Arrhythmia: Common Complications and Conditions

MCG Health
Inpatient & Surgical Care
30th Edition

CCC: CCC-005 (ISC)
Link to Codes

Prevention

- Prevention issues and possible preventive measures include:
  - Avoidance of or careful observation surrounding precipitating factors; examples include(1)(2)(3)(4)(5):
    - Patient with known arrhythmic history or structural heart disease (eg, atrial fibrillation, supraventricular tachycardia, long QT syndrome, congenital heart defects, cardiac amyloidosis, cardiomyopathy)(1)(6)(7)(8)(9)(10)(11)(12)
    - Myocardial ischemia or injury (eg, myocarditis)(1)(11)(13)
    - Heart failure(1)(14)(15)
    - Electrolyte imbalance(11)(16)(17)
    - Sleep apnea(1)(11)
    - Hypoxia(11)(18)
    - Medications[A]; examples include(17)(19)(20):
      - Antiarrhythmic medications[B](21)
      - Antidepressants and antipsychotics(21)
      - Antihistamines(21)
      - Inotropic agents(21)
  - Preventive measures; examples include:
    - For cardiac or thoracic surgery, pharmacologic atrial fibrillation prophylaxis (eg, initiation or continuation of beta-blocker therapy)(1)(15)
    - For patient with impaired ventricular function, beta-blockers, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, and aldosterone blockers have demonstrated decreased risk of sudden cardiac arrest.(22)(23)
    - Avoidance or correction of volume and metabolic abnormalities(24)(25)
    - Placement of ICD or cardiac monitor as appropriate(2)(10)(26)(27)

Clinical Indications for Ongoing Inpatient Care

- Ongoing inpatient care is indicated for **1 or more** of the following(1)(2)(9)(26)(28)(29):
  - Supraventricular tachycardia (eg, atrial fibrillation, atrial flutter), as indicated by **1 or more** of the following:
    - Hypotension that is severe, as indicated by **ALL** of the following:
      - Hypotension (1)
      - Severe hypotension, as indicated by **1 or more** of the following:
        - Lactate of 2.0 mmol/L (18 mg/dL) or more secondary to hypotension (ie, hypoperfusion)[C](30)(35)
        - Metabolic acidosis (arterial or venous pH less than 7.35)[D] not otherwise explained
        - Mean arterial pressure[E] less than 65 mm Hg MAP Calculator
        - IV inotropic or vasopressor medication required to maintain adequate blood pressure or perfusion(1)
    - Hypotension that persists despite initial treatment(1)
    - Persistent symptomatic Tachycardia (eg, chest pain, dyspnea)(1)(11)(21)
    - Acute myocardial ischemia[F](11)(48)
    - Altered mental status (21)
    - Syncope(21)
    - Heart failure (eg, pulmonary edema with dyspnea, Tachypnea, or Hypoxemia)(1)(14)(21)
    - Suspected accessory pathway (eg, Wolff-Parkinson-White syndrome) on ECG(21)
    - Medication toxicity (eg, digitalis) causing arrhythmia(11)(21)(28)
    - Underlying medical condition that necessitates inpatient care (eg, thyrotoxicosis, myocarditis)(1)(11)
  - Initiation or adjustment of antiarrhythmic medication that requires cardiac monitoring (eg, telemetry), as indicated by **1 or more** of the following(1)(21):
    - Significant structural heart disease (eg, cardiomyopathy, dilation, scar or fibrosis, disruption to normal cardiac electrical propagation, hypertrophy)[G]
    - Underlying sinus node or atrioventricular conduction disturbance (eg, tachy-brady syndrome)(1)(21)
    - Prolonged QT interval(21)
    - Need for treatment with antiarrhythmic medication regimen that has significant proarrhythmic potential (eg, monomorphic ventricular tachycardia, torsades de pointes, bradycardia)[H][I](21)
    - Patient without a sinus rhythm ECG to evaluate (eg, to determine QT interval, presence of accessory pathways)[J](21)
  - Ventricular arrhythmia, as indicated by **1 or more** of the following:
    - Resuscitated or aborted sudden cardiac arrest (eg, ventricular fibrillation, asystole, pulseless ventricular tachycardia) in patient without ICD(10)(18)(21)(50)(51)(52)
    - Newly recognized (eg, new diagnosis for patient) sustained (30 seconds or more of ventricular rhythm at more than 100 beats per minute) ventricular tachycardia(10)(18)(21)(52)
    - Previously identified sustained (30 seconds or more of ventricular rhythm at more than 100 beats per minute) ventricular tachycardia in patient with **1 or more** of the following:
      - Structural heart disease (eg, reduced ejection fraction, hypertrophic cardiomyopathy, severe valvular disease, congenital heart disease) and without ICD[K](6)(10)(12)(21)(50)(52)(55)
      - Need for treatment of drug toxicity (eg, digitalis toxicity, prolonged QT interval)(21)(56)(57)
      - Need for electrical cardioversion (eg, continued ventricular tachycardia and Hypotension)(18)(21)(52)
      - Three or more episodes of sustained ventricular tachycardia within 24 hours (ie, electrical storm)(21)(58)

