions
Myopathy	Part of multisystem disease in many mitochondrial disorders, especially mtDNA depletion syndromes	Congenital muscular dystrophies, myositis, many other disorders
Rhabdomyolysis	Mitochondrial myopathies (e.g., *MTCO1, MTCO2, MTCO3,* and *MTCYB* pathogenic variants)	*LPIN1* pathogenic variants, fatty acid oxidation defects (VLCAD, LCHAD), TANGO deficiency, glycolytic defects, toxic, postexercise
Low copper	Cytochrome oxidase deficiency	Menkes, *SLC33A1* pathogenic variants
Complex multisystem disorders	Many mitochondrial disorders, particularly in childhood	Congenital disorders of glycosylation, peroxisomal disorders, lysosomal storage disorders, other syndromic genetic conditions

ADEM, Acute disseminated encephalomyelitis; ADOA, autosomal dominant optic atrophy; CAPOS, cerebellar ataxia, areflexia, pes cavus, optic atrophy and sensorineural hearing loss; Fe-S, iron-sulfur; KSS, Kearns-Sayre syndrome; LHON, Leber hereditary optic neuropathy; MERRF, myoclonic epilepsy with ragged red fibers; MIDD, maternally inherited

A child has coarse facies, corneal clouding, joint contractures, and developmental impairment. Which mucopolysaccharidosis pattern in the table is especially compatible?

A. MPS I Hurler syndrome
B. MPS III with no ocular findings
C. MPS IV with no skeletal findings
D. Isolated phenylketonuria
E. Turner syndrome

Original table 109.1 | Nelson printed p. 939 | PDF p. 985

Table 109.1 Recognition Pattern of Mucopolysaccharidoses

MANIFESTATIONS	MUCOPOLYSACCHARIDOSIS (MPS) TYPE						
	I-H	I-S	II	III	IV	VI	VII
Intellectual disability	+	−	±	+	−	−	±
Coarse facial features	+	(+)	+	+	−	+	±
Corneal clouding	+	+	−	−	(+)	+	±
Visceromegaly	+	(+)	+	(+)	−	+	+
Short stature	+	(+)	+	−	+	+	+
Joint contractures	+	+	+	−	−	+	+
Dysostosis multiplex	+	(+)	+	(+)	+	+	+
Leucocyte inclusions	+	(+)	+	+	−	+	+
Mucopolysacchariduria	+	+	+	+	+	+	+

I-H, Hurler syndrome; I-S, Scheie syndrome; II, Hunter syndrome; III, Sanfilippo syndrome; IV, Morquio syndrome; VI, Maroteaux-Lamy syndrome; VII, Sly syndrome, + presence of manifestation, − absence of manifestation; ± possible presence of

A child with adenine phosphoribosyltransferase deficiency develops recurrent renal stones. Which treatment class in the table helps prevent stones and kidney failure?

A. Xanthine oxidoreductase inhibitor
B. An opioid antagonist
C. An inhaled bronchodilator alone
D. A proton pump inhibitor alone
E. A topical corticosteroid

Original table 110.1 | Nelson printed p. 945 | PDF p. 991

Table 110.1 Disorders of Purines and Pyrimidines with Specific Treatments

DISORDER	GENE SYMBOL	TREATMENT	OUTCOME
APRT deficiency	*APRT*	XOR inhibitor	Prevents renal stones and renal failure
Uridine-responsive epileptic encephalopathy	*CAD*	Uridine	Suppresses seizures, reverses neurobehavioral and hematologic abnormalities
Familial juvenile hyperuricemic nephropathy	*UMOD, REN, MUC,* or *HNF-1b*	XOR inhibitor	Prevents renal stones, renal failure, and gout
Renal hypouricemia	*SLC2A9* or *SLC22A12*	XOR inhibitor	Prevents renal stones and renal failure
Hereditary orotic aciduria	*UMPS*	Uridine	Reverses neurobehavioral and hematologic deficits
Hereditary xanthinurias			
Type 1	*XOR*	XOR inhibitor	Prevents renal stones and renal failure
Type 2	*MOCOS*	XOR inhibitor	Prevents renal stones and renal failure
Molybdenum cofactor deficiencies	*MOCS1-3, GPHN*	XOR inhibitor	Prevents renal stones and renal failure
MOCS1 deficiency	*MOCS1*	cPMP	Reverses neurobehavioral deficits
HPRT1-associated disorders	*HPRT1*	XOR inhibitor	Prevents renal stones, renal failure, and gout
PRPP synthetase hyperactivity	*PRPS1*	XOR inhibitor	Prevents renal stones, renal failure, and gout
Nucleotidase-associated pervasive developmental delay	Unknown	Uridine	Reverses neurobehavioral deficits

The most common XOR inhibitors include allopurinol, febuxostat, and topiroxostat.
cPMP, Cyclic pyranopterin monophosphate; XOR, xanthine oxidoreductase.

A child with APRT deficiency forms radiolucent stones. Which stone constituent does the purine-disorders table identify?

A. 2,8-Dihydroxyadenine
B. Cystine
C. Calcium carbonate only
D. Struvite
E. Silica

Original table 110.3 | Nelson printed p. 949 | PDF p. 995

Table 110.3 Renal Stones in Disorders of Purines and Pyrimidines

DISORDER	GENE SYMBOL	STONES
APRT deficiency	*APRT*	Dihydroxy-adenine
Familial juvenile hyper-uricemic nephropathy	*UMOD*, *REN*, *MUC*, or *HNF-1*b	Uric acid
Hereditary orotic aciduria	*UMPS*	Orotic acid
Hereditary xanthinurias		
Type 1	*XOR*	Xanthine
Type 2	*MOCOS*	Xanthine
Molybdenum cofactor deficiencies	*MOCS1-3*, *GPHN*	Xanthine
HPRT1-associated disorders	*HPRT1*	Uric acid
PRPP synthetase hyperactivity	*PRPS1*	Uric acid
Tumor lysis syndrome	Not applicable	Uric acid

An adolescent with suspected acute intermittent porphyria has recurrent severe abdominal pain and neuropathic symptoms. Which screening test does the comparison table emphasize during an acute attack?

A. Urinary porphobilinogen
B. A sweat chloride test
C. A stool ova-and-parasite examination alone
D. A serum IgE level
E. An audiogram

Original table 112.2 | Nelson printed p. 965 | PDF p. 1011

Table 112.2 The Three Most Common Human Porphyrias and Major Features

	PRESENTING SYMPTOMS	EXACERBATING FACTORS	MOST IMPORTANT SCREENING TESTS	TREATMENT
Acute intermittent porphyria	Neurologic, adult onset	Drugs (mostly P450 inducers), progesterone, dietary restriction	Urinary porphobilinogen	Hemin, glucose, givosiran
Porphyria cutanea tarda	Skin blistering and fragility (chronic), adult onset	Iron, alcohol, smoking, estrogens, hepatitis C, HIV, halogenated hydrocarbons	Plasma or urine porphyrins	Phlebotomy, low-dose hydroxychloroquine, direct acting antivirals (if hepatitis C is present)
Erythropoietic protoporphyria	Phototoxic pain and swelling (mostly acute), childhood onset	Sunlight exposure	Total erythrocyte protoporphyrin with metal-free and zinc protoporphyrin	Sun protection

nonblistering photosensitivity that occurs acutely after sun exposure

protoporphyrin). Thus the obsolete term *free protoporphyrin* does not

A teen has severe prolonged poorly localized abdominal pain and vomiting without fever or peritoneal signs. Which disorder in the symptom table should remain in the differential?

A. Acute porphyria
B. Acute perforated viscus as the only possibility
C. Isolated chronic myopia
D. Primary tic disorder
E. Uncomplicated allergic rhinitis

Original table 112.4 | Nelson printed p. 969 | PDF p. 1015

Table 112.4 Common Presenting Symptoms and Signs of Acute Porphyria

SYMPTOMS AND SIGNS	FREQUENCY (%)	COMMENT
GASTROINTESTINAL		
Abdominal pain	85–95	Usually unremitting (for hours or longer) and poorly localized but can be cramping.
Vomiting	43–88	Neurologic in origin and rarely accompanied by peritoneal signs, fever, or leukocytosis.
Constipation	48–84	Nausea and vomiting often accompany abdominal pain. May be accompanied by bladder paresis.
Diarrhea	5–12	
NEUROLOGIC		
Pain in extremities, back	50–70	Pain may begin in the chest or back and move to the abdomen. Extremity pain from the chest, neck, or head indicates involvement of sensory nerves; objective sensory loss reported in 10–40% of cases.
Paresis	42–68	May occur early or late during a severe attack. Muscle weakness usually begins proximally rather than distally and more often in the upper than lower extremities.
Respiratory paralysis	9–20	Preceded by progressive peripheral motor neuropathy and paresis.
Mental symptoms	40–58	May range from minor behavioral changes to agitation, confusion, hallucinations, and depression.
Convulsions	10–20	A central neurologic manifestation of porphyria or caused by hyponatremia, which often results from syndrome of inappropriate antidiuretic hormone secretion or sodium depletion.
CARDIOVASCULAR		
Tachycardia	64–85	May warrant treatment to control rate, if symptomatic.
Systemic arterial hypertension	36–55	May require treatment during acute attacks, and sometimes becomes chronic.

From Anderson KE, Bloomer JR, Bonkovsky HL, et al. Desnick recommendations for the diagnosis and treatment of the acute porphyrias, *Ann Intern Med.* 2005;142(6):439–450.

A child with documented hypoglycemia becomes tremulous, sweaty, and tachycardic before confusion develops. Which physiologic response explains the first group of symptoms?

A. Autonomic activation and epinephrine release
B. Isolated cerebral glucopenia only
C. Chronic vitamin A excess
D. A primary hearing deficit
E. Acute limb ischemia

Original table 113.1 | Nelson printed p. 981 | PDF p. 1027

Table 113.1 Manifestations of Hypoglycemia in Childhood

FEATURES ASSOCIATED WITH ACTIVATION OF AUTONOMIC NERVOUS SYSTEM AND EPINEPHRINE RELEASE*
Anxiety
Perspiration
Palpitation (tachycardia)
Pallor
Tremulousness
Weakness
Hunger
Nausea
Emesis
FEATURES ASSOCIATED WITH CEREBRAL GLUCOPENIA
Headache
Mental confusion
Visual disturbances (↓ acuity, diplopia)
Inability to concentrate
Dysarthria
Staring
Paresthesias
Dizziness
Amnesia
Ataxia
Refusal to feed
Somnolence, lethargy
Seizures
Coma
Stroke, hemiplegia, aphasia
Decerebrate or decorticate posture

*Some of these features will be attenuated if the patient is receiving β-adrenergic blocking agents.

A hypoglycemic newborn has macroglossia and is large for gestational age. Which diagnosis in the clinical-clues table should be considered?

A. Beckwith-Wiedemann syndrome with hyperinsulinism
B. Isolated familial short stature
C. Turner syndrome
D. Simple allergic rhinitis
E. Isolated vasovagal syncope

Original table 113.2 | Nelson printed p. 982 | PDF p. 1028

Table 113.2 Clinical Features of Hypoglycemia Disorders

BIRTH HISTORY	
Large for gestational age	Congenital HI, BWS
Small for gestational age	Perinatal stress HI
Maternal gestational diabetes	Infant of diabetic mother, dominant K_{ATP} -HI
FAMILY HISTORY	
Sudden infant death	Fatty acid oxidation disorder
Diabetes*	HNF4A-HI, HNF1A-HI, dominant K_{ATP} -HI
PHYSICAL EXAM	
Hepatomegaly	Glycogen storage disease
Congenital heart disease	Perinatal stress HI, Kabuki or Turner syndrome
Midline defect	Hypopituitarism
Macroglossia	BWS
Hyperpigmentation	Primary adrenal insufficiency
Short stature	Growth hormone deficiency, glycogen storage disease

*Specifically, non–type 1 diabetes diagnosed at a younger age in lean individuals.
HI, Hyperinsulinism; BWS, Beckwith-Wiedemann syndrome; K_{ATP}, ATP-sensitive potas-

A preterm newborn has transient low glucose shortly after birth that resolves as feeding is established. Which category in the classification table is most consistent?

A. Neonatal transitional hypoglycemia
B. Persistent congenital hyperinsulinism
C. An inherited glycogen storage disease
D. Acquired insulinoma
E. Adult-onset type 2 diabetes

Original table 113.3 | Nelson printed p. 983 | PDF p. 1029

Table 113.3 Classification of Hypoglycemia in Infants and Children

NEONATAL TRANSITIONAL (ADAPTIVE) HYPOGLYCEMIA Associated with inadequate substrate or immature enzyme function in otherwise normal neonates Prematurity Small for gestational age Normal newborn *Transient Neonatal Hyperinsulinism* Infant of diabetic mother Small for gestational age Discordant twin Birth asphyxia Infant of toxemic mother NEONATAL, INFANTILE, OR CHILDHOOD PERSISTENT HYPOGLYCEMIA *Hyperinsulinism (see Tables 113.4 and 113.5)* *Counter-Regulatory Hormone Deficiency* Panhypopituitarism Isolated growth hormone deficiency Adrenocorticotropic hormone deficiency Addison disease (including congenital adrenal hypoplasia, adrenal leukodystrophy, triple A syndrome, ACTH receptor deficiency, and autoimmune disease complex) Epinephrine deficiency *Glycogenolysis and Gluconeogenesis Disorders* Glucose-6-phosphatase deficiency (GSD Ia) Glucose-6-phosphate translocase deficiency (GSD Ib) Amylo-1,6-glucosidase (debranching enzyme) deficiency (GSD III) Liver phosphorylase deficiency (GSD VI) Phosphorylase kinase deficiency (GSD IX) Glycogen synthetase deficiency (GSD 0) Fructose-1,6-diphosphatase deficiency Pyruvate carboxylase deficiency Galactosemia Hereditary fructose intolerance *Lipolysis Disorders* *Fatty Acid Oxidation Disorders* Carnitine transporter deficiency (primary carnitine deficiency) Carnitine palmitoyltransferase-1deficiency Carnitine translocase deficiency Carnitine palmitoyltransferase-2 deficiency Secondary carnitine deficiencies Very long-, long-, medium-, and short-chain acyl-CoA dehydrogenase deficiency	OTHER ETIOLOGIES *Substrate-Limited Causes* Ketotic hypoglycemia Poisoning—drugs Salicylates Alcohol Oral hypoglycemic agents Insulin Propranolol Pentamidine Quinine Disopyramide Ackee fruit (unripe)—hypoglycin Litchi-associated toxin (toxic hypoglycemic syndrome) Vacor (rat poison) Trimethoprim-sulfamethoxazole (with renal failure) L-Asparaginase and other antileukemic drugs *Liver Disease* Reye syndrome Hepatitis Cirrhosis Hepatoma AMINO ACID AND ORGANIC ACID DISORDERS Maple syrup urine disease Propionic acidemia Methylmalonic acidemia Tyrosinosis Glutaric aciduria 3-Hydroxy-3-methylglutaric aciduria SYSTEMIC DISORDERS Sepsis Carcinoma/sarcoma (secreting—insulin-like growth factor II) Heart failure Malnutrition Malabsorption Antiinsulin receptor antibodies Antiinsulin antibodies Neonatal hyperviscosity Renal failure Diarrhea Burns Shock Chiari malformation Postsurgical complication Pseudohypoglycemia (leukocytosis, polycythemia) Excessive insulin therapy of insulin-dependent diabetes mellitus Factitious disorder Nissen fundoplication (dumping syndrome) Falciparum malaria

GSD, Glycogen storage disease; HI, hyperinsulinemia; KATP, regulated potassium channel.

A neonate of a mother with diabetes has hypoglycemia shortly after delivery with evidence of excess insulin. Which mechanism group in the table applies?

A. Transient hyperinsulinemic hypoglycemia
B. Primary adrenal insufficiency only
C. Isolated fatty acid oxidation failure
D. A chronic insulinoma in every case
E. Primary renal glucose wasting

Original table 113.4 | Nelson printed p. 983 | PDF p. 1029

Table 113.4 Endocrine and Metabolic Causes of Hyperinsulinemic Hypoglycemia

TRANSIENT
Infant of diabetic mother
Perinatal asphyxia
Rhesus hemolytic disease
Intrauterine growth restriction
HNF4A / HNF1A

CONGENITAL
ABCC8 / KCNJ11 / GCK / GDH / HADH / HNF4A / HNF1A / UCP2 / SLC16A1 / PMM2 / HK1 / PGM1 / FOXA2 / CACNA1D / EIF2S3

OTHERS
Postprandial hyperinsulinemic hypoglycemia
Insulinoma
Munchausen by proxy
Exercise-induced hyperinsulinemic hypoglycemia

Modified from Güemes M, Rahman SA, Kapoor RR, et al. Hyperinsulinemic hypoglyce-

A large-for-gestational-age infant has macroglossia, an abdominal-wall defect, and persistent hyperinsulinemic hypoglycemia. Which syndrome in the table best fits?