- Inadequate perfusion due to ventricular arrhythmia, as indicated by **1 or more** of the following:
  - Lactate of 2.0 mmol/L (18 mg/dL) or more[L](34)
  - Altered mental status
  - Hypotension
  - Syncope(21)
  - Seizure(59)
  - IV vasopressor medication required to maintain adequate blood pressure(18)
  - Significant decrease in left ventricular assist device flow(2)
- Respiratory distress (eg, dyspnea, Tachypnea)(21)
- Hypoxemia (21)
- Suspected cardiac ischemia[F] as cause or consequence of arrhythmia(12)(18)(50)(60)
- Continuous ECG monitoring needed (eg, drug initiation or adjustment requiring monitoring, ventricular tachycardia persists or recurs)(12)

- Patient has ICD and **1 or more** of the following(61)(62)(63):
  - Three or more ICD interventions (shocks or antitachycardia pacing) within 24 hours (ie, electrical storm)(58)(62)(63)
  - Urgent need for catheter ablation and electrophysiologic study(62)(63)(64)
  - Urgent need for adjustment of ICD settings(61)(62)(63)
  - Device malfunctioning or malpositioning that requires immediate attention(61)(62)
- Atrioventricular conduction abnormality (atrioventricular block), as indicated by **1 or more** of the following(49)(65)(66)(67)(68):
  - Hemodynamic instability
  - Symptomatic (eg, dizziness, presyncope, syncope, confusional state due to hypoperfusion, or heart failure symptoms) first-degree,[M] second-degree, or third-degree atrioventricular block(49)(65)(67)(68)(69)
  - Asymptomatic type II second-degree atrioventricular heart block (Mobitz type II) or third-degree atrioventricular heart block[N](49)(65)(66)
  - Pre-existing pacer-dependent atrioventricular heart block with permanent pacemaker malfunction requiring adjustment, repair, or replacement(70)
  - Other conduction abnormality with need for telemetry monitoring or temporary pacemaker placement(65)
- Bradycardia that is symptomatic (eg, dizziness, Hypotension)(68)
- Medication toxicity (eg, digitalis, chemotherapeutic agent) causing arrhythmia(71)
- Continuous ECG monitoring is required for condition causing arrhythmia (eg, severe hyperkalemia, hypokalemia, acid-base disturbance).(49)

Alternatives to Inpatient Care

- Alternatives to inpatient stay extension include[O](1)(2)(9)(26)(28)(72)(73):
  - Home
    - Antiarrhythmic medication as appropriate
    - Anticoagulation monitoring as appropriate
    - Monitoring of cardiac device, including pacemaker or ICD, as appropriate
  - Home care
    - Antiarrhythmic medication as appropriate
    - Anticoagulation monitoring as appropriate
    - Monitoring of cardiac device, including pacemaker or ICD, as appropriate
  - Recovery facility
    - Antiarrhythmic medication as appropriate
    - Anticoagulation monitoring as appropriate

- Monitoring of cardiac device, including pacemaker or ICD, as appropriate
- Skilled care of cardiopulmonary system and comorbidities