A. Beckwith-Wiedemann syndrome
B. Turner syndrome
C. Marfan syndrome
D. Fragile X premutation
E. Classic phenylketonuria

Original table 113.5 | Nelson printed p. 984 | PDF p. 1030

Table 113.5 Syndromic Forms of Hyperinsulinemic Hypoglycemia*

SYNDROME NAME	GENETIC ETIOLOGY *GENE* (LOCATION)	CLINICAL CHARACTERISTICS
PRENATAL AND POSTNATAL OVERGROWTH (MACROSOMIA)		
Beckwith-Wiedemann	(11p15)	Macroglossia, abdominal wall defects, ear lobe pits/creases, hemihypertrophy, tumor risk; IUGR if associated with placental mesenchymal dysplasia
Sotos	*NSD1* (5q35)	Macrocephaly, frontal bossing, pointed chin, developmental delay, tumor risk
Simpson-Golabi-Behmel	GPC3 (Xq26), GPC4 (Xp22)	Coarse facial features, broad feet, polydactyly, cryptorchidism, hepatomegaly, tumor risk
Perlman	*DIS3L2* (2q37)	Inverted V-shaped upper lip, prominent forehead, developmental delay, hypotonia, tumor risk
POSTNATAL GROWTH FAILURE (SHORT STATURE)		
Kabuki	*KMT2D* (12q13), *KDM6A* (Xp11.3)	Arched eyebrows, long eyelashes, developmental delay, fetal finger pads, scoliosis, heart defects, hypotonia
Costello	*HRAS* (11p15)	Deep palmar/plantar creases, developmental delay, coarse facial features, heart abnormalities, papillomas, tumor risk
CHROMOSOMAL ABNORMALITY		
Mosaic Turner	Loss of X in some cells	Milder Turner syndrome phenotype (short stature, coarctation of aorta, gonadal dysgenesis)
Patau	Trisomy 13	Developmental delay, microphthalmia, heart and neural defects
CONGENITAL DISORDERS OF GLYCOSYLATION		
Types 1a, 1b, and 1d	*PMM2* (16p13.2), *MPI* (15q24.1), *ALG3* (3q27.1)	Developmental delay, hypotonia, growth failure
CONTIGUOUS GENE DELETION AFFECTING THE *ABCC8* GENE		
Usher	11 genes	Hearing loss, visual impairment
ABNORMALITIES IN CALCIUM HOMOEOSTASIS		
Timothy	*CACNA1C* (12p13.33)	Long QT syndrome, syndactyly, developmental delay, immune deficiency
INSULIN RECEPTOR PATHOGENIC VARIANT		
Insulin resistance syndrome (leprechaunism)	*INS* (19p13)	Hypoglycemia and hyperglycemia, prenatal and postnatal growth restriction, elfin-like features, hirsutism
OTHER SYNDROMES		
Congenital central hypoventilation syndrome	*PHOX2B* (4p13)	Central hypoventilation, "box-shaped" face, neurocristopathies (Hirschsprung disease, tumor risk)

IUGR, intrauterine growth restriction.
*Various developmental syndromes have been described with the gene/s linked to the condition and the common clinical features.
Modified from Güemes M, Rahman SA, Kapoor RR, et al. Hyperinsulinemic hypoglycemia in children and adolescents: recent advances in understanding of pathophysiology and

A child has recurrent unexplained hypoglycemia. Which diagnostic step in the table is most informative if safely obtained during an episode?

A. Collect a critical sample while plasma glucose is low
B. Wait until after intravenous glucose and a full meal for every test
C. Measure only height at a routine visit
D. Use a random urine dipstick as the complete workup
E. Avoid ketone measurement

Original table 113.6 | Nelson printed p. 985 | PDF p. 1031

Table 113.6 Hypoglycemia Diagnostic Evaluation

LABORATORY TEST	INTERPRETATION
"CRITICAL SAMPLE" TO BE OBTAINED WHEN PLASMA GLUCOSE <50 MG/DL	
Comprehensive metabolic panel	Low HCO_3 suggests elevation of ketones or lactate Elevated liver function tests may indicate GSD
β-hydroxybutyrate	Low levels suggest insulin excess (most commonly HI) or FAO disorder Elevated levels suggest GSD, hormone deficiency, or ketone utilization disorder
Insulin C-peptide	Detectable levels consistent with insulin excess Detectable insulin with undetectable c-peptide is consistent with exogenous insulin
Cortisol Growth hormone	Low levels concerning for hormone deficiency; need stimulation testing to confirm
Lactate	Elevated levels concerning for disorder of gluconeogenesis
Ammonia	Elevation can be seen in forms of HI and in IEM
Acylcarnitine profile Free and total carnitine Urine organic acids	Abnormalities suggestive of FAO disorder
IGF-BP1	Low levels suggest insulin excess
GLUCAGON STIMULATION TEST	
Administer 1 mg of glucagon IV or IM when plasma glucose <50 mg/dL Check point-of-care glucose every 10 min for 40 min If glucose does not increase 20 points in 20 min, terminate test and feed child Interpretation: Increase in glucose by 30 points is consistent with insulin excess	

HCO_3, Bicarbonate; GSD, glycogen storage disorder; HI, hyperinsulinism; FAO, fatty acid oxidation; IEM, inborn errors of metabolism.

A child with confirmed congenital hyperinsulinism needs pharmacologic therapy under specialist care. Which table-listed agent is used to reduce insulin-driven hypoglycemia?

A. Diazoxide
B. Albuterol
C. Oral iron
D. Lidocaine cream
E. Cholestyramine

Original table 113.7 | Nelson printed p. 987 | PDF p. 1033

Table 113.7 Treatments for Hypoglycemia Disorders

DRUG/THERAPY	INDICATION	DOSE (ROUTE OF ADMINISTRATION)	SIDE EFFECTS/COMMENTS
Diazoxide	HI	5-15 mg/kg/day every 12 hr (PO)	Hypertrichosis, fluid overload* neutropenia, thrombocytopenia, respiratory distress, hyperglycemia
Octreotide	HI	2-20 mcg/kg/day every 6 hr (SQ)	Gallstones, transaminitis, malabsorption, suppression of thyroid and growth hormones
Lanreotide	HI	60-90 mg every 28 days (SQ)	Gallstones, transaminitis, malabsorption, suppression of thyroid and growth hormones
Enteral D20	HI	Up to 10 mg/kg/min continuously (via gastrostomy or nasogastric tube)	Vomiting, diarrhea, fluid overload
Cornstarch	GSD, rarely FAOD, IKH	1-2 g/kg per dose (PO)	Diarrhea in infants
Growth hormone	Growth hormone deficiency	0.3 mg/kg/wk daily or every 12 hr (infants) (SQ)	Pseudotumor cerebri, edema, slipped capital femoral epiphysis, hyperglycemia
Hydrocortisone	Adrenal insufficiency	8-12 mg/m^2/day (PO)	High doses: Immunosuppression, hyperglycemia, hypertension, obesity
Acarbose	Postprandial hypoglycemia	12.5-50 mg with meals	Transaminitis, diarrhea, abdominal pain
PANCREATECTOMY			
Partial	Focal HI Insulinoma		>50% pancreatectomy increases risk of diabetes and exocrine insufficiency later in life
Near-total (98%)	Severe diffuse HI		Insulin-dependent diabetes, exocrine insufficiency

*Concomitant use of diuretics is strongly recommended in neonates and infants; older children may require this as well.
HI, Hyperinsulinism; GSD, glycogen storage disease; FAOD, fatty acid oxidation disorder; IKH, idiopathic ketotic hypoglycemia.

During a hypoglycemic critical sample, a child has suppressed ketones and free fatty acids with an inappropriate rise in glucose after glucagon. Which cause is supported?

A. Excess insulin action
B. Normal prolonged fasting adaptation
C. Complete absence of insulin
D. Isolated dehydration
E. Pure anemia

Original table 113.8 | Nelson printed p. 987 | PDF p. 1033

Table 113.8 Criteria for Diagnosing Hyperinsulinism and Other Forms of Insulin Excess

DRAWN AT A TIME OF FASTING HYPOGLYCEMIA: PLASMA GLUCOSE <50 MG/DL
Detectable insulin or c-peptide (plasma insulin ≥2 μU/mL or plasma C-peptide ≥0.5 ng/mL)*
Hypofattyacidemia (plasma free fatty acids <1.7 mmol/L)
Hypoketonemia (plasma β-hydroxybutyrate <1.8 mmol/L)
Inappropriate glycemic response to glucagon (increase in glucose >30 mg/dL)

*Depends on sensitivity of insulin assay. Detectable insulin and C-peptide is not necessary to make a diagnosis of HI.

A child has recurrent ketotic hypoglycemia after overnight fasting and short stature. Which endocrine condition in the table should be evaluated?

A. Growth hormone deficiency
B. Isolated insulinoma
C. Excess insulin action as the only option
D. Congenital hyperthyroidism in every case
E. Primary acute appendicitis

Original table 113.9 | Nelson printed p. 990 | PDF p. 1036

Table 113.9 Causes of Ketotic Hypoglycemia in Children

	GENE OR CHROMOSOME	INHERITANCE
HORMONAL		
Growth hormone deficiency or resistance	Genetic or acquired	Variable
ACTH deficiency or resistance; cortisol deficiency	Genetic or acquired	Variable
Glucagon deficiency*	*GCG, DBH*	N/D
Dopamine β-hydroxylase deficiency*	*GCG, DBH*	N/D
METABOLIC		
Glycogen storage disease (GSD)		
GSD 0; glycogen synthase deficiency	*GYS2*	AR
GSD III; glycogen debranching enzyme deficiency	*AGL*	AR
GSD VI; glycogen phosphorylase deficiency	*PYGL*	AR
GSD IX; phosphorylase kinase subunit deficiencies	*PHKA2, PHKB, PHKG2*	X-linked, AR
GLUCOSE METABOLISM AND TRANSPORT		
Phosphoglucomutase I deficiency	*PMG1*	AR
Pyruvate carboxylase deficiency	*PC*	AR
ORGANIC ACIDEMIAS		
Maple syrup urine disease, propionic aciduria, methylmalonic aciduria	Multiple genes	AR
Ketone body transport and metabolism		
Monocarboxylase transporter 1 defect	*SLC16A1 (MCT1)*	AR, AD
Ketolysis		
Succinyl CoA oxoacid transferase deficiency	*SCOT*	AR
Mitochondrial acetoacetyl-CoA thiolase (β-ketothiolase) deficiency	*ACAT1*	AR
SYNDROMES		
Silver-Russel syndrome	11p15 or 7**	Mostly sporadic
Prader-Willi syndrome	15q11-q13***	Mostly sporadic
Fanconi-Bickel syndrome	*SLC2A2 (GLUT2)*	AR
KH secondary to chronic malnutrition, severe malaria, other chronic diseases	—	—
Idiopathic ketotic hypoglycemia		
Physiologic KH in prolonged fasting or acute illness	—	—
Pathologic KH	—	—
IGF2BP1 deficiency*	*IGF2BP1*	N/D
Sodium glucose co-transporter 2 defect*	*SLC5A2*	N/D
PEP carboxykinase 1 and G-6P catalytic transcriptional induction*	*NCOR1*	N/D
Mitosis gene A-related kinase 11 defect*	*NEK11*	N/D

*Suggested, not well-established, causes of KH.
**Several mechanisms, rare other mechanisms, or unknown.
***Paternal deletion, maternal uniparental disomy, or imprinting defect

Prenatal imaging shows congenital diaphragmatic hernia with severe pulmonary concerns. Which care setting in the table may assess selected fetal diagnoses before birth?

A. A multidisciplinary fetal center
B. An isolated dental clinic
C. Only an adult orthopedics service
D. Routine hearing screening only
E. A school vaccination office

Original table 118.1 | Nelson printed p. 1029 | PDF p. 1039

Table 118.1 Fetal Diagnoses Evaluated and Treated in Fetal

Amniotic band syndrome (ABS)
Anomalies in monochorionic twins
Aortic stenosis
Arachnoid cyst
Bladder exstrophy
Bladder outlet obstruction
Bronchopulmonary sequestration (BPS)
Cervical teratoma
Cloaca
Cloaca exstrophy
Complete heart block
Congenital pulmonary airway malformation (CPAM)
Congenital diaphragmatic hernia (CDH)
Congenital high airway obstruction syndrome (CHAOS)
EXIT to airway procedure for CHAOS
Conjoined twins
Dandy-Walker malformation
Duodenal atresia
Encephalocele
Enteric duplication atresia
Esophageal atresia

EXIT, Ex utero intrapartum treatment.

A fetus has severe congenital diaphragmatic hernia with anticipated pulmonary hypoplasia. What rationale does the fetal-intervention table identify for selected prenatal intervention?

A. Improve lung development before postnatal defect repair
B. Completely avoid every need for newborn respiratory care
C. Treat a maternal ear infection
D. Replace fetal heart development with an artificial pump
E. Correct the defect only by giving fetal antibiotics

Original table 118.2 | Nelson printed p. 1029 | PDF p. 1039

Table 118.2 Indications and Rationales for In Utero Surgery on the Fetus, Placenta, Cord, or Membranes

FETAL SURGERY	PATHOPHYSIOLOGY	RATIONALE FOR IN UTERO INTERVENTION
SURGERY ON THE FETUS		
1. Congenital diaphragmatic hernia	Pulmonary hypoplasia and anatomic substrate for pulmonary hypertension	Reversal of pulmonary hypoplasia and reduced degree of pulmonary hypertension Repair of actual defect delayed until after birth
2. Lower urinary tract obstruction	Progressive renal damage due to obstructive uropathy Pulmonary hypoplasia due to oligohydramnios	Prevention of renal failure and pulmonary hypoplasia by anatomic correction or urinary deviation
3. Sacrococcygeal teratoma	High-output cardiac failure due to AV shunting and/or bleeding Direct anatomic effects of the tumoral mass Polyhydramnios-related preterm labor	Reduction of functional impact of tumor by ablation of tumor or (part of) its vasculature Reduction of anatomic effects by drainage of cysts or bladder Amnioreduction preventing obstetric complications
4. Thoracic space-occupying lesions	Pulmonary hypoplasia (space-occupying mass) Hydrops due to impaired venous return (mediastinal compression)	Creation of space for lung development Reversal of the process of cardiac failure
5. Neural tube defects	Damage to exposed neural tube Chronic CSF leak, leading to Arnold-Chiari malformation and hydrocephalus	Prevention of exposure of the spinal cord to amniotic fluid Restoration of CSF pressure correcting Arnold-Chiari malformation
6. Cardiac malformations	Critical lesions causing irreversible hypoplasia or damage to developing heart	Reversal of process by anatomic correction of restrictive pathology
SURGERY ON THE PLACENTA, CORD, OR MEMBRANES		
7. Chorioangioma	High-output cardiac failure due to AV shunting Effects of polyhydramnios	Reversal of process of cardiac failure and hydrops fetoplacentalis by ablation or reduction of flow
8. Amniotic bands	Progressive constrictions causing irreversible neurologic or vascular damage	Prevention of amniotic band syndrome leading to deformities and function loss
9. Abnormal monochorionic twinning: twin-to-twin transfusion; fetus acardius, and discordant anomalies	Twin-twin transfusion leading to oligopolyhydramnios sequence, hemodynamic changes; preterm labor, and rupture of membranes; in utero damage to brain, heart, or other organs In utero fetal death may cause damage to co-twin Cardiac failure of pump twin and consequences of polyhydramnios Serious anomaly raising the question of termination of pregnancy Selective feticide	Arrest of intertwin transfusion Prevention/reversal of cardiac failure and/or neurologic damage, including at in utero death Prolongation of gestation Selective feticide to arrest parasitic relationship, to prevent consequences of in utero fetal death, and to avoid termination of entire pregnancy

AV, Arteriovenous; CSF, cerebrospinal fluid.
From Deprest J, Hodges R, Gratacos E, Lewi L. Invasive fetal therapy. In: Creasy RK, Resnick R, Iams JD, et al., eds. *Creasy & Resnik's Maternal-Fetal Medicine*. 7th ed. Philadelphia: Elsevier, 2014, Table 35-1.

A fetus with a major structural anomaly is being considered for fetal repair, but testing also identifies trisomy 18. Which selection factor from the table is relevant?

A. The prognosis associated with a major chromosomal condition
B. A routine school attendance record
C. Maternal shoe size
D. Only the newborn name
E. A normal adult lipid panel

Original table 118.3 | Nelson printed p. 1037 | PDF p. 1047

Table 118.3 Selection of Patients for Fetal Repair

LEVEL OF CERTAINTY	DIAGNOSIS
DIAGNOSTIC CERTAINTY/PROGNOSTIC CERTAINTY	
Genetic problems	Trisomy 13, 15, or 18 Triploidy
Central nervous system abnormalities	Anencephaly/acrania Holoprosencephaly Large encephaloceles
Heart problems	Acardia Inoperable heart anomalies
Kidney problems	Potter syndrome/renal agenesis Multicystic/dysplastic kidneys Polycystic kidney disease
DIAGNOSTIC UNCERTAINTY/PROGNOSTIC CERTAINTY	
Genetic problems	Thanatophoric dwarfism or lethal forms of osteogenesis imperfecta
Early oligo/anhydramnios and pulmonary hypoplasia	Potter syndrome with unknown etiology
Central nervous system abnormalities	Hydranencephaly
	Congenital severe hydrocephalus with absent or minimal brain growth
Prematurity	<23 weeks' gestation
PROGNOSTIC UNCERTAINTY/BEST INTEREST	
Genetic problems	Errors of metabolism that are expected to be lethal even with available therapy
Mid oligo/anhydramnios	Renal failure requiring dialysis
Central nervous system abnormalities	Complex or severe cases of meningomyelocele Neurodegenerative diseases, such as spinal muscular atrophy
Heart problems	Some cases of hypoplastic left heart syndrome Pentalogy of Cantrell (ectopia cordis)
Other structural anomalies	Some cases of giant omphalocele Severe congenital diaphragmatic hernia with hypoplastic lungs Idiopathic nonimmune hydrops Inoperable conjoined twins Multiple severe anomalies
Prematurity	23-24 weeks' gestation

From Leuthner SR. Fetal palliative care. *Clin Perinatol* 2004;31:649–665. Table 1.

A pregnant patient has diabetes and hypertension, and the fetus has a known growth concern. Which newborn-planning category in the table follows?

A. Higher neonatal risk meriting anticipatory planning
B. Guaranteed low-risk uncomplicated birth
C. A diagnosis of neonatal infection without testing
D. Automatic exclusion of fetal surveillance
E. Only a dental referral

Original table 119.1 | Nelson printed p. 1038 | PDF p. 1048

Table 119.1 Factors in Considering Infants as High Risk for Morbidity or Mortality in the Neonatal Period

BIRTH PARENT DEMOGRAPHIC FACTORS
Maternal age <16 yr or >40 yr
Environmental, economic, social disadvantage, racial discrimination
BIRTH PARENT MEDICAL HISTORY
Genetic disorders
Diabetes mellitus
Hypertension
Asymptomatic bacteriuria
Rheumatologic illness (systemic lupus erythematosus)
Immune-mediated diseases
Long-term medication (see Chapters 117.4 and 117.5)
PREVIOUS PREGNANCY
Intrauterine fetal demise
Neonatal death
Prematurity
Intrauterine growth restriction
Congenital malformation
Incompetent cervix
Blood group sensitization, neonatal jaundice
Neonatal thrombocytopenia
Hydrops
Inborn errors of metabolism
PRESENT PREGNANCY
Vaginal bleeding (abruptio placentae, placenta previa)
Sexually transmitted infections (colonization: herpes simplex, group B streptococcus, chlamydia, syphilis, hepatitis B, HIV)
Multiple gestation
Preeclampsia
Premature rupture of membranes
Short interpregnancy time
Poly-/oligohydramnios
Acute medical or surgical illness
Familial or acquired hypercoagulable states
Abnormal fetal ultrasonographic findings
Treatment of infertility
Inadequate prenatal care
Substance use disorder
LABOR AND DELIVERY
Premature labor (<37 wk)
Postdates pregnancy (≥42 wk)
Fetal distress
Breech presentation
Meconium-stained fluid
Nuchal cord
Cesarean delivery
Forceps or vacuum assisted delivery
Apgar score <4 at 5 min
NEONATE
Birthweight <2,500 g or >4,000 g
Birth <37 wk or ≥42 wk of gestation
Small or large for gestational age
Respiratory distress, cyanosis
Congenital malformation
Pallor, plethora, petechiae

In monochorionic twins with uncompensated placental vascular shunting, one fetus is pale and growth restricted with oligohydramnios. Which twin is described?

A. Donor twin
B. Recipient twin
C. Neither twin
D. A singleton fetus
E. Only the larger polyhydramnios twin

Original table 119.2 | Nelson printed p. 1041 | PDF p. 1051

Table 119.2 Characteristic Changes in Monochorionic Twins with Uncompensated Placental Arteriovenous Shunts

	TWIN ON:
ARTERIAL SIDE—DONOR	**VENOUS SIDE—RECIPIENT**
Prematurity	Prematurity
Oligohydramnios	Polyhydramnios
Intrauterine growth restriction	Hydrops
Pale	Plethoric
Anemic	Polycythemic
Hypovolemic	Hypervolemic
Hypoglycemic	Cardiac hypertrophy
Microcardia	Myocardial dysfunction
Glomeruli small or normal	Glomeruli large Tricuspid valve regurgitation Right ventricular outflow obstruction
Arterioles thin walled	Arterioles thick walled

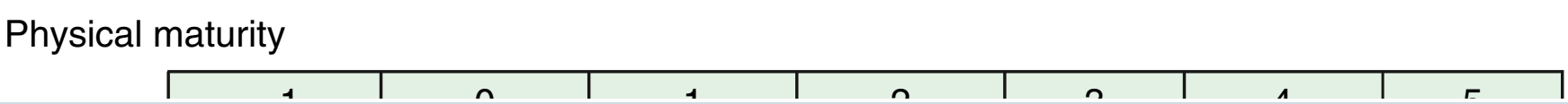
A pregnant patient previously delivered preterm and now has a short interval before another pregnancy. Which category of risk in the table do these findings represent?

A. Maternal risk factors for preterm birth
B. Only fetal chromosomal anomalies
C. Only postnatal infectious exposures
D. Signs that exclude preterm delivery
E. A newborn cardiac diagnosis

Original table 119.3 | Nelson printed p. 1043 | PDF p. 1053

Table 119.3 Identifiable Risk Factors for Preterm Birth

FETAL
Fetal distress
Multiple gestation
Erythroblastosis
Nonimmune hydrops
Polyhydramnios
PLACENTAL
Placental dysfunction
Placenta previa
Placental abruption
UTERINE
Bicornuate uterus
Incompetent cervix (premature dilation)
MATERNAL
Previous preterm birth
Preeclampsia
Experiencing racism
Chronic medical illness (cyanotic heart disease, renal disease, thyroid disease)
Short interpregnancy interval
Infection (*Listeria monocytogenes*, group B streptococcus, urinary tract infection, bacterial vaginosis, chorioamnionitis)
Obesity
Substance use disorder
Extremes of maternal age
OTHER
Premature rupture of membranes
Polyhydramnios
Iatrogenic due to factors listed above
Assisted reproductive technology
Trauma



A fetus has growth restriction and a congenital cytomegalovirus infection. Which category of IUGR cause in the table fits?

A. Fetal chronic infection
B. Maternal overnutrition as the sole cause
C. Normal placental growth in every case
D. A postnatal seizure disorder
E. Isolated renal stone disease

Original table 119.6 | Nelson printed p. 1048 | PDF p. 1058

Table 119.6 Factors Often Associated with Intrauterine Growth Restriction

FETAL
Chromosomal (trisomies, microdeletions, copy number variants) and monogenetic disorders
Chronic fetal infections (cytomegalic inclusion disease, congenital rubella, syphilis)
Congenital anomalies—syndrome complexes
Irradiation
Multiple gestation
Pancreatic hypoplasia
Insulin deficiency (production or action of insulin)
Insulin-like growth factor type I deficiency
PLACENTAL
Decreased placental weight, cellularity, or both
Decrease in surface area
Villous placentitis (bacterial, viral, parasitic)
Infarction
Tumor (chorioangioma, hydatidiform mole)
Placental separation
Placental mesenchymal dysplasia
Twin transfusion syndrome
MATERNAL/PATERNAL
Preeclampsia
Hypertension or renal disease, or both
Hypoxemia (high altitude, cyanotic cardiac or pulmonary disease)
Malnutrition (micronutrient or macronutrient deficiencies)
Chronic illness
Sickle cell anemia
Drugs (opiates, alcohol, cigarettes, cocaine, prescribed medications, antimetabolites)

IUGR is indicative of compromise in utero and is associated with

A fetus has proportionately small head, abdomen, and long bones, with a suspected early gestational insult. Which growth pattern fits the comparison table?

A. Symmetric growth restriction
B. Asymmetric growth restriction
C. Normal late fetal growth
D. Acquired postnatal obesity
E. Isolated macrocephaly

Original table 119.7 | Nelson printed p. 1048 | PDF p. 1058

Table 119.7 Characteristics of Symmetric vs Asymmetric IUGR

CHARACTERISTICS	SYMMETRIC IUGR	ASYMMETRIC IUGR
Typical period of insult and presentation	Earlier gestation (often second trimester)	Later gestation (often detected in the third trimester)
Percentage of all IUGR cases	20–30%	70–80%
Etiology	Genetic disorders Congenital infections	Placental insufficiency
Antenatal scan	Proportionately decreased head circumference (HC), abdominal circumference (AC), biparietal diameter, and femur length	Only abdominal circumference decreased
Cell number	Decreased	Normal
Cell size	Normal	Decreased
Postnatal anthropometry	All parameters (HC, length, and weight) reduced	Reduced weight, HC normal, length low to normal
Features of malnutrition	Less pronounced	More pronounced

IUGR, Intrauterine growth restriction.
Adapted from Sharma D, Shastri S, Sharma P. Intrauterine growth restriction: –part 2. *J Matern Fetal Neonatal Med*. 2016 Mar 15:1–12.

A small-for-gestational-age neonate develops hypoglycemia shortly after birth. Which predisposing mechanism is included in the table?

A. Reduced glycogen stores and limited gluconeogenesis
B. Excess stored glycogen in every case
C. Absence of any glucose utilization
D. An obligatory insulinoma
E. Only high maternal calcium

Original table 119.8 | Nelson printed p. 1048 | PDF p. 1058

Table 119.8 Problems of Infants Small for Gestational Age or with Intrauterine Growth Restriction*

PROBLEM	PATHOGENESIS
Intrauterine fetal demise	Hypoxia, acidosis, infection, lethal anomaly
Perinatal asphyxia	↓ Uteroplacental perfusion during labor ± chronic fetal hypoxia-acidosis; meconium aspiration syndrome
Hypoglycemia	↓ Tissue glycogen stores, ↓ gluconeogenesis, hyperinsulinism, ↑ glucose needs of hypoxia, hypothermia, large brain
Polycythemia-hyperviscosity	Fetal hypoxia with ↑ erythropoietin production
Reduced oxygen consumption/hypothermia	Hypoxia, hypoglycemia, starvation effect, poor subcutaneous fat stores
Dysmorphology	Syndrome anomalads, chromosomal-genetic disorders, oligohydramnios-induced deformation, TORCH†

*Other problems include pulmonary hemorrhage and those common to the gestational age–related risks of prematurity if born at <37 wk.
†TORCH, Toxoplasmosis, other agents, rubella, cytomegalovirus, herpes simplex infection.

A former preterm infant has recovered from an acute illness but is still unable to maintain temperature outside an incubator. Which discharge-readiness criterion is unmet?

A. Stable temperature regulation
B. A previously passed fetal ultrasound
C. Maternal blood type documentation alone
D. The ability to cry once
E. A one-time normal heart rate

Original table 119.9 | Nelson printed p. 1049 | PDF p. 1059

Table 119.9 Readiness for Discharge of High-Risk Infants Criteria

Resolution of acute life-threatening illnesses
Ongoing follow-up for chronic but stable problems:
  Bronchopulmonary dysplasia
  Intraventricular hemorrhage
  Necrotizing enterocolitis after surgery or recovery
  Ventricular septal defect, other cardiac lesions
  Anemia
  Retinopathy of prematurity
  Hearing problems
  Apnea
  Cholestasis
Stable temperature regulation
Gain of weight with enteral feedings:
  Breastfeeding
  Bottle feeding
  Gastric tube feeding
Free of significant apnea
Appropriate immunizations and planning for respiratory syncytial virus prophylaxis if indicated
Hearing screenings
Ophthalmologic examination if <30 wk of gestation or <1,500 g at birth
Parental knowledge, skill, and confidence documented in:
  Administration of medications (diuretics, methylxanthines, aerosols, etc.)
  Use of oxygen, apnea monitors, oximeters
Nutritional support:
  Timing
  Volume
  Mixing concentrated formulas
Recognition of illness and deterioration
Basic cardiopulmonary resuscitation
Infant safety
Scheduling of referrals:
  Primary care provider
  Neonatal follow-up clinic
  Occupational therapy/physical therapy
Imaging (head ultrasound)
Assessment of and solution to social risks

Data from American Academy of Pediatrics, American College of Obstetricians: *Guidelines for Perinatal Care*. 7th ed. Elk Grove Village, IL: American Academy of

A preterm infant survives intraventricular hemorrhage. Which later complication is listed among possible sequelae?

A. Posthemorrhagic hydrocephalus
B. A guaranteed absence of neurologic impairment
C. Congenital cleft lip caused by the bleed
D. An inherited trisomy produced by hemorrhage
E. Only acute gastroenteritis

Original table 119.10 | Nelson printed p. 1050 | PDF p. 1060

Table 119.10 Sequelae of Prematurity

IMMEDIATE	LATE
Hypoxia, ischemia	Intellectual disability, spastic diplegia, microcephaly, seizures, poor school performance
Intraventricular hemorrhage	Intellectual disability, spasticity, seizures, post hemorrhagic hydrocephalus
Sensorineural injury	Hearing and visual impairment, retinopathy of prematurity, strabismus, myopia
Respiratory failure	Bronchopulmonary dysplasia, pulmonary hypertension, bronchospasm, malnutrition, subglottic stenosis
Necrotizing enterocolitis	Short-bowel syndrome, malabsorption, malnutrition
Cholestatic liver disease	Cirrhosis, hepatic failure, malnutrition
Nutrient deficiency	Osteopenia, fractures, anemia, growth failure
Social stress	Child abuse or neglect, failure to thrive, divorce
Other sequelae	Sudden infant death syndrome, infections, inguinal hernia, cutaneous scars (chest tube, patent ductus arteriosus ligation, intravenous infiltration), gastroesophageal reflux, hypertension, craniosynostosis, cholelithiasis, nephrocalcinosis, cutaneous hemangiomas

be followed in a follow-up program that tracks medical and neurode-

A cyanotic neonate has a scaphoid abdomen, bowel sounds in the chest, and respiratory distress soon after birth. Which life-threatening congenital anomaly in the table is most likely?

A. Congenital diaphragmatic hernia
B. Uncomplicated choanal stenosis
C. Isolated pyloric stenosis
D. Intussusception
E. Esophageal candidiasis

Original table 121.1 | Nelson printed p. 1053 | PDF p. 1064

Table 121.1 Common Life-Threatening Congenital Anomalies

ANOMALY	MANIFESTATIONS
Choanal atresia	Respiratory distress in delivery room; nasogastric tube cannot be passed through nares Suspect CHARGE (coloboma of eye, heart anomaly, choanal atresia, retardation, genital and ear anomalies) syndrome
Pierre Robin syndrome, Stickler syndrome	Micrognathia, cleft palate, airway obstruction
Diaphragmatic hernia	Scaphoid abdomen, bowel sounds present in chest, respiratory distress
Tracheoesophageal fistula	Polyhydramnios, aspiration pneumonia, excessive salivation; nasogastric tube cannot be placed in stomach Suspect VATER (vertebral defects, imperforate anus, tracheoesophageal fistula, radial and renal dysplasia) syndrome
Intestinal obstruction: volvulus, duodenal atresia, ileal atresia	Polyhydramnios, bile-stained emesis, abdominal distention Suspect trisomy 21, cystic fibrosis, or cocaine use
Gastroschisis, omphalocele	Polyhydramnios, intestinal obstruction
Renal agenesis, Potter syndrome	Oligohydramnios, anuria, pulmonary hypoplasia, pneumothorax
Neural tube defects: anencephaly, meningomyelocele	Polyhydramnios, elevated α-fetoprotein, decreased fetal activity
Ductus-dependent congenital heart disease	Cyanosis, hypotension, murmur

A newborn has central cyanosis and hypoventilation following maternal sedative exposure near delivery. Which etiologic category in the cyanosis table applies?

A. Central nervous system depressant effect and hypoventilation
B. Only congenital cardiac shunting
C. Isolated peripheral acrocyanosis
D. Normal transition in every case
E. Congenital intestinal obstruction

Original table 121.2 | Nelson printed p. 1054 | PDF p. 1065

Table 121.2 | Differential Diagnosis of Cyanosis in the Newbo

CENTRAL OR PERIPHERAL NERVOUS SYSTEM HYPOVENTILATION
Birth asphyxia
Intracranial hypertension, hemorrhage
Oversedation (direct or through maternal route)
Diaphragm palsy
Neuromuscular diseases
Seizures
RESPIRATORY DISEASE
Airway
Choanal atresia/stenosis
Pierre Robin syndrome
Intrinsic airway obstruction (laryngeal/bronchial/tracheal stenosis)
Extrinsic airway obstruction (bronchogenic cyst, duplication cyst, vascular compression)
Lung
Respiratory distress syndrome
Transient tachypnea
Meconium aspiration
Pneumonia (sepsis)
Pneumothorax
Congenital diaphragmatic hernia
Pulmonary hypoplasia
CARDIAC RIGHT-TO-LEFT SHUNT
Abnormal Connections (Pulmonary Blood Flow Normal or Increased)
Transposition of great vessels
Total anomalous pulmonary venous return
Truncus arteriosus
Hypoplastic left heart syndrome
Single ventricle or tricuspid atresia with large ventricular septal defect but without pulmonic stenosis

From Smith F: Cyanosis. In: Kliegman RM: *Practical Strategies in Pediatric Diagnosis and T*

A preterm infant develops new periventricular echolucent cysts on ultrasound 2 weeks after an earlier echogenic lesion. Which process in the table does this represent?

A. Cystic evolution of periventricular leukomalacia
B. A normal fetal cranial suture
C. An acute extracranial scalp hematoma
D. A congenital cataract
E. A normal choroid plexus variant by definition

Original table 122.3 | Nelson printed p. 1061 | PDF p. 1072

Table 122.3 Ultrasound Diagnosis of Periventricular Leukomalacia

US APPEARANCE	TEMPORAL FEATURES	NEUROPATHOLOGIC CORRELATION
Echogenic foci, bilateral, posterior > anterior	First week	Necrosis with congestion and/or hemorrhage (size >1 cm)
Echolucent foci ("cysts")	1-3 weeks	Cyst formation secondary to tissue dissolution (size >3 mm)
Ventricular enlargement, often with disappearance of "cysts"	≥2-3 months	Deficient myelin formation; gliosis, often with collapse of cyst

From Neil JJ, Volpe JJ. Encephalopathy of prematurity: Clinical-neurological features, diagnosis, imaging, prognosis, therapy. In: Volpe JJ, Inder TE, Darras BT, et al., eds. *Volpe's Neurology of the Newborn*. 6th ed. Philadelphia: Elsevier; 2018: Table 16-6.

A neonate recovering from severe birth asphyxia develops myocardial dysfunction and acute renal injury. Which statement from the table explains these findings?

A. Asphyxia may affect multiple organ systems
B. Asphyxia affects the brain only
C. Kidney injury rules out hypoxic injury
D. Cardiac dysfunction implies only an inherited arrhythmia
E. The infant must have an intestinal infection

Original table 122.5 | Nelson printed p. 1062 | PDF p. 1073

Table 122.5 Multiorgan Systemic Effects of Asphyxia

SYSTEM	EFFECTS
Central nervous	Hypoxic-ischemic encephalopathy, infarction, intracranial hemorrhage, seizures, cerebral edema, hypotonia, hypertonia
Cardiovascular	Myocardial ischemia, poor contractility, cardiac stunning, tricuspid insufficiency, hypotension
Pulmonary	Pulmonary hypertension, pulmonary hemorrhage, respiratory distress syndrome
Renal	Acute tubular or cortical necrosis
Adrenal	Adrenal hemorrhage
Gastrointestinal	Perforation, ulceration with hemorrhage, necrosis
Metabolic	Inappropriate secretion of antidiuretic hormone, hyponatremia, hypoglycemia, hypocalcemia, myoglobinuria
Integumentary	Subcutaneous fat necrosis
Hematologic	Disseminated intravascular coagulation

caused by perinatal events. Brain MRI or autopsy findings in full-term

A term infant with HIE has basal-ganglia and thalamic injury on MRI and later develops movement abnormalities. Which relationship in the topography table is relevant?