Discharge

- Extended stay beyond goal length of stay for primary condition may be needed until **ALL** of the following are present(1)(2)(26)(28)(29):
  - Hypotension absent
  - No evidence of acute myocardial ischemia
  - Mental status at baseline
  - Sinus rhythm or acceptable ventricular rate
  - Tachypnea absent
  - Hypoxemia absent
  - Anticoagulants not indicated or regimen for next level of care established
  - Antiarrhythmic medication absent or no requirement for further inpatient ECG monitoring
  - ICD absent or settings acceptable for next level of care
  - No precipitating conditions requiring continued inpatient care identified
  - Medical comorbidities manageable at lower level of care

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Footnotes

[A] Lists of agents associated with QT prolongation may be found at www.crediblemeds.org. [A in Context Link 1]

[B] Antiarrhythmic agents also have the potential to be proarrhythmic.(3) [B in Context Link 1]

[C] There are numerous causes of an elevated lactate level. The most common are cardiogenic or hypovolemic shock, severe heart failure, severe trauma, or sepsis. However, there are also other etiologies to consider, such as vigorous exercise, seizures, liver disease, or medication use (eg, metformin, beta2-agonists); therefore, interpretation of elevated lactate levels requires consideration of the clinical context (eg, well-appearing post exercise vs hypotensive). The severity and persistence of the elevation can sometimes be helpful in this differentiation. In most instances of lactic acidosis, blood pH is less than 7.35, with a serum bicarbonate level of 20 mEq/L (mmol/L) or lower. However, a coexisting respiratory or metabolic alkalosis can mask these findings.(30)(31)(32)(33)(34) [C in Context Link 1]

[D] Analyses have concluded that venous and arterial pH measurements are highly correlated, with small differences between them that are usually not clinically significant.(36)(37)(38)(39)(40) If a mixed acid-base disorder is suspected, an arterial blood gas is indicated.(37) [D in Context Link 1]

[E] The mean arterial pressure (MAP) takes into account both systolic and diastolic blood pressure readings.(41)(42) [E in Context Link 1]

[F] Troponin elevation alone does not indicate acute myocardial infarction, as patients can have elevated levels of cardiac troponin due to other causes of myocardial injury, either acutely or chronically.(43) Patients with elevated troponin levels without known baseline troponin levels should, upon subsequent measurements, have a troponin level rise or fall of more than 20% to confirm acuity of myocardial injury. Absent this variation, the acuity of the myocardial injury should be questioned (ie, patient may have chronic troponin elevation), as should the diagnosis of acute myocardial infarction.(43) Examples of acute nonischemic causes of myocardial injury include heart failure exacerbation, myocarditis, cardiac procedures, cardiac contusion, pulmonary embolism, and defibrillation shock.(43) Examples of chronic cardiac causes not due to acute ischemia would be cardiomyopathy, valvular disease, chronic heart failure, cardiac amyloidosis, or sarcoidosis.(43)(44) Patients with chronic kidney disease are particularly susceptible to chronic nonischemic elevations of cardiac troponin levels.(43) In clinical situations where it is unknown if troponin release is due to ischemia or not, the dynamic nature of the troponin levels (rising or falling vs stable), presence or absence of associated symptoms, ECG changes, and imaging findings become even more important in diagnosing acute myocardial infarction.(43)(44) Serial cardiac troponin levels are generally measured 3 hours apart using standard assays, but dynamic changes in troponin can be detected in as little as 1 hour using high-sensitivity troponin assays, allowing for faster diagnosis of acute myocardial injury.(43)(45)(46) Because cardiac troponin levels are more sensitive and specific

measures of cardiac injury than creatinine kinase myocardial band (CK-MB) measurements, CK-MB is not recommended for diagnosing acute coronary syndromes unless both conventional and high-sensitivity troponin measurements are unavailable.(43)(45)(47) [F in Context Link 1, 2]

[G] It is not possible to list all the structural cardiac conditions that may render initiation or adjustment of antiarrhythmic agents more risky. One of the mechanisms of increased risk is scar or fibrosis formation or other disruption to normal cardiac electrical propagation (eg, myocardial infarction, dilation, cardiomyopathy, hypertrophy).(9) [G in Context Link 1]