A. Deep gray injury can be associated with motor sequelae
B. MRI location has no relationship to clinical course
C. All HIE injuries occur in peripheral nerves
D. Only the liver determines later motor signs
E. Deep gray structures are never affected

Original table 122.6 | Nelson printed p. 1063 | PDF p. 1074

Table 122.6 Topography of Brain Injury in Term Infants with Hypoxic-Ischemic Encephalopathy and Clinical Correlates

AREA OF INJURY	LOCATION OF INJURY	CLINICAL CORRELATES	LONG-TERM SEQUELAE
Selective neuronal necrosis	Entire neuraxis, deep cortical area, brainstem and pontosubicular	• Stupor or coma • Seizures • Hypotonia • Oculomotor abnormalities • Suck/swallow abnormalities	• Cognitive delay • Cerebral palsy • Dystonia • Seizure disorder • Ataxia • Bulbar and pseudobulbar palsy
Parasagittal injury	Cortex and subcortical white matter Parasagittal regions, especially posterior	• Proximal-limb weakness • Upper extremities affected > lower extremities	• Spastic quadriparesis • Cognitive delay • Visual and auditory processing difficulty
Focal ischemic necrosis	Cortex and subcortical white matter Vascular injury (usually middle cerebral artery distribution)	• Unilateral findings • Seizures common and typically focal	• Hemiparesis • Seizures • Cognitive delays
Periventricular injury	Injury to motor tracts, especially lower extremity	• Bilateral and symmetric weakness in lower extremities • More common in preterm infants	• Spastic diplegia

Adapted from Volpe JJ, ed. *Neurology of the Newborn*. 4th ed. Philadelphia: Saunders; 2001.

A term newborn with HIE is lethargic, has reduced spontaneous activity, and has an abnormal suck but is not comatose. Which stage in the table is most compatible?

A. Stage 2 moderate HIE
B. Stage 1 mild HIE
C. Stage 3 severe HIE
D. Normal newborn examination
E. No neurologic stage can be assigned

Original table 122.8 | Nelson printed p. 1064 | PDF p. 1075

Table 122.8 Hypoxic-Ischemic Encephalopathy in Term Infants

SIGNS	STAGE 1 (MILD)	STAGE 2 (MODERATE)	STAGE 3 (SEVERE)
Level of consciousness	Hyperalert, responds to minimal stimuli	Lethargic	Stuporous, coma
Spontaneous activity	Normal or decreased	Decreased	None
Posture	Mild flexion of distal joints (fingers, wrist)	Distal flexion or complete extension	Decerebrated
Tone	Normal	Hypotonia (focal or general) or hypertonia	Flaccid or rigid
PRIMITIVE REFLEXES	1	2	3
Suck	Weak or incomplete	Weak or bite	Absent
Moro reflex	Intact, low threshold	Incomplete	Absent
AUTONOMIC NERVOUS SYSTEM	1	2	3
Pupils	Mydriasis	Miosis	Variable or nonreactive
Heart rate	Tachycardia	Bradycardia	Variable heart rate
Respirations	Hyperventilation	Periodic breathing	Apnea or requiring ventilation
Seizures	None	Common	Decerebration
Electroencephalographic findings	Normal	Low voltage changing to seizure activity	Burst suppression to isoelectric
Duration	<24 hr if progresses; otherwise, may remain normal	24 hr to 14 days	Days to weeks
Outcome	Good	Variable	Death, severe deficits

Adapted from Chalak L, Latremouille S, Mir I, Sánchez PJ, Sant'Anna G. A review of the conundrum of mild hypoxic-ischemic encephalopathy: current challenges and moving forward. *Early Hum Dev*. 2018;120:88–94.

A term neonate with suspected HIE has abnormal basal-ganglia and thalamic signal on brain MRI. Which diagnostic value of MRI is illustrated?

A. Defining the location and extent of hypoxic-ischemic injury
B. Proving a congenital metabolic disorder in every case
C. Replacing all neurologic examination
D. Excluding HIE when any deep gray lesion exists
E. Assessing only pulmonary circulation

Original table 122.9 | Nelson printed p. 1066 | PDF p. 1077

Table 122.9 Major Aspects of MRI in Diagnosis of Hypoxic-Ischemic Encephalopathy in the Term Infant

MAJOR CONVENTIONAL MR FINDINGS IN FIRST WEEK

- Cerebral cortical gray-white differentiation lost (on T1W or T2W)
- Cerebral cortical high signal (T1W and FLAIR), especially in parasagittal peri-rolandic cortex
- Basal ganglia/thalamus, high signal (T1W and FLAIR), usually associated with the cerebral cortical changes but possibly alone with increased signal in brainstem tegmentum in cases of acute severe insult
- Parasagittal cerebral cortex, subcortical white matter, high signal (T1W and FLAIR)
- Periventricular white matter, decreased signal (T1W) or increased signal (T2W)
- Posterior limb of internal capsule, decreased signal (T1W or FLAIR)
- Cerebrum in a vascular distribution, decreased signal (T1W), but much better visualized as decreased diffusion (increased signal) on diffusion-weighted MRI
- **Diffusion-weighted MRI** more sensitive than conventional sequences in MRI, especially in first days after birth, when former shows decreased diffusion (increased signal) in injured areas

FLAIR, Fluid-attenuated inversion recovery; T1W and T2W, T1 weighted and T2 weighted images.

From Volpe JJ, ed. *Neurology of the Newborn*, 5th ed. Philadelphia: Elsevier; 2008:

An asphyxiated term infant undergoes early EEG evaluation. Why does the table recommend interpreting the tracing together with clinical examination and its evolution?

A. Early severe patterns can improve, and recovery affects prognosis
B. A single EEG pattern guarantees the final outcome
C. EEG has no value after birth
D. Clinical examination is never informative
E. Improvement of background is invariably harmful

Original table 122.10 | Nelson printed p. 1066 | PDF p. 1077

Table 122.10 Value of Electroencephalography in Assessment of Asphyxiated Term Infants

- Detection of severe abnormalities (i.e., CLV, FT, BSP) in first hours of life has a positive predictive value of an unfavorable outcome of 80–90%.
- Severe abnormalities may improve within 24 hr (~50% of BSP and 10% of CLV/FT).
- Rapid recovery of severe abnormalities is associated with a favorable outcome in 60% of cases.
- The *combination* of early neonatal neurologic examination and early aEEG enhances the positive predictive value and specificity.

aEEG, Amplitude integrated encephalography; BSP, burst suppression pattern; CLV, continuous low voltage; FT, flat trace.

From Inder TE, Volpe JJ. Hypoxic-ischemic injury in the term infant: clinical-neurological

A term infant with HIE has an EEG background that normalizes by day 7. Which prognostic association is listed?

A. More favorable outcome
B. Unfavorable outcome by definition
C. A diagnosis of congenital deafness
D. An obligatory brain hemorrhage
E. No association with recovery

Original table 122.11 | Nelson printed p. 1067 | PDF p. 1078

Table 122.11 Electroencephalographic Patterns of Prognostic Significance in Asphyxiated Term Infants*

ASSOCIATED WITH FAVORABLE OUTCOME
Mild depression (or less) on day 1
Normal background by day 7
ASSOCIATED WITH UNFAVORABLE OUTCOME
Predominant interburst interval >20 sec on any day
Burst suppression pattern on any day
Isoelectric tracing on any day
Mild (or greater) depression after day 12

*Associations with favorable or unfavorable outcome are generally ≥90%, but the clinical context must be considered.

From Inder TE, Volpe JJ. Hypoxic-ischemic injury in the term infant: clinical-neurological

A preterm infant develops apnea and bradycardia with new temperature instability. Which category in the apnea differential warrants immediate investigation?

A. Infection such as sepsis or pneumonia
B. Normal developmental language variation
C. Isolated myopia
D. Routine dental eruption
E. Simple familial tall stature

Original table 125.1 | Nelson printed p. 1075 | PDF p. 1086

Table 125.1 Potential Causes of Neonatal Apnea and Bradycardia

Central nervous system	Intraventricular hemorrhage, drugs, seizures, hypoxic injury, herniation, neuromuscular disorders, Leigh syndrome, brainstem infarction or anomalies (e.g., olivopontocerebellar atrophy), transient following general anesthesia, congenital central hypoventilation syndrome
Respiratory	Pneumonia, obstructive airway lesions, upper airway collapse, atelectasis, extreme prematurity, laryngeal reflex, phrenic nerve paralysis, pneumothorax, paradoxical response to hypoxia
Infectious	Sepsis, meningitis (bacterial, fungal, viral), respiratory syncytial virus, pertussis
Gastrointestinal	Oral feeding, bowel movement, necrotizing enterocolitis, intestinal perforation
Metabolic	↓ Glucose, ↓ calcium, ↓/↑ sodium, ↑ ammonia, ↑ organic acids, ↑ ambient temperature, hypothermia
Cardiovascular	Hypotension, hypertension, heart failure, anemia, hypovolemia, vagal tone
Other	Immaturity of respiratory center (prematurity); sleep state; sudden unexpected postnatal collapse

A term neonate with meconium aspiration has hypoxemia and elevated pulmonary vascular resistance. Which PPHN mechanism in the table is most consistent?

A. Maladaptation with reactive pulmonary vasoconstriction
B. Only a fixed congenital absence of all pulmonary vessels
C. An isolated renal tubular defect
D. A normal fall in resistance after birth
E. A primary intestinal obstruction

Original table 130.1 | Nelson printed p. 1092 | PDF p. 1103

Table 130.1 Etiology of Persistent Pulmonary Hypertension of the Newborn in Neonates

Maladaptation of pulmonary vasculature (abnormal, "reactive" pulmonary vasoconstriction)

- Parenchymal lung diseases, such as meconium aspiration syndrome (MAS), respiratory distress syndrome (RDS), and pneumonia
- In response to systemic disorders, such as hypothermia, sepsis, fetal hypoxia/distress, hypercapnia, acidosis, and hyperviscosity
- Toxic/pharmacologic exposure in utero (maternal selective serotonin reuptake inhibitor (SSRI) use)

Maldevelopment of pulmonary vasculature (remodeling of pulmonary vasculature)

- In utero closure of ductus arteriosus (maternal cyclooxygenase inhibitor use)
- Sustained pulmonary over circulation in congenital heart disease with large left-to-right shunts
- Intrauterine growth restriction
- Genetic/chromosomal anomalies (trisomy 21, alveolar-capillary dysplasia, surfactant protein deficiency)

Underdevelopment of pulmonary vasculature (hypoplastic pulmonary vessels; ↓ cross-sectional area)

- Congenital diaphragmatic hernia
- Pulmonary hypoplasia (premature prolonged rupture of membranes, oligohydramnios and anhydramnios, space-occupying lesions in the chest).

From Sharma M, Callan E, Konduri GG. Pulmonary vasodilator therapy in persistent pulmonary hypertension of the newborn. *Clin Perinatol*. 2022;49:103–105. Box 1.

A preterm infant develops feeding intolerance, abdominal distension, bloody stool, and new apnea. Which condition is supported by the combined gastrointestinal and systemic signs in the table?

A. Necrotizing enterocolitis
B. Uncomplicated physiologic reflux
C. Isolated congenital cataract
D. Primary bronchiolitis alone
E. Normal feeding transition

Original table 136.1 | Nelson printed p. 1104 | PDF p. 1116

Table 136.1 Signs and Symptoms Associated with Necrotizing Enterocolitis

GASTROINTESTINAL	SYSTEMIC
Abdominal distention	Lethargy
Abdominal tenderness	Apnea/respiratory distress
Feeding intolerance	Temperature instability
Delayed gastric emptying	Acidosis (metabolic and/or respiratory)
Emesis	Glucose instability
Occult/gross blood in stool	Poor perfusion/shock
Change in stool pattern/diarrhea	Thrombocytopenia
Abdominal mass	Disseminated intravascular coagulopathy
Erythema of abdominal wall	

From Kanto WP Jr, Hunter JE, Stoll BJ. Recognition and medical management of necrotizing enterocolitis. *Clin Perinatol*. 1994;21:335–346.

Answer key and teaching notes

001. B | Table 42.1 | printed p. 278, PDF p. 323

Why: A pattern of angry/irritable and defiant behavior for at least 6 months involving someone other than a sibling supports ODD.
Closest distractor: Conduct disorder requires more serious violations of rights or societal norms.

002. A | Table 42.2 | printed p. 278, PDF p. 323

Why: Disproportionate, impulsive, nonpremeditated aggressive outbursts fit intermittent explosive disorder.
Closest distractor: Conduct disorder is a persistent pattern violating the rights of others, potentially including planned behavior.

003. C | Table 42.3 | printed p. 279, PDF p. 324

Why: Aggression, cruelty, and confrontational stealing are among the major violations listed under conduct disorder.
Closest distractor: ODD comprises defiance and irritability without this pattern of major rights violations.

004. C | Table 47.1 | printed p. 285, PDF p. 331

Why: Brief psychotic disorder lasts at least 1 day but less than 1 month, followed by full return to baseline.
Closest distractor: Schizophreniform disorder requires an episode lasting at least 1 month.

005. B | Table 47.2 | printed p. 286, PDF p. 332

Why: Schizophreniform disorder has psychotic features lasting at least 1 month but less than 6 months.
Closest distractor: Schizophrenia requires continuous signs of illness for at least 6 months.

006. C | Table 47.3 | printed p. 286, PDF p. 332

Why: The table requires characteristic active psychotic symptoms, functional decline, and continuous disturbance for at least 6 months.
Closest distractor: Schizophreniform disorder is limited to an illness lasting under 6 months.

007. A | Table 47.4 | printed p. 287, PDF p. 333

Why: The table lists autoimmune disorders including NMDA receptor encephalitis among secondary causes of psychosis.
Closest distractor: Academic stress alone does not explain new seizures with rapidly progressive psychosis.

008. B | Table 47.5 | printed p. 288, PDF p. 334

Why: Acute onset, fever, dyskinesias, and fluctuating consciousness are red flags for secondary psychosis.
Closest distractor: Primary psychosis alone does not readily explain fluctuating consciousness with new neurologic signs.

009. A | Table 47.6 | printed p. 288, PDF p. 334

Why: Rapidly progressive psychosis accompanied by unexplained seizures or movement disorder meets features raising possible autoimmune psychosis.
Closest distractor: A tic disorder cannot account for rapidly progressive psychosis and new seizures.

010. C | Table 47.7 | printed p. 291, PDF p. 337

Why: The table requires a temporal relation to exposure and a substance/medication capable of causing the psychotic symptoms.
Closest distractor: Schizophrenia is less fitting when onset tracks a causative medication exposure.

011. A | Table 47.8 | printed p. 291, PDF p. 337

Why: The criteria require prominent delusions or hallucinations with direct evidence of a medical pathophysiologic cause and exclusion of delirium.
Closest distractor: Delirium has a disturbance of attention and awareness, absent in this vignette.

012. B | Table 47.9 | printed p. 292, PDF p. 338

Why: Stupor, staring, mutism, and maintained posture are clinical signs of catatonia in the table.
Closest distractor: Selective mutism concerns speech in particular social settings and does not explain stupor and posturing.

013. A | Table 47.10 | printed p. 292, PDF p. 338

Why: Autoimmune and infectious encephalitis and epilepsy are among neurologic conditions associated with catatonia.
Closest distractor: Seasonal allergic rhinitis alone does not explain the new neurologic findings.

014. B | Table 47.11 | printed p. 292, PDF p. 338

Why: The criteria call for at least three characteristic catatonic signs; the stem names stupor, mutism, and waxy flexibility.
Closest distractor: A single isolated motor sign does not meet the three-sign criterion.

015. B | Table 47.12 | printed p. 293, PDF p. 339

Why: The examination instructions say to rate an uncertain finding as zero and score only clearly present signs.
Closest distractor: Assigning maximum points to uncertain signs would inflate the screening result.

016. B | Table 48.1 | printed p. 295, PDF p. 341

Why: Delirium combines acute fluctuating disturbances in attention and awareness with an additional cognitive disturbance.
Closest distractor: Primary schizophrenia usually does not present with this acute waxing and waning attentional disturbance.

017. B | Table 48.2 | printed p. 295, PDF p. 341

Why: Hypoactive delirium involves decreased psychomotor activity, lethargy, sluggishness, and confusion.
Closest distractor: Hyperactive delirium more typically includes agitation and increased activity.

Answer key and teaching notes (continued)

018. A | Table 48.3 | printed p. 297, PDF p. 343

Why: The table includes prolonged or excessive sedation and medication-related toxic effects as delirium contributors.
Closest distractor: A developmental learning difficulty does not explain sudden ICU inattention.

019. A | Table 48.4 | printed p. 297, PDF p. 343

Why: Fluctuating attention and acute onset with visual perceptual disturbances are characteristic of delirium in the table.
Closest distractor: Primary psychosis tends to have more sustained attention and a less acutely fluctuating course.

020. B | Table 48.5 | printed p. 298, PDF p. 344

Why: Environmental modification includes a visible clock/calendar, daytime-consistent lighting, and caregiver reorientation.
Closest distractor: Bright overnight lighting disrupts day-night cues and is the opposite of the listed approach.

021. B | Table 49.1 | printed p. 302, PDF p. 348

Why: Working-memory difficulty is illustrated by completing only part of a multistep instruction.
Closest distractor: Initiation impairment mainly affects beginning a task independently.

022. A | Table 49.2 | printed p. 304, PDF p. 350

Why: Phonologic processing is listed under language functions relevant to reading difficulties.
Closest distractor: Gross motor endurance is not among the proposed cognitive pathways for reading disability in this table.

023. A | Table 49.3 | printed p. 308, PDF p. 354

Why: The working-memory row recommends repeating concise instructions and providing concrete references.
Closest distractor: Longer uncued directions raise the memory load and do not implement the listed strategy.

024. A | Table 50.1 | printed p. 310, PDF p. 357

Why: The DSM-5 ADHD table requires several symptoms present before age 12 and interference in more than one setting.
Closest distractor: A single isolated symptom does not satisfy the persistent multi-symptom criteria.

025. A | Table 50.2 | printed p. 311, PDF p. 358

Why: The DSM-5 column allows either symptom domain, whereas the ICD-10 HKD column requires inattentive, hyperactive, and impulsive criteria.
Closest distractor: The ICD-10 criteria include substantial inattention requirements rather than excluding them.

026. A | Table 50.3 | printed p. 313, PDF p. 360

Why: A sleep disorder, including obstructive sleep apnea, is listed in the ADHD differential and fits snoring with daytime impairment.
Closest distractor: Eczema does not explain habitual snoring with sleepiness.

027. A | Table 52.2 | printed p. 321, PDF p. 368

Why: Low math performance and teacher concern about taking the next step are listed risk indicators for math-specific learning disability.
Closest distractor: Family history alone is not required and the table says it would not by itself initiate intervention.

028. A | Table 52.3 | printed p. 321, PDF p. 368

Why: Persistent written-expression difficulty despite targeted intervention and documented academic impairment fit the listed criteria.
Closest distractor: A transient variation does not explain persistence despite intervention and objectively low achievement.

029. A | Table 53.1 | printed p. 325, PDF p. 372

Why: Speech refers to the production of spoken sounds; preserved comprehension and sentence structure point away from broad language impairment.
Closest distractor: Receptive language impairment would affect understanding of instructions.

030. C | Table 53.2 | printed p. 326, PDF p. 373

Why: The 7-to-12-month entries include responsiveness to simple words/requests and emerging spoken words.
Closest distractor: The 4-to-6-month band emphasizes babbling and response to sound rather than a first word with comprehension.

031. A | Table 53.3 | printed p. 330, PDF p. 377

Why: Language disorder involves persistent deficits in language comprehension or production across modalities.
Closest distractor: Speech sound disorder chiefly affects articulation and intelligibility rather than comprehension.

032. B | Table 53.4 | printed p. 333, PDF p. 380

Why: The terminology table equates childhood-onset fluency disorder with stuttering.
Closest distractor: Selective mutism is context-specific inability to speak despite speech ability, not disrupted fluency.

033. A | Table 53.5 | printed p. 333, PDF p. 380

Why: Persistent repetitions, prolongations, and blocks that impair communication are characteristic of childhood-onset fluency disorder.
Closest distractor: A language disorder primarily affects vocabulary or grammar rather than the time pattern of speech.

034. A | Table 54.1 | printed p. 337, PDF p. 384

Why: An eye-gaze picture board is listed among low-technology aided augmentative communication options.
Closest distractor: Unaided sign language requires hand movements and is a different category.

Answer key and teaching notes (continued)

035. A | Table 55.1 | printed p. 340, PDF p. 387

Why: The table cautions that a passed newborn screen does not rule out subsequent or missed hearing loss, so new concerns warrant evaluation.
Closest distractor: Dismissal after a past screening pass may delay identification of hearing loss.

036. A | Table 55.2 | printed p. 341, PDF p. 388

Why: American Sign Language is a distinct natural language with its own linguistic structure.
Closest distractor: An oral-only approach does not provide the requested natural visual language.

037. A | Table 55.5 | printed p. 345, PDF p. 392

Why: The table emphasizes actively listening to family concerns and keeping families central to decisions.
Closest distractor: Selecting a method before hearing family goals contradicts family-centered planning.

038. A | Table 56.3 | printed p. 348, PDF p. 395

Why: The table lists a diet restricted in phenylalanine for phenylketonuria.
Closest distractor: An unrestricted high-protein diet would increase phenylalanine exposure.

039. C | Table 56.6 | printed p. 352, PDF p. 399

Why: The table lists language delay among typical concerns in toddlerhood at 2-3 years.
Closest distractor: The newborn period more commonly raises concern through dysmorphism or major organ dysfunction.

040. A | Table 56.7 | printed p. 354, PDF p. 401

Why: The evaluation table emphasizes prenatal/perinatal history, developmental attainments, and a three-generation pedigree.
Closest distractor: A school report alone misses medical, family, and examination clues.

041. A | Table 56.8 | printed p. 355, PDF p. 402

Why: The first tier includes plasma amino acids along with other blood and urine metabolic screens.
Closest distractor: Serum troponin is not a broad screen for treatable inborn errors of metabolism.

042. A | Table 56.9 | printed p. 356, PDF p. 403

Why: Gastrointestinal issues including constipation and reflux are listed as co-occurring medical conditions.
Closest distractor: Dental eruption alone would not account for persistent gastrointestinal symptoms.

043. A | Table 56.11 | printed p. 360, PDF p. 407

Why: Mild intellectual disability is paired with intermittent support and relatively independent everyday skills.
Closest distractor: Pervasive support is associated with much more substantial adaptive limitations.

044. A | Table 57.1 | printed p. 362, PDF p. 409

Why: Holoprosencephaly, clefting, and scalp defects are characteristic findings in the trisomy 13 column.
Closest distractor: Trisomy 18 has a different pattern including clenched hands and prominent occiput.

045. A | Table 57.2 | printed p. 363, PDF p. 410

Why: The trisomy 8 row describes common mosaicism and characteristic deep palmar and plantar creases.
Closest distractor: Trisomy 21 has a different constellation and does not specifically match the deep furrows in this table.

046. A | Table 57.3 | printed p. 366, PDF p. 413

Why: Neonatal hypotonia, flat facies, upslanting palpebral fissures, and a reduced Moro reflex are listed features of trisomy 21.
Closest distractor: Trisomy 13 more often has severe midline abnormalities such as holoprosencephaly.

047. A | Table 57.6 | printed p. 370, PDF p. 417

Why: The table identifies speech intelligibility as a common speech-and-language concern in trisomy 21.
Closest distractor: Cardiac anatomy does not account for reduced intelligibility as a developmental domain.

048. A | Table 58.1 | printed p. 374, PDF p. 421

Why: Both social-communication deficits and restricted/repetitive behavior patterns are required core ASD domains.
Closest distractor: An isolated speech sound disorder does not encompass both domains.

049. A | Table 58.2 | printed p. 374, PDF p. 421

Why: The table lists atypical language and motor findings as associated ASD features beyond the core DSM-5 criteria.
Closest distractor: Their presence does not by itself establish a separate psychotic disorder.

050. A | Table 58.3 | printed p. 375, PDF p. 422

Why: Loss of speech and deficits in nonverbal social communication are warning signs meriting prompt assessment.
Closest distractor: Waiting years after regression would delay evaluation and early support.

051. A | Table 58.4 | printed p. 376, PDF p. 423

Why: The table defines severity levels by support needed in both social communication and restricted/repetitive behavior domains.
Closest distractor: IQ alone does not define the table's support-based severity categories.

Answer key and teaching notes (continued)

052. A | Table 58.6 | printed p. 378, PDF p. 425

Why: The syndromic table associates Phelan-McDermid syndrome with SHANK3 and autistic-like behaviors.
Closest distractor: Turner syndrome is not the SHANK3-associated disorder.

053. A | Table 58.7 | printed p. 378, PDF p. 425

Why: Biotinidase deficiency appears among inborn errors of metabolism associated with autism-like behavior.
Closest distractor: Familial tall stature is not an inborn metabolic explanation for seizures with developmental symptoms.

054. A | Table 58.8 | printed p. 380, PDF p. 427

Why: The table lists chromosomal microarray in all individuals as part of genetic evaluation.
Closest distractor: Lead testing is targeted to children with pica in this table.

055. A | Table 58.10 | printed p. 382, PDF p. 429

Why: The stimulant row recommends monitoring height, weight, blood pressure, and heart rate.
Closest distractor: A chest radiograph is not listed as routine stimulant monitoring.

056. A | Table 59.2 | printed p. 384, PDF p. 431

Why: An FMR1 allele with more than 200 CGG repeats is categorized as a full mutation, typically associated with methylation and silencing.
Closest distractor: A premutation has fewer repeats and different genetic consequences.

057. A | Table 59.3 | printed p. 385, PDF p. 432

Why: The full-mutation row includes infant hypotonia and early-childhood developmental and behavioral features.
Closest distractor: The presentation is not restricted to asymptomatic adulthood.

058. A | Table 60.2 | printed p. 388, PDF p. 435

Why: The table lists fat as 30-40% of energy at ages 1-3 and 25-35% at ages 4-18.
Closest distractor: The carbohydrate range is the same in both age bands in the table.

059. A | Table 61.1 | printed p. 409, PDF p. 456

Why: Secretory IgA is among beneficial immunologic components of human milk.
Closest distractor: Human milk is not compositionally identical to cow milk and contains immune factors.

060. A | Table 61.2 | printed p. 410, PDF p. 457

Why: The table distinguishes temporary or relative precautions for maternal active untreated tuberculosis from permanent milk contraindications.
Closest distractor: A permanent prohibition on all expressed human milk is not the blanket rule in the table.

061. A | Table 61.3 | printed p. 410, PDF p. 457

Why: Necrotizing enterocolitis is listed among infant conditions for which human milk may confer protection.
Closest distractor: Malrotation is an anatomic abnormality and is not the table's listed protective association.

062. A | Table 61.5 | printed p. 411, PDF p. 458

Why: The recommendations call for about 6 months of exclusive breastfeeding and introduction of iron- and zinc-rich complementary foods around 6 months.
Closest distractor: Starting solids does not require stopping breastfeeding.

063. A | Table 61.6 | printed p. 411, PDF p. 458

Why: Lactogenesis with rising milk production is listed during days 2-4.
Closest distractor: Low initial volume alone does not establish lactation failure.

064. A | Table 61.7 | printed p. 413, PDF p. 460

Why: The table emphasizes iron-containing foods such as meat or iron-fortified cereal at weaning.
Closest distractor: Dilute juice does not meet the highlighted iron need.

065. B | Table 61.8 | printed p. 414, PDF p. 461

Why: Spoon feeding and beginning finger feeding with upright posture appear in the 6-9-month stage.
Closest distractor: The birth-to-4-month stage centers on breast or bottle nipple feeding.

066. A | Table 61.9 | printed p. 415, PDF p. 462

Why: The table provides objective, family-friendly language relating BMI to height and weight.
Closest distractor: Shaming is not part of the suggested family communication.

067. A | Table 61.12 | printed p. 417, PDF p. 464

Why: Responsive feeding assigns caregivers healthy options and a meal routine while the child determines intake.
Closest distractor: Insisting on finishing a fixed portion overrides the child's fullness cues.

Answer key and teaching notes (continued)

068. A | Table 62.2 | printed p. 423, PDF p. 470

Why: WHO severe wasting is weight-for-height below -3 SD in the table.
Closest distractor: Moderate wasting lies between -2 and -3 SD.

069. A | Table 62.6 | printed p. 426, PDF p. 473

Why: The table labels a moon face as a feature of kwashiorkor.
Closest distractor: Marasmus is associated with a thin, simian facial appearance.

070. A | Table 62.7 | printed p. 428, PDF p. 475

Why: In a malnourished child, lethargy or unconsciousness and cold hands plus weak rapid pulse meet the table's shock pattern.
Closest distractor: Stable malnutrition does not account for impaired perfusion and lethargy.

071. A | Table 62.8 | printed p. 429, PDF p. 476

Why: The stabilization table notes hypoglycemia and hypothermia often coexist and are signs of severe infection.
Closest distractor: A normal sleep cycle does not explain both acute abnormalities.

072. A | Table 63.1 | printed p. 432, PDF p. 479

Why: Hypophosphatemia during refeeding can impair diaphragmatic contractility and cause respiratory failure.
Closest distractor: Primary asthma does not explain a new phosphate fall temporally linked to feeding.

073. A | Table 64.1 | printed p. 433, PDF p. 480

Why: A weight-for-length z score at or below -3 is in the severe category.
Closest distractor: Moderate malnutrition uses values from -2.0 through -2.99.

074. A | Table 64.2 | printed p. 434, PDF p. 481

Why: Sensory-based restriction causing nutritional deficiency or growth faltering without weight-shape concerns meets the ARFID pattern.
Closest distractor: Anorexia nervosa involves weight or shape concerns absent here.

075. A | Table 64.3 | printed p. 435, PDF p. 482

Why: The table lists poor mealtime structure and intrusive or permissive feeding among psychosocial causes of inadequate intake.
Closest distractor: Cardiac procedures do not follow from the provided feeding-history clues.

076. A | Table 64.4 | printed p. 436, PDF p. 483

Why: Semi-elemental peptide products are described for malabsorption and contain MCT.
Closest distractor: Standard formula is not the table's specially designated peptide category.

077. A | Table 64.5 | printed p. 437, PDF p. 484

Why: The table lists cornstarch as a carbohydrate that can be added to address hypoglycemia in glycogen storage disease.
Closest distractor: A nonnutritive sweetener does not provide glucose calories for this purpose.

078. A | Table 65.2 | printed p. 444, PDF p. 491

Why: The table includes sleep-related breathing problems among obesity-associated comorbidities.
Closest distractor: An acute appendicitis diagnosis does not explain chronic snoring and sleepiness.

079. A | Table 65.3 | printed p. 445, PDF p. 492

Why: Olanzapine is listed among medications associated with obesity.
Closest distractor: Amoxicillin is not included among the table's weight-gain-associated agents.

080. A | Table 65.9 | printed p. 450, PDF p. 497

Why: The table advises against using food rewards and supports modeled healthy eating with repeated food exposure.
Closest distractor: Punishment creates an adverse emotional atmosphere and contradicts the table.

081. A | Table 66.1 | printed p. 453, PDF p. 500

Why: Vitamin A is necessary for vision and its deficiency causes ocular changes including night blindness.
Closest distractor: Vitamin C deficiency principally affects connective tissue and gums rather than this visual pattern.

082. A | Table 67.3 | printed p. 459, PDF p. 506

Why: The table describes recurrent encephalopathy with dystonia and other neurologic signs under SLC19A3 defects.
Closest distractor: FMR1 is associated with fragile X syndrome, not this thiamine-responsive encephalopathy pattern.

083. A | Table 69.2 | printed p. 3, PDF p. 518

Why: Malabsorption is listed among causes of secondary vitamin D deficiency leading to rickets.
Closest distractor: A traumatic injury does not explain diffuse rickets from malabsorption.

084. A | Table 69.3 | printed p. 3, PDF p. 518

Why: The clinical features table names costochondral enlargement the rachitic rosary.
Closest distractor: Pectus carinatum describes a different chest-wall shape rather than enlarged junctions.

Answer key and teaching notes (continued)

085. A | Table 69.5 | printed p. 474, PDF p. 521

Why: The table highlights infant vitamin D deficiency risk from limited exposure and insufficient intake/supplementation.
Closest distractor: Excess vitamin D would not be the deficiency risk in this vignette.

086. A | Table 73.1 | printed p. 489, PDF p. 536

Why: Improperly mixed concentrated formula is listed under excessive sodium causes of hypernatremia.
Closest distractor: Central diabetes insipidus causes water deficit and is a different table category.

087. A | Table 73.2 | printed p. 492, PDF p. 539

Why: Hyperglycemia is listed as a cause of hyperosmolality-associated hyponatremia.
Closest distractor: Pseudohyponatremia due to hyperproteinemia does not account for the elevated serum osmolality here.

088. A | Table 73.3 | printed p. 492, PDF p. 539

Why: Low serum osmolality/sodium, non-dilute urine, urinary sodium excretion, and exclusion of other causes support SIADH.
Closest distractor: Diabetes insipidus causes impaired urinary concentration and commonly hypernatremia.

089. A | Table 73.4 | printed p. 496, PDF p. 543

Why: The table explicitly lists potassium-sparing diuretics among medication causes of decreased potassium excretion.
Closest distractor: Loop diuretics generally increase potassium excretion.

090. A | Table 73.5 | printed p. 499, PDF p. 546

Why: Vomiting is a listed contributor to hypokalemia through gastrointestinal and secondary renal mechanisms.
Closest distractor: Potassium-sparing medication typically favors hyperkalemia.

091. A | Table 73.7 | printed p. 503, PDF p. 550

Why: Cisplatin is listed among medication causes of renal magnesium losses.
Closest distractor: Excess magnesium intake would increase rather than lower serum magnesium.

092. A | Table 73.9 | printed p. 506, PDF p. 553

Why: Refeeding is listed under transcellular shifts causing hypophosphatemia.
Closest distractor: Decreased kidney excretion more commonly produces hyperphosphatemia.

093. A | Table 73.10 | printed p. 508, PDF p. 555

Why: Tumor lysis syndrome is listed as a transcellular-release cause of hyperphosphatemia.
Closest distractor: Phosphate binders decrease phosphate absorption rather than causing release from tumor cells.

094. B | Table 73.11 | printed p. 513, PDF p. 560

Why: Winter compensation gives 1.5 x 12 + 8 = 26 mm Hg, with about 2 mm Hg variation.
Closest distractor: A $PaCO_2$ near 40 mm Hg is too high and would imply an additional respiratory-acidosis component.

095. A | Table 73.13 | printed p. 515, PDF p. 562

Why: Diarrhea is listed among normal-anion-gap causes of metabolic acidosis.
Closest distractor: Lactic acidosis due to shock generally elevates the anion gap.

096. A | Table 73.14 | printed p. 518, PDF p. 565

Why: Gastric loss from vomiting with low urinary chloride is characteristic chloride-responsive metabolic alkalosis.
Closest distractor: Mineralocorticoid excess is generally in the high-urine-chloride resistant category.