[H] An evidence-based specialty society guideline makes several recommendations concerning the need for monitoring with the use of certain antiarrhythmic medications.(1) Patients who are initiating, increasing the dose of, or reinitiating dofetilide therapy should be admitted for a minimum of 3 days to provide continuous ECG monitoring, to allow repeated assessments of renal function, and to perform cardiac resuscitation if needed.(1) The same recommendation is given for the initiation of oral sotalol. It is noted that, if IV sotalol is used, a shorter monitored initiation period may be possible.(1) If a pill-in-the-pocket approach is applied (as-needed self-administration of high-dose flecainide (200 to 300 mg) or propafenone (450 to 600 mg)), it is recommended that the first dose be given in a setting that can provide continuous ECG monitoring.(1) For infusion of ibutilide, continuous ECG monitoring is recommended for at least 4 hours after infusion or until the QTc has returned to baseline.(1) For infusion of procainamide, ECG and blood pressure monitoring are recommended during the infusion.(1) IV amiodarone is infused over 24 hours.(1)(9)(49) Oral amiodarone and dronedarone may be safely started in the outpatient setting without monitoring in some patients. However, both can lead to bradycardia, so monitoring may be needed for patients who are prone to bradycardia (eg, sinus node dysfunction).(1)(9)(49) [H in Context Link 1]

[I] The required duration of QTc monitoring is a complex clinical decision and depends upon many factors; examples include: QTc length, whether a prolonged QTc has returned to baseline, time to drug elimination dependent on hepatic or renal function, presence of arrhythmias, administration of other medications that prolong the QT interval, presence of other conduction abnormalities, and electrolyte levels.(1)(9)(49) [I in Context Link 1]

[J] These criteria refer to the availability of a sinus rhythm ECG to the clinicians attending to the patient (eg, in the emergency department) who are making the current decisions concerning antiarrhythmic therapy. An older sinus rhythm ECG (performed elsewhere or during a previous encounter) is sufficient if interpretable and clinically appropriate (eg, no significant change in medications since ECG performed, no significant intervening cardiac disease or events).(1)(9)(49) [J in Context Link 1]

[K] An electrophysiologic study with programmed ventricular stimulation may be used to clarify the need for an ICD in the setting of myocardial infarction or structural heart disease and should be evaluated on an individual basis.(47)(53)(54) [K in Context Link 1]

[L] There are numerous causes of an elevated lactate level. The most common are cardiogenic or hypovolemic shock, severe heart failure, severe trauma, or sepsis. However, there are also other etiologies to consider such as vigorous exercise, seizures, liver disease, or medication use (eg, metformin, beta2-agonists); therefore, interpretation of elevated lactate levels requires consideration of the clinical context (eg, well-appearing post exercise vs hypotensive). The severity and persistence of the elevation can sometimes be helpful in this differentiation. In most instances of lactic acidosis, blood pH is less than 7.35, with a serum bicarbonate level 20 mEq/L (mmol/L) or lower. However, a coexisting respiratory or metabolic alkalosis can mask these findings.(30)(31)(32)(33)(34) [L in Context Link 1]

[M] Patients with first-degree atrioventricular block are usually asymptomatic; however, in severe cases (eg, PR interval greater than 300 msec), dyssynchrony between atrial and ventricular contraction may occur, resulting in symptoms from decreased cardiac output and increased pulmonary congestion. This is also known as pseudo-pacemaker syndrome.(65) [M in Context Link 1]

[N] Mobitz type I (Wenckebach) second-degree heart block is common, is usually caused by disease within the atrioventricular node, and has a generally benign prognosis. Mobitz type II and high-grade second-degree atrioventricular block are caused by disease distal to the atrioventricular node (infranodal). Patients with distal, infranodal second-degree blocks are at risk of developing infranodal third-degree blocks, which are characterized by slow ventricular escape rhythms that may cause hemodynamic instability. Mobitz type II second-degree heart block has been associated with progression to third-degree heart block, syncope, and sudden death, and should be monitored until a pacemaker is placed.(49)(66) [N in Context Link 1]

[O] Patients without significant hemodynamic compromise who have an arrhythmia that has been previously evaluated or who have an arrhythmia (eg, atrial fibrillation) that can be evaluated in non-inpatient settings may not require a stay extension.(26)(28) [O in Context Link 1]

Definitions

Altered mental status

- Altered