097. A | Table 73.15 | printed p. 522, PDF p. 569

Why: Narcotic exposure is listed among causes of CNS depression and hypoventilation with respiratory acidosis.
Closest distractor: Increased ventilation lowers $PaCO_2$ and would not fit this presentation.

098. A | Table 73.16 | printed p. 524, PDF p. 571

Why: Pneumonia appears in the table under both hypoxemia and lung-receptor stimulation causes of respiratory alkalosis.
Closest distractor: Hypoventilation from opioids tends toward respiratory acidosis.

099. A | Table 74.1 | printed p. 525, PDF p. 572

Why: Maintenance fluids are intended to prevent dehydration, electrolyte disorders, ketoacidosis, and protein degradation.
Closest distractor: Resuscitating active hemorrhage is a distinct treatment objective.

100. C | Table 74.2 | printed p. 526, PDF p. 573

Why: For 11-20 kg, the table gives 1,000 mL plus 50 mL for each kilogram above 10: 1,250 mL/day at 15 kg.
Closest distractor: 1,500 mL is the amount at 20 kg, not 15 kg.

101. D | Table 74.3 | printed p. 526, PDF p. 573

Why: Above 20 kg, the table gives 60 + 1 mL/kg/hr for each kg over 20, or 65 mL/hr.
Closest distractor: 60 mL/hr is the starting rate at 20 kg.

Answer key and teaching notes (continued)

102. D | Table 74.4 | printed p. 527, PDF p. 574

Why: The intravenous-fluid composition table lists 154 mEq/L sodium for 0.9% saline.
Closest distractor: 130 mEq/L is the listed sodium concentration for lactated Ringer solution.

103. A | Table 74.5 | printed p. 527, PDF p. 574

Why: Urine contributes approximately 60% of typical water losses in the table.
Closest distractor: Insensible losses are important but contribute around 35%, less than urine.

104. A | Table 74.6 | printed p. 528, PDF p. 575

Why: Radiant warmers and phototherapy are listed as factors increasing water needs through skin losses.
Closest distractor: They do not eliminate insensible water loss.

105. A | Table 74.7 | printed p. 528, PDF p. 575

Why: The table recommends replacing measured ongoing stool losses mL for mL, with attention to electrolytes.
Closest distractor: Maintenance fluid alone does not automatically cover continuing losses.

106. A | Table 74.8 | printed p. 528, PDF p. 575

Why: The table lists gastric fluid as chloride-rich, with approximately 90 mEq/L chloride.
Closest distractor: Bicarbonate is not the dominant listed gastric ion.

107. A | Table 74.9 | printed p. 528, PDF p. 575

Why: For polyuria, the table recommends measuring urine electrolytes and replacing urine volume with a solution informed by its composition.
Closest distractor: Assuming urine is electrolyte-free could misdirect replacement.

108. A | Table 75.1 | printed p. 529, PDF p. 576

Why: The table lists tachycardia, scant urine, dry mucosa, reduced tears, and delayed refill among moderate-dehydration findings.
Closest distractor: An absence of dehydration would not fit multiple perfusion and fluid-deficit signs.

109. A | Table 75.2 | printed p. 530, PDF p. 577

Why: The table starts with restoration of intravascular volume using isotonic fluid.
Closest distractor: Calculating a 24-hour plan follows initial stabilization.

110. A | Table 75.3 | printed p. 530, PDF p. 577

Why: The table recommends tracking vital signs, intake/output, urine output, weight, clinical signs, and electrolytes.
Closest distractor: One admission temperature cannot reveal response to fluid therapy.

111. A | Table 78.1 | printed p. 549, PDF p. 596

Why: Cardiac arrest is a level 1 immediate-resuscitation example in the table.
Closest distractor: Level 2 is urgent but does not describe active cardiac arrest.

112. A | Table 78.2 | printed p. 550, PDF p. 597

Why: Tripod positioning with drooling and respiratory distress is listed as a red flag for emergency intervention.
Closest distractor: Delaying assessment risks worsening airway obstruction.

113. A | Table 79.1 | printed p. 555, PDF p. 602

Why: The listed adolescent heart-rate range is approximately 60-100/min.
Closest distractor: A rate of 80/min is not below the listed adolescent minimum.

114. B | Table 79.2 | printed p. 555, PDF p. 602

Why: V denotes response only to verbal stimulation such as being called.
Closest distractor: Alert means spontaneously awake and appropriately responsive.

115. A | Table 79.3 | printed p. 555, PDF p. 602

Why: Spontaneous eye opening earns 4, and age-appropriate babbling/cooing in a child under 2 earns verbal 5.
Closest distractor: Eye opening only to pressure would earn 2, unlike spontaneous opening.

116. A | Table 79.4 | printed p. 556, PDF p. 603

Why: Bilateral miosis is listed with opiate exposure.
Closest distractor: Anticholinergic exposure generally causes dilated pupils.

117. A | Table 79.6 | printed p. 567, PDF p. 614

Why: Hemorrhage is listed as a setting for hypovolemia, one of the reversible causes of arrest.
Closest distractor: Chronic language delay does not explain the acute circulatory collapse.

118. A | Table 80.2 | printed p. 574, PDF p. 621

Why: Hyperresonance, reduced ipsilateral breath sounds, contralateral tracheal deviation, and venous distension support tension pneumothorax.
Closest distractor: Massive hemothorax more commonly produces dull percussion.

Answer key and teaching notes (continued)

119. A | Table 80.3 | printed p. 574, PDF p. 621

Why: A one-way pleural air leak with collapse and reduced venous return defines tension pneumothorax in the table.
Closest distractor: Pulmonary contusion does not arise from a one-way pleural valve effect.

120. A | Table 80.4 | printed p. 575, PDF p. 622

Why: The table shows increased heart rate and thready peripheral pulses with a still-normal systolic pressure during earlier blood loss.
Closest distractor: Waiting for hypotension could miss a child compensating for hemorrhage.

121. A | Table 80.5 | printed p. 576, PDF p. 623

Why: Midline cervical tenderness is one of the NEXUS findings that preclude very-low-risk classification.
Closest distractor: Normal alertness is reassuring and is not itself a positive NEXUS risk finding.

122. A | Table 80.6 | printed p. 577, PDF p. 624

Why: A massive continuing air leak suggesting tracheobronchial injury is listed among urgent thoracotomy indications.
Closest distractor: Outpatient observation would not address inability to expand and ventilate the lung.

123. A | Table 80.7 | printed p. 578, PDF p. 625

Why: A palpable skull fracture is one of the exclusion findings from the very-low-risk group for children under 2.
Closest distractor: The rule explicitly considers a palpable fracture in this age group.

124. A | Table 80.8 | printed p. 578, PDF p. 625

Why: Evidence of abdominal-wall trauma or a seatbelt sign removes a child from the table's very-low-risk group.
Closest distractor: A visible seatbelt sign is not a reassuring exclusion of internal injury.

125. A | Table 81.1 | printed p. 579, PDF p. 626

Why: Trisomy 21 is listed among conditions predisposing to cervical spine injury via abnormal development.
Closest distractor: Lumbar spondylosis is not the relevant listed cervical risk factor.

126. A | Table 81.2 | printed p. 580, PDF p. 627

Why: Persistent neck pain and focal sensory symptoms are factors precluding purely clinical C-spine clearance.
Closest distractor: Being able to talk does not negate the listed risk factors.

127. A | Table 81.3 | printed p. 581, PDF p. 628

Why: Sharp or aching pain radiating distally from the neck in a root pattern favors radiculopathy.
Closest distractor: Myelopathy more often has cord signs rather than isolated root-distribution radiating pain.

128. A | Table 82.1 | printed p. 583, PDF p. 630

Why: The Glasgow Coma Scale separately scores eye opening, verbal output, and best motor response.
Closest distractor: APGAR assesses newborn adaptation, not this three-domain coma examination.

129. A | Table 83.1 | printed p. 2, PDF p. 638

Why: The neurologic-examination table includes coma assessment along with brainstem reflex examinations.
Closest distractor: Prior school grades are not a component of the formal neurologic examination.

130. A | Table 83.2 | printed p. 2, PDF p. 638

Why: The ancillary-test table distinguishes modalities by confounders and limitations; the appropriate test depends on accepted practice and the specific clinical obstacle.
Closest distractor: A normal structural CT is not equivalent to a validated ancillary assessment.

131. A | Table 84.1 | printed p. 593, PDF p. 640

Why: Pain and needle phobia are listed triggers for reflex vasodepressor or vasovagal syncope.
Closest distractor: Ventricular tachycardia is a cardiac cause and is not explained by the classic needle-triggered pattern alone.

132. A | Table 84.2 | printed p. 593, PDF p. 640

Why: Postural and heat triggers, pallor, diaphoresis, and rapid recovery favor syncope.
Closest distractor: A generalized seizure more often has different triggers and a longer postevent confused period.

133. A | Table 84.3 | printed p. 594, PDF p. 641

Why: A spinning or whirling sensation is the table's description of vertigo.
Closest distractor: Presyncope is a feeling of impending faint rather than movement illusion.

134. A | Table 84.4 | printed p. 594, PDF p. 641

Why: The cardiovascular syncope table lists potentially fatal arrhythmias, including inherited electrical disorders.
Closest distractor: Needle-triggered vasovagal faint is a different pattern from exertional syncope with sudden-death family history.

Answer key and teaching notes (continued)

135. A | Table 84.5 | printed p. 595, PDF p. 642

Why: Jervell-Lange-Nielsen syndrome is described as long-QT syndrome with congenital deafness.
Closest distractor: Romano-Ward long-QT syndrome is not defined by congenital deafness.

136. A | Table 84.6 | printed p. 595, PDF p. 642

Why: The table includes syncope after exertion in a well-trained athlete among neurocardiogenic patterns.
Closest distractor: Exertional timing alone does not prove ventricular tachycardia; concerning features still need evaluation.

137. A | Table 84.7 | printed p. 596, PDF p. 643

Why: Exertional syncope and family history of drowning or sudden death are listed red flags for cardiac disease.
Closest distractor: A benign standing-related vasovagal faint usually has different circumstances and prodrome.

138. A | Table 84.8 | printed p. 596, PDF p. 643

Why: The table recommends education about the diagnosis and recognition or avoidance of prolonged standing and warm environments.
Closest distractor: Bed rest would not be a routine response to common vasovagal syncope.

139. A | Table 84.9 | printed p. 599, PDF p. 646

Why: The midodrine row describes alpha-1 agonism and peripheral vasoconstriction.
Closest distractor: Beta-2 bronchodilation is not its listed therapeutic mechanism.

140. A | Table 85.1 | printed p. 601, PDF p. 648

Why: Fluid depletion from vomiting/diarrhea with vasoconstriction and low preload fits hypovolemic shock.
Closest distractor: Tamponade would require an obstructive cardiac process not suggested by this history.

141. A | Table 85.2 | printed p. 603, PDF p. 650

Why: The Phoenix score uses respiratory, cardiovascular, coagulation, and neurologic organ dysfunction domains.
Closest distractor: GCS evaluates neurologic responsiveness but does not incorporate the other organ dysfunction domains.

142. A | Table 85.3 | printed p. 604, PDF p. 651

Why: The SIRS differential includes noninfectious inflammatory and rheumatologic conditions.
Closest distractor: Age-appropriate speech behavior is not a cause of systemic inflammatory findings.

143. A | Table 85.4 | printed p. 605, PDF p. 652

Why: The table shows declining urine volume and neurologic changes as perfusion worsens.
Closest distractor: Improved perfusion would not usually produce oliguria with confusion.

144. A | Table 85.5 | printed p. 606, PDF p. 653

Why: The table asks which occult infection and co-infection may prime the hyperferritinemic process.
Closest distractor: Assuming a single trivial infection overlooks the table's broader investigation.

145. A | Table 85.6 | printed p. 607, PDF p. 654

Why: The table notes cerebral hypoperfusion symptoms can occur at apparently normal pressures, while oliguria is an additional shock sign.
Closest distractor: A preserved single blood-pressure reading does not exclude poor perfusion.

146. A | Table 85.7 | printed p. 610, PDF p. 657

Why: Norepinephrine is described as a potent vasoconstrictor raising systemic vascular resistance and pressure.
Closest distractor: Albuterol is a bronchodilator rather than the table's vasoconstrictor.

147. A | Table 86.1 | printed p. 612, PDF p. 659

Why: The table associates extrathoracic airway pathology with stridor and pronounced retractions.
Closest distractor: Alveolar disease more often produces crackles or grunting.

148. A | Table 86.2 | printed p. 613, PDF p. 660

Why: Thoracic cage abnormalities such as kyphoscoliosis can compromise the respiratory pump.
Closest distractor: A foreign body is categorized as central airway obstruction rather than cage restriction.

149. A | Table 86.3 | printed p. 613, PDF p. 660

Why: The table lists diabetic ketoacidosis under metabolic causes producing compensatory respiratory drive.
Closest distractor: Primary asthma would usually have airway obstruction signs rather than isolated compensation for acidosis.

150. A | Table 86.4 | printed p. 614, PDF p. 661

Why: The table lists large left-to-right shunts among cardiovascular causes of reduced lung compliance and respiratory distress.
Closest distractor: An airway foreign body is not the hemodynamic shunt mechanism described.

151. A | Table 86.6 | printed p. 615, PDF p. 662

Why: The table associates apneustic breathing with pontine dysfunction.
Closest distractor: Cortical involvement is linked with hyperpnea and tachypnea rather than the apneustic pattern.

Answer key and teaching notes (continued)

152. A | Table 86.7 | printed p. 616, PDF p. 663

Why: PARDS requires acute onset within 7 days of an insult, new pulmonary opacities, and edema not fully explained by cardiac failure or overload.
Closest distractor: Cardiac failure alone would not satisfy the table's origin-of-edema criterion.

153. A | Table 86.9 | printed p. 618, PDF p. 665

Why: The table lists a non-rebreather at approximately 0.7-0.95 FiO2 versus about 0.21-0.4 for nasal cannula.
Closest distractor: Room air delivers approximately 0.21 and does not provide comparable supplemental oxygen.

154. A | Table 86.11 | printed p. 620, PDF p. 667

Why: The table notes ketamine causes bronchodilation during intubation.
Closest distractor: Propofol does not have the table's specifically highlighted bronchodilator property and may lower blood pressure.

155. A | Table 86.12 | printed p. 625, PDF p. 672

Why: In pressure control, delivered volume varies with compliance and resistance while inflation pressure is set.
Closest distractor: Volume control fixes tidal volume, with pressure varying as mechanics change.

156. A | Table 86.13 | printed p. 628, PDF p. 675

Why: The low-compliance ARDS row includes pressure-controlled and other lung-protective ventilatory approaches.
Closest distractor: A spontaneous-only approach cannot be assumed sufficient for severe ARDS.

157. A | Table 87.1 | printed p. 631, PDF p. 677

Why: The Lake Louise score includes headache, gastrointestinal symptoms, and fatigue or weakness.
Closest distractor: GCS measures consciousness and does not combine these altitude-illness complaints.

158. A | Table 87.2 | printed p. 633, PDF p. 679

Why: The altitude-treatment table identifies acetazolamide as a carbonic anhydrase inhibitor.
Closest distractor: Midodrine is an alpha-agonist used for a different indication.

159. A | Table 87.3 | printed p. 634, PDF p. 680

Why: The table lists cardiac defects that increase pulmonary blood flow or pulmonary arterial pressure among HAPE risks.
Closest distractor: The shunt does not eliminate pulmonary circulation or the need for oxygen.

160. A | Table 88.1 | printed p. 645, PDF p. 691

Why: The drowning-prevention table highlights unexpected toddler exposure and lapses in active supervision.
Closest distractor: Schoolwork is unrelated to this immediate water-safety hazard.

161. A | Table 89.1 | printed p. 646, PDF p. 692

Why: The table recommends limiting water-heater temperature to 48.9 C (120 F).
Closest distractor: Leaving hot beverages accessible increases rather than reduces scald risk.

162. A | Table 89.2 | printed p. 647, PDF p. 693

Why: The table lists inhalation injury as a referral indication independent of total body-surface area.
Closest distractor: A small external burn does not rule out major airway injury.

163. A | Table 89.3 | printed p. 647, PDF p. 693

Why: The acute burn-care table includes fluid resuscitation, analgesia, infection prevention, and nutritional support.
Closest distractor: Withholding needed nutrition conflicts with the table's provision of energy requirements.

164. A | Table 89.4 | printed p. 648, PDF p. 694

Why: The first burn phase features capillary leak and shock risk and prioritizes ABC stabilization and careful resuscitation.
Closest distractor: Rehabilitation becomes important later and cannot replace early stabilization.

165. A | Table 89.5 | printed p. 649, PDF p. 695

Why: Dry leathery eschar with absent blanching and reduced sensation fits a full-thickness burn.
Closest distractor: Superficial burns are typically painful and blanch.

166. A | Table 89.7 | printed p. 652, PDF p. 698

Why: The table lists bacitracin as gram-positive topical coverage for wounds expected to heal within 7-10 days.
Closest distractor: Systemic amphotericin is not a routine clear topical ointment for this scenario.

167. A | Table 89.8 | printed p. 655, PDF p. 701

Why: Contractures are listed as long-term skin, soft-tissue, and orthopedic burn complications.
Closest distractor: Acute hypovolemia is an early hemodynamic problem rather than chronic scar-related restriction.

168. A | Table 89.9 | printed p. 656, PDF p. 702

Why: The electrical-injury table includes serious cardiac dysrhythmias even when external injury does not reflect full internal damage.
Closest distractor: A small skin mark does not ensure absence of deep or cardiac injury.

Answer key and teaching notes (continued)

169. A | Table 90.1 | printed p. 658, PDF p. 704

Why: The hypothermia table shows dysarthria, ataxia, apathy, then more severe neurologic and physiologic impairment as temperature falls.
Closest distractor: Normal cognition cannot be assumed as hypothermia progresses.

170. A | Table 90.2 | printed p. 660, PDF p. 706

Why: Grade I frostbite is superficial with erythema and edema but no blistering or necrosis.
Closest distractor: Grade II is associated with blister formation.

171. A | Table 91.2 | printed p. 665, PDF p. 711

Why: The table emphasizes previous anesthetic records, mask ventilation, laryngoscopy, and tube details.
Closest distractor: The medication list alone cannot establish what happened during prior airway management.

172. A | Table 91.3 | printed p. 666, PDF p. 712

Why: Asthma is listed with potentially serious intraoperative bronchospasm, supporting preoperative medical optimization.
Closest distractor: Atrioventricular block is not the table's specific asthma-related implication.

173. A | Table 91.5 | printed p. 667, PDF p. 713

Why: Pierre Robin sequence is included among syndromes with potentially difficult airways.
Closest distractor: Routine easy mask ventilation should not be assumed in this craniofacial condition.

174. A | Table 92.1 | printed p. 676, PDF p. 722

Why: The table calls for medical and airway assessment, pediatric dosing, appropriately sized equipment, and monitoring.
Closest distractor: Adult fixed dosing is not the table's weight-based pediatric approach.

175. A | Table 93.1 | printed p. 678, PDF p. 724

Why: Superficial tissue injury such as burns can produce sharp, localized somatic pain.
Closest distractor: Visceral pain originates from internal organs rather than superficial skin.

176. A | Table 93.2 | printed p. 679, PDF p. 725

Why: The visual analog scale is a self-report tool validated for children generally around 6-8 years and older.
Closest distractor: CRIES is developed for neonatal pain and does not replace an older child's self-report.

177. A | Table 93.3 | printed p. 680, PDF p. 726

Why: The table lists both physiologic and behavioral signs, including tachycardia, grimacing, and clenching, in infants with pain.
Closest distractor: The absence of verbal report does not mean an infant cannot experience pain.

178. A | Table 93.4 | printed p. 680, PDF p. 726

Why: CRIES scores Crying, Required oxygen, Increased vital signs, Expression, and Sleeplessness.
Closest distractor: NEXUS is a cervical-injury screening rule rather than a neonatal pain tool.

179. A | Table 93.5 | printed p. 680, PDF p. 726

Why: The revised FLACC scale supports behavioral pain assessment in children with cognitive impairment, including individualized behaviors.
Closest distractor: A self-report VAS may not be usable when reliable self-report is not possible.

180. A | Table 93.6 | printed p. 681, PDF p. 727

Why: NSAIDs are listed as nonopioid antiinflammatory analgesics.
Closest distractor: Thiazide diuretics do not treat inflammatory pain.

181. A | Table 93.8 | printed p. 684, PDF p. 730

Why: Naloxone is the listed opioid antagonist for clinically significant opioid-induced respiratory depression, along with airway support.
Closest distractor: Flumazenil reverses benzodiazepine effects rather than opioid toxicity.

182. A | Table 93.10 | printed p. 685, PDF p. 731

Why: The renal-failure table marks fentanyl preferred and cautions with morphine because of active metabolite accumulation.
Closest distractor: Morphine metabolites may accumulate in significant renal impairment.

183. A | Table 93.11 | printed p. 686, PDF p. 732

Why: The table advises individualized titration and extra caution in infants or when sedatives are coadministered.
Closest distractor: Fixed adult dosing overlooks pediatric age and drug-interaction risk.

184. A | Table 93.13 | printed p. 688, PDF p. 734

Why: The table explicitly contraindicates codeine for pain or cough in children under 12 years.
Closest distractor: Morphine is not the agent named in that specific under-12 codeine restriction.

185. A | Table 93.14 | printed p. 688, PDF p. 734

Why: Lidocaine-prilocaine is listed for intact skin with application time and occlusive dressing to achieve topical anesthesia.
Closest distractor: Silver sulfadiazine is a burn antimicrobial rather than the listed procedural anesthetic.

Answer key and teaching notes (continued)

186. A | Table 93.15 | printed p. 689, PDF p. 735

Why: Gabapentin is listed as an adjunctive treatment for pediatric neuropathic pain.
Closest distractor: Ondansetron is an antiemetic and is not listed as the neuropathic analgesic.

187. A | Table 93.16 | printed p. 690, PDF p. 736

Why: The tricyclic-antidepressant section advises obtaining a 12-lead ECG to check for prolonged QT.
Closest distractor: A brain biopsy is not routine safety monitoring for amitriptyline.

188. A | Table 93.17 | printed p. 695, PDF p. 741

Why: Disproportionate pain with sensory, vasomotor, edema, and motor/trophic changes is characteristic of the Budapest CRPS criteria.
Closest distractor: NEXUS screens cervical spine injury rather than this regional pain syndrome.

189. A | Table 93.18 | printed p. 695, PDF p. 741

Why: The table includes posttraumatic neuralgia after surgery and nerve-root compression among neuropathic pain examples.
Closest distractor: Visceral pain does not follow a peripheral nerve distribution.

190. A | Table 93.19 | printed p. 697, PDF p. 743

Why: The top ladder step includes a strong opioid for severe pain or inadequate relief at lower steps.
Closest distractor: Withholding analgesia does not follow the ladder's response to severe pain.

191. A | Table 93.20 | printed p. 698, PDF p. 744

Why: Activating SCN9A/Nav1.7 variants are listed with warmth-triggered inherited erythromelalgia.
Closest distractor: CFTR causes cystic fibrosis rather than this inherited pain phenotype.

192. A | Table 94.1 | printed p. 701, PDF p. 747

Why: The table warns that small amounts of aliphatic hydrocarbons can produce acute lung injury.
Closest distractor: Rickets is not the acute toxic effect of lamp-oil ingestion.

193. A | Table 94.2 | printed p. 702, PDF p. 748

Why: Opioids are listed among causes of miosis in the toxicology examination table.
Closest distractor: Anticholinergics more often cause mydriasis.

194. A | Table 94.4 | printed p. 704, PDF p. 750

Why: The alpha-2 agonist row includes clonidine with CNS depression, bradycardia, and miosis.
Closest distractor: Atropine usually produces tachycardia and dilated pupils.

195. A | Table 94.5 | printed p. 704, PDF p. 750

Why: Calcium-channel blockers appear among ingestion causes associated with bradycardia.
Closest distractor: Amphetamines usually produce sympathetic tachycardia.

196. A | Table 94.6 | printed p. 705, PDF p. 751

Why: Ethylene glycol is listed among toxicologic causes of both relevant laboratory clues.
Closest distractor: Topical petrolatum is not a plausible cause of these linked gaps.

197. A | Table 94.7 | printed p. 706, PDF p. 752

Why: Tricyclic antidepressants are listed among poisoning causes of QRS widening.
Closest distractor: A normal ECG is not expected when clinically significant QRS widening is present.

198. A | Table 94.9 | printed p. 708, PDF p. 754

Why: Intravenous lipid emulsion is listed for local anesthetic systemic toxicity.
Closest distractor: Vitamin K is not the antidotal strategy for this toxic mechanism.

199. A | Table 94.10 | printed p. 708, PDF p. 754

Why: Organophosphate insecticides are included among substances capable of systemic toxicity after skin absorption.
Closest distractor: Plain water exposure does not produce cholinergic toxicity.

200. A | Table 94.11 | printed p. 709, PDF p. 755

Why: The table lists iron among substances poorly adsorbed by activated charcoal.
Closest distractor: Assuming complete charcoal binding would provide false reassurance.

201. A | Table 94.12 | printed p. 710, PDF p. 756

Why: Stage II features improvement of initial symptoms but emerging hepatic tenderness and laboratory liver injury at 24-48 hours.
Closest distractor: Stage I generally precedes detectable hepatic injury.

202. A | Table 94.13 | printed p. 713, PDF p. 759

Why: Methadone is listed as an opioid associated with QT widening.
Closest distractor: Naloxone is an opioid antagonist rather than the listed QT-prolonging prescription opioid.

Answer key and teaching notes (continued)

203. A | Table 94.15 | printed p. 715, PDF p. 761

Why: Iron poisoning can have early gastrointestinal symptoms, a misleading latent period, then serious systemic toxicity.
Closest distractor: Transient improvement does not establish safety after a significant iron ingestion.

204. A | Table 94.16 | printed p. 717, PDF p. 763

Why: The table lists SSRIs including sertraline and analgesics including tramadol among serotonergic agents.
Closest distractor: Plain saline is not a serotonergic interacting drug.

205. A | Table 94.17 | printed p. 718, PDF p. 764

Why: Clonus with agitation and autonomic hyperthermia appears in the serotonergic toxicity spectrum.
Closest distractor: Opioid toxicity more typically causes respiratory depression and miosis, not clonus.

206. A | Table 94.18 | printed p. 718, PDF p. 764

Why: Rapid onset after a proserotonergic agent and clonus favors serotonin syndrome.
Closest distractor: NMS generally follows a neuroleptic exposure and often evolves more slowly with different rigidity.

207. A | Table 94.19 | printed p. 722, PDF p. 768

Why: Autumn crocus ingestion is listed with gastrointestinal symptoms followed by bone marrow failure and multisystem toxicity.
Closest distractor: Speech delay is not the acute delayed toxic consequence described.

208. A | Table 94.20 | printed p. 723, PDF p. 769

Why: Aconite is listed as potentially causing cardiac arrhythmias.
Closest distractor: Rickets is not an acute herbal cardiac toxicity.

209. A | Table 95.2 | printed p. 727, PDF p. 773

Why: Distinctive findings with minimal locus heterogeneity favor testing the implicated single gene.
Closest distractor: Broader genomic testing may be useful elsewhere but is not the most focused first strategy for a clear single-gene phenotype.

210. A | Table 98.1 | printed p. 749, PDF p. 795

Why: Chromosomal microarray can detect small deletions and duplications over many loci.
Closest distractor: EEG evaluates brain electrical activity, not genomic copy number.

211. A | Table 98.2 | printed p. 751, PDF p. 797

Why: The classification separates age at onset from whether knowledge of the variant permits preventive or therapeutic action.
Closest distractor: A variant enabling meaningful prevention is not in the not-actionable category.

212. A | Table 98.3 | printed p. 754, PDF p. 800

Why: BCHE affects butyrylcholinesterase function and is listed with prolonged succinylcholine paralysis.
Closest distractor: CFTR is associated with cystic fibrosis rather than this drug response.

213. A | Table 98.4 | printed p. 756, PDF p. 802

Why: Both consanguinity and a prior child with a metabolic disorder are listed indications for genetic counseling.
Closest distractor: No assessment would miss recurrence-risk discussion.

214. A | Table 99.2 | printed p. 763, PDF p. 809

Why: The cytogenetic-notation table defines del as deletion.
Closest distractor: Duplication uses different cytogenetic notation.

215. A | Table 99.3 | printed p. 766, PDF p. 812

Why: The table associates holoprosencephaly, clefting, and postaxial polydactyly with trisomy 13.
Closest distractor: Trisomy 18 features a different pattern such as clenched overlapping fingers.

216. A | Table 99.4 | printed p. 767, PDF p. 813

Why: The 4p deletion row is Wolf-Hirschhorn syndrome with the characteristic craniofacial appearance.
Closest distractor: Williams syndrome involves a different chromosomal region and characteristic findings.

217. A | Table 99.6 | printed p. 769, PDF p. 815

Why: The table includes 7q11.23 among microduplication syndromes with developmental and language features.
Closest distractor: A whole-chromosome trisomy is a different type of copy-number change.

218. A | Table 99.7 | printed p. 770, PDF p. 816

Why: The table identifies 47,XXY as Klinefelter syndrome.
Closest distractor: Turner syndrome is associated with a missing or altered X chromosome in phenotypic females.

219. A | Table 99.8 | printed p. 771, PDF p. 817

Why: Coarctation and bicuspid aortic valve are among listed cardiac findings in Turner syndrome.
Closest distractor: Tetralogy of Fallot is not the characteristic lesion singled out by this table.

Answer key and teaching notes (continued)

220. A | Table 99.10 | printed p. 774, PDF p. 820

Why: Fanconi anemia is listed with radial-ray anomalies, short stature, and bone-marrow failure.
Closest distractor: Turner syndrome does not account for this characteristic pancytopenia with radial defects.

221. A | Table 99.11 | printed p. 776, PDF p. 822

Why: The table emphasizes infant hypotonia/feeding difficulty followed by later hyperphagia and obesity in Prader-Willi syndrome.
Closest distractor: Angelman syndrome has a different developmental and behavioral pattern.

222. A | Table 99.12 | printed p. 777, PDF p. 823

Why: The early phase is hypotonia with poor feeding; heightened appetite develops later.
Closest distractor: Immediate neonatal hyperphagia is not required and contradicts the table's sequence.

223. A | Table 99.13 | printed p. 777, PDF p. 823

Why: Paternal deletion of 15q11-q13 is a major mechanism of Prader-Willi syndrome.
Closest distractor: A maternal deletion in the region is associated with Angelman syndrome.

224. A | Table 100.1 | printed p. 778, PDF p. 824

Why: A sequence begins with one developmental anomaly that causes a cascade of secondary defects, as illustrated by Pierre Robin sequence.
Closest distractor: An association does not imply that one defect directly causes the others.

225. A | Table 100.2 | printed p. 780, PDF p. 826

Why: The table links DLL3 and abnormal vertebral/rib segmentation with spondylocostal dysostosis.
Closest distractor: Turner syndrome does not have this specified DLL3-related segmentation mechanism.

226. A | Table 100.3 | printed p. 781, PDF p. 827

Why: Maternal intrauterine infections are one category of congenital malformation causes.
Closest distractor: Postnatal iron deficiency would not explain multiple congenital defects present at birth.

227. A | Table 100.4 | printed p. 784, PDF p. 830

Why: Brachydactyly is defined as short digits.
Closest distractor: Permanent flexion is camptodactyly, a distinct term in the table.

228. A | Table 100.5 | printed p. 785, PDF p. 831

Why: Omphalocele is listed under major abdominal-wall malformations.
Closest distractor: It is not a minor auricular finding.

229. A | Table 100.6 | printed p. 785, PDF p. 831

Why: Preauricular tags appear among minor ear malformations in the table.
Closest distractor: A major cardiac defect is an entirely different category.

230. A | Table 100.7 | printed p. 786, PDF p. 832

Why: Williams syndrome is listed with supravalvular aortic stenosis, a characteristic social style, and iris findings.
Closest distractor: WAGR syndrome centers on Wilms tumor, aniridia, genitourinary findings, and developmental concerns.

231. A | Table 101.1 | printed p. 788, PDF p. 834

Why: PTPN11 and SHP2 are listed within the RAS/MAPK pathway associated with Noonan syndrome.
Closest distractor: The urea cycle is a separate metabolic pathway.

232. A | Table 101.2 | printed p. 789, PDF p. 835

Why: These craniofacial, growth, and chest-wall findings appear in the Noonan syndrome table.
Closest distractor: Phenylketonuria alone does not produce this characteristic constellation.

233. A | Table 101.3 | printed p. 790, PDF p. 836

Why: At diagnosis the table includes full examination, genetics consultation, and consideration of molecular testing/counseling.
Closest distractor: Deferring all evaluation misses baseline multisystem assessment.

234. A | Table 101.4 | printed p. 792, PDF p. 838

Why: Motile primary ciliary dyskinesia is listed with chronic airway/ear disease and laterality defects.
Closest distractor: Nephronophthisis is a sensory/primary ciliopathy with a different renal-centered presentation.

235. A | Table 102.1 | printed p. 797, PDF p. 843

Why: These facial features appear on the Kabuki phenotype-scoring list.
Closest distractor: NEXUS evaluates cervical spine injury, not a congenital phenotype.

236. A | Table 104.4 | printed p. 806, PDF p. 852

Why: Fatty acid oxidation defects are listed among inborn errors associated with neonatal hypoglycemia.
Closest distractor: Dyslexia cannot explain recurrent neonatal hypoglycemia.

Answer key and teaching notes (continued)

237. A | Table 104.5 | printed p. 807, PDF p. 853

Why: Urea-cycle enzyme defects, including OTC and CPS1 deficiency, are listed causes of severe hyperammonemia.
Closest distractor: Vasovagal syncope cannot explain persistent marked ammonia elevation.

238. A | Table 104.11 | printed p. 810, PDF p. 856

Why: The table pairs maple-syrup or burnt-sugar odor with maple syrup urine disease.
Closest distractor: Isovaleric acidemia is classically described as sweaty-feet odor.

239. A | Table 104.12 | printed p. 811, PDF p. 857

Why: An unexplained affected or deceased sibling and a neonatal sepsis-like presentation are red flags for metabolic workup.
Closest distractor: A possible infection does not eliminate inherited metabolic disease from the differential.

240. A | Table 104.13 | printed p. 811, PDF p. 857

Why: Hyperammonemia, hypoglycemia, and metabolic acidosis are among laboratory findings that should trigger a metabolic workup.
Closest distractor: A vision screen cannot evaluate these acute biochemical abnormalities.

241. A | Table 105.4 | printed p. 849, PDF p. 895

Why: Low citrulline with hyperammonemia is described for proximal urea-cycle disorders such as CPS1 and NAGS defects.
Closest distractor: Lactose intolerance does not produce this amino-acid and ammonia pattern.

242. A | Table 105.5 | printed p. 850, PDF p. 896

Why: Organic acidemias such as propionic and methylmalonic acidemia are listed among metabolic causes of hyperammonemia.
Closest distractor: A speech disorder cannot account for an acute biochemical crisis.

243. A | Table 105.6 | printed p. 850, PDF p. 896

Why: The acute hyperammonemia table prioritizes adequate IV energy and fluid/electrolyte support with ammonia-directed therapy.
Closest distractor: Prolonged fasting worsens catabolism and endogenous nitrogen generation.

244. A | Table 106.2 | printed p. 866, PDF p. 912

Why: The Zellweger spectrum is categorized among peroxisomal biogenesis disorders involving PEX genes.
Closest distractor: CFTR causes cystic fibrosis and is not the peroxisome biogenesis gene group.

245. A | Table 106.3 | printed p. 866, PDF p. 912

Why: The table lists defective oxidation and accumulation of very-long-chain fatty acids.
Closest distractor: Elevated phenylalanine points toward a different metabolic disorder.

246. A | Table 106.5 | printed p. 869, PDF p. 915

Why: The Zellweger spectrum row shows increased VLCFA and reduced plasmalogens.
Closest distractor: Isolated X-linked adrenoleukodystrophy generally has elevated VLCFA with normal plasmalogens in this table.

247. A | Table 106.6 | printed p. 874, PDF p. 920

Why: Chylomicrons originate in the intestine, are lipid-rich and large, and contain apoB-48.
Closest distractor: LDL is smaller and contains apoB-100 rather than apoB-48.

248. A | Table 106.7 | printed p. 875, PDF p. 921

Why: Familial hypercholesterolemia is listed with high LDL, tendon xanthomas, and early coronary risk.
Closest distractor: Primary chylomicronemia chiefly affects triglyceride-rich lipoproteins rather than isolated LDL elevation.

249. A | Table 106.10 | printed p. 880, PDF p. 926

Why: Hypothyroidism is listed among secondary causes of hypercholesterolemia.
Closest distractor: Seasonal allergy alone is not a listed explanation for this lipid change.

250. A | Table 106.11 | printed p. 881, PDF p. 927

Why: Toe II-III syndactyly with craniofacial and genital findings is characteristic in the Smith-Lemli-Opitz table.
Closest distractor: Turner syndrome has a different sex-chromosome and congenital feature pattern.

251. A | Table 106.12 | printed p. 882, PDF p. 928

Why: Renal hypoplasia and other kidney anomalies appear under urinary-tract malformations.
Closest distractor: A skin-appendage category would not include a hypoplastic kidney.

252. A | Table 106.13 | printed p. 883, PDF p. 929

Why: HMG-CoA reductase inhibitors (statins) reduce cholesterol synthesis and increase hepatic LDL receptor activity.
Closest distractor: Fibrinolytics are not agents for chronic LDL lowering.

253. A | Table 106.14 | printed p. 883, PDF p. 929

Why: The table lists myalgia and myositis as statin-associated adverse effects.
Closest distractor: Routine tooth eruption is not a medication adverse effect explaining new muscle symptoms.

Answer key and teaching notes (continued)

254. A | Table 106.17 | printed p. 893, PDF p. 939

Why: The table marks cognitive decline in all three clinical forms.
Closest distractor: Coarse facial features are associated mainly with the infantile presentation, not every form.

255. A | Table 106.18 | printed p. 894, PDF p. 940

Why: The table reports early childhood gastrointestinal complaints and acroparesthesia among Fabry manifestations.
Closest distractor: An exclusively adult onset is inconsistent with the listed pediatric reports.

256. A | Table 106.19 | printed p. 895, PDF p. 941

Why: The table lists several inflammatory and neurologic diagnoses as common misclassifications of Fabry disease.
Closest distractor: An initial inflammatory label does not exclude an inherited storage disorder.

257. A | Table 107.2 | printed p. 914, PDF p. 960

Why: Beta-agonists appear in the drug/toxin group for type B2 lactic acidosis.
Closest distractor: Type A requires inadequate tissue oxygenation and is not the only explanation here.

258. A | Table 107.4 | printed p. 919, PDF p. 965

Why: The bedside criteria score clinical features, metabolic/imaging studies, and morphology.
Closest distractor: NEXUS screens for cervical spine injury rather than mitochondrial disease.

259. A | Table 107.5 | printed p. 920, PDF p. 966

Why: Nonvascular strokelike lesions and a characteristic lactate MRS peak are among mitochondrial clues.
Closest distractor: A refractive error does not explain either neuroimaging feature.

260. A | Table 107.6 | printed p. 924, PDF p. 970

Why: The table characterizes recognizable congenital disorders of glycosylation using the clinical profile and transferrin isoform analysis.
Closest distractor: Lactose intolerance does not explain multisystem neurologic abnormalities with abnormal glycosylation.

261. A | Table 107.7 | printed p. 927, PDF p. 973

Why: The table lists mannose therapy for MPI-CDG with improvement in digestive and systemic manifestations.
Closest distractor: Eliminating all carbohydrate is not the specified metabolic therapy.

262. A | Table 108.2 | printed p. 934, PDF p. 980

Why: The criteria include muscular, neurologic, and multisystem features including endocrine and hearing findings.
Closest distractor: A single sodium value does not cover the multidomain assessment.

263. A | Table 108.3 | printed p. 935, PDF p. 981

Why: Biotinidase deficiency is listed as a differential diagnosis for the dystonia phenotype.
Closest distractor: Dental caries does not explain a progressive movement disorder.

264. A | Table 109.1 | printed p. 939, PDF p. 985

Why: The MPS I Hurler pattern includes coarse facies, corneal clouding, contractures, and intellectual impairment.
Closest distractor: MPS III is not the best fit for prominent corneal clouding and contracture combination.

265. A | Table 110.1 | printed p. 945, PDF p. 991

Why: APRT deficiency is paired with an XOR inhibitor to prevent stone formation and renal damage.
Closest distractor: A proton pump inhibitor does not address the metabolic stone mechanism.

266. A | Table 110.3 | printed p. 949, PDF p. 995

Why: The table pairs APRT deficiency with dihydroxyadenine urinary stones.
Closest distractor: Struvite is typically infection-associated and is not the APRT-specific stone listed.

267. A | Table 112.2 | printed p. 965, PDF p. 1011

Why: The acute intermittent porphyria row names urinary porphobilinogen as the key screening test.
Closest distractor: Sweat chloride tests cystic fibrosis and does not screen an acute porphyria attack.

268. A | Table 112.4 | printed p. 969, PDF p. 1015

Why: Acute porphyria may present with persistent diffuse pain and neurologic vomiting without typical peritoneal signs.
Closest distractor: A perforated viscus generally suggests peritoneal irritation, which is absent here.

269. A | Table 113.1 | printed p. 981, PDF p. 1027

Why: The table separates autonomic adrenergic symptoms such as tremor and diaphoresis from later neuroglycopenic confusion.
Closest distractor: Cerebral glucopenia more directly causes confusion, visual changes, and impaired cognition.

270. A | Table 113.2 | printed p. 982, PDF p. 1028

Why: Macroglossia is paired with Beckwith-Wiedemann syndrome, and large-for-gestational-age status can signal congenital hyperinsulinism.
Closest distractor: Turner syndrome does not explain this characteristic combination of macroglossia and neonatal hyperinsulinism.

Answer key and teaching notes (continued)

271. A | Table 113.3 | printed p. 983, PDF p. 1029

Why: Prematurity and limited substrate adaptation are included in transitional neonatal hypoglycemia.
Closest distractor: A persistent genetic disorder would not be inferred from a brief self-limited transitional episode.

272. A | Table 113.4 | printed p. 983, PDF p. 1029

Why: An infant of a diabetic mother is listed among transient causes of hyperinsulinemic hypoglycemia.
Closest distractor: Insulinoma is an uncommon separate cause and is not implied by the birth history.

273. A | Table 113.5 | printed p. 984, PDF p. 1030

Why: Beckwith-Wiedemann syndrome is associated with overgrowth, macroglossia, abdominal-wall defects, and hyperinsulinism.
Closest distractor: Turner syndrome does not explain neonatal overgrowth with macroglossia.

274. A | Table 113.6 | printed p. 985, PDF p. 1031

Why: The table emphasizes a critical sample at low plasma glucose with metabolites and hormones to identify the mechanism.
Closest distractor: Delaying all testing until the metabolic state has resolved may lose key diagnostic information.

275. A | Table 113.7 | printed p. 987, PDF p. 1033

Why: Diazoxide is listed among therapies for hyperinsulinism.
Closest distractor: Albuterol is a bronchodilator, not the table's targeted hyperinsulinism agent.

276. A | Table 113.8 | printed p. 987, PDF p. 1033

Why: Hypoketonemia, low free fatty acids, and a strong glucagon response during hypoglycemia support hyperinsulinism.
Closest distractor: Normal fasting ordinarily permits lipolysis and ketone production.

277. A | Table 113.9 | printed p. 990, PDF p. 1036

Why: Growth hormone deficiency or resistance appears among hormonal causes of ketotic hypoglycemia.
Closest distractor: Persistent excess insulin tends to suppress ketone production rather than cause marked ketosis.

278. A | Table 118.1 | printed p. 1029, PDF p. 1039

Why: Congenital diaphragmatic hernia is among fetal diagnoses evaluated by fetal centers.
Closest distractor: A dental clinic does not provide the multispecialty fetal evaluation described.

279. A | Table 118.2 | printed p. 1029, PDF p. 1039

Why: The table describes in-utero intervention aimed at reversing pulmonary hypoplasia and reducing pulmonary hypertension before postnatal repair.
Closest distractor: Fetal intervention does not guarantee the neonate will need no respiratory support.

280. A | Table 118.3 | printed p. 1037, PDF p. 1047

Why: The patient-selection table places trisomy 18 among genetic diagnoses requiring consideration of diagnostic and prognostic certainty.
Closest distractor: School attendance is unrelated to fetal prognostic assessment.

281. A | Table 119.1 | printed p. 1038, PDF p. 1048

Why: Maternal diabetes and hypertension are listed in birth-parent medical history factors influencing neonatal risk.
Closest distractor: These factors do not guarantee a low-risk neonatal course.

282. A | Table 119.2 | printed p. 1041, PDF p. 1051

Why: The donor is associated with anemia/pallor, hypovolemia, growth restriction, and oligohydramnios.
Closest distractor: The recipient more typically develops polyhydramnios, plethora, and volume overload.

283. A | Table 119.3 | printed p. 1043, PDF p. 1053

Why: Prior preterm birth and short interpregnancy interval appear among maternal risk factors.
Closest distractor: They are not themselves evidence of a fetal chromosomal abnormality.

284. A | Table 119.6 | printed p. 1048, PDF p. 1058

Why: Chronic fetal infections including congenital CMV are listed as fetal factors in intrauterine growth restriction.
Closest distractor: Postnatal renal stones do not cause fetal growth restriction.

285. A | Table 119.7 | printed p. 1048, PDF p. 1058

Why: Early insult with proportionate reduction in multiple fetal measurements is a symmetric IUGR pattern.
Closest distractor: Asymmetric restriction typically arises later and disproportionately affects abdominal growth.

286. A | Table 119.8 | printed p. 1048, PDF p. 1058

Why: The table links SGA hypoglycemia to lower tissue glycogen and impaired gluconeogenesis, among other factors.
Closest distractor: An insulinoma is not an obligatory explanation in these newborns.

287. A | Table 119.9 | printed p. 1049, PDF p. 1059

Why: Maintaining stable temperature is explicitly listed among high-risk infant discharge requirements.
Closest distractor: A single normal heart rate cannot substitute for sustained thermal stability.

Answer key and teaching notes (continued)

288. A | Table 119.10 | printed p. 1050, PDF p. 1060

Why: The table links IVH to subsequent posthemorrhagic hydrocephalus and other neurologic concerns.
Closest distractor: IVH does not create a congenital trisomy.

289. A | Table 121.1 | printed p. 1053, PDF p. 1064

Why: A scaphoid abdomen, bowel sounds in the thorax, and severe distress fit congenital diaphragmatic hernia.
Closest distractor: Choanal atresia causes nasal obstruction without intrathoracic bowel sounds.

290. A | Table 121.2 | printed p. 1054, PDF p. 1065

Why: Maternal or direct oversedation is listed as a CNS cause of hypoventilation and cyanosis.
Closest distractor: Congenital cardiac shunting is a separate possible cause but not the exposure mechanism in this vignette.

291. A | Table 122.3 | printed p. 1061, PDF p. 1072

Why: The ultrasound timeline shows echogenic periventricular lesions early, then echolucent cysts after 1-3 weeks.
Closest distractor: A scalp hematoma is extracranial and does not explain this periventricular evolution.

292. A | Table 122.5 | printed p. 1062, PDF p. 1073

Why: The table includes cardiovascular and renal injury along with neurologic, pulmonary, and other systemic effects of asphyxia.
Closest distractor: Asphyxia is not restricted to the brain.

293. A | Table 122.6 | printed p. 1063, PDF p. 1074

Why: The table links deep gray and related patterns of hypoxic-ischemic injury with neurologic sequelae including movement difficulties.
Closest distractor: A peripheral nerve-only explanation ignores the documented brain findings.

294. A | Table 122.8 | printed p. 1064, PDF p. 1075

Why: Lethargy and decreased activity with abnormal primitive reflexes fit the moderate HIE column.
Closest distractor: Severe stage 3 more commonly involves stupor or coma and absent spontaneous activity.

295. A | Table 122.9 | printed p. 1066, PDF p. 1077

Why: The MRI table describes deep-gray and cortical signal patterns useful in characterizing term HIE.
Closest distractor: A deep-gray lesion does not exclude HIE; it may be part of its pattern.

296. A | Table 122.10 | printed p. 1066, PDF p. 1077

Why: The table notes severe early abnormalities may recover and that rapid recovery is associated with a more favorable outcome.
Closest distractor: An early tracing alone does not establish an inevitable outcome.

297. A | Table 122.11 | printed p. 1067, PDF p. 1078

Why: A normal EEG background by day 7 is listed among patterns associated with favorable outcome.
Closest distractor: Persistent burst suppression is listed among concerning patterns instead.

298. A | Table 125.1 | printed p. 1075, PDF p. 1086

Why: The neonatal-apnea table includes infections and respiratory disease as potentially important causes.
Closest distractor: A vision refractive error does not explain acute apnea and temperature instability.

299. A | Table 130.1 | printed p. 1092, PDF p. 1103

Why: Parenchymal lung disease such as meconium aspiration is listed as a trigger for reactive pulmonary vasoconstriction in PPHN.
Closest distractor: A normal postnatal fall in pulmonary resistance would not explain PPHN.

300. A | Table 136.1 | printed p. 1104, PDF p. 1116

Why: The table lists distension, feeding intolerance, blood in stool, and apnea among NEC signs.
Closest distractor: Physiologic reflux alone does not explain bloody stool and systemic deterioration.

Table selection log

300 selected, readable, single-page tables in ascending source-table order. Source page numbers are shown below.
Calendar-year statistics, low clinical-value material, and tables continued onto additional PDF pages were skipped.
Scope: after Table 41.7 (PDF p. 320), through Table 136.1 (PDF p. 1116); resume after Table 136.1.

001. Table 42.1 | PDF p. 323 | printed p. 278 | Completed
Table 42.1 DSM-5 Diagnostic Criteria for Oppositional Defiant Disorder

002. Table 42.2 | PDF p. 323 | printed p. 278 | Completed
Table 42.2 DSM-5 Diagnostic Criteria for Intermittent Explosive Disorder

003. Table 42.3 | PDF p. 324 | printed p. 279 | Completed
Table 42.3 DSM-5 Diagnostic Criteria for Conduct Disorder

004. Table 47.1 | PDF p. 331 | printed p. 285 | Completed
Table 47.1 DSM-5 Diagnostic Criteria for Brief Psychotic Disorder

005. Table 47.2 | PDF p. 332 | printed p. 286 | Completed
Table 47.2 DSM-5 Diagnostic Criteria for Schizophreniform Disorder

006. Table 47.3 | PDF p. 332 | printed p. 286 | Completed
Table 47.3 DSM-5 Diagnostic Criteria for Schizophrenia

007. Table 47.4 | PDF p. 333 | printed p. 287 | Completed
Table 47.4 Possible Causes of Secondary Psychosis

008. Table 47.5 | PDF p. 334 | printed p. 288 | Completed
Table 47.5 Red Flags and Features Suggesting Secondary Etiologies of Psychosis

009. Table 47.6 | PDF p. 334 | printed p. 288 | Completed
Table 47.6 Proposed Diagnostic Criteria for Autoimmune Psychosis

010. Table 47.7 | PDF p. 337 | printed p. 291 | Completed
Table 47.7 DSM-5 Diagnostic Criteria for Substance/Medication-Induced Psychotic Disorder

011. Table 47.8 | PDF p. 337 | printed p. 291 | Completed
Table 47.8 DSM-5 Diagnostic Criteria for Psychotic Disorder Due to Another Medical Condition

012. Table 47.9 | PDF p. 338 | printed p. 292 | Completed
Table 47.9 Catatonia

013. Table 47.10 | PDF p. 338 | printed p. 292 | Completed
Table 47.10 Conditions Associated with Catatonia

014. Table 47.11 | PDF p. 338 | printed p. 292 | Completed
Table 47.11 DSM-5 Criteria for Catatonia Due to Another Medical Condition

015. Table 47.12 | PDF p. 339 | printed p. 293 | Completed
Table 47.12 Standard Examination of Catatonia

016. Table 48.1 | PDF p. 341 | printed p. 295 | Completed
Table 48.1 DSM-5 Diagnostic Criteria for Delirium

017. Table 48.2 | PDF p. 341 | printed p. 295 | Completed
Table 48.2 DSM-5 Delirium Subtypes

018. Table 48.3 | PDF p. 343 | printed p. 297 | Completed
Table 48.3 Etiologies of Pediatric Delirium (CRITICAL CARE mnemonic)

019. Table 48.4 | PDF p. 343 | printed p. 297 | Completed
Table 48.4 Differential Diagnosis of Delirium

020. Table 48.5 | PDF p. 344 | printed p. 298 | Completed
Table 48.5 Nonpharmacologic Management of Delirium

021. Table 49.1 | PDF p. 348 | printed p. 302 | Completed
Table 49.1 Symptom Expression of Executive Dysfunction

022. Table 49.2 | PDF p. 350 | printed p. 304 | Completed
Table 49.2 Neurodevelopmental Dysfunction Underlying Academic Disorders

023. Table 49.3 | PDF p. 354 | printed p. 308 | Completed
Table 49.3 Executive Function Categories: Presenting Symptoms, Suggested Dysfunction, and Potential Interventions

024. Table 50.1 | PDF p. 357 | printed p. 310 | Completed
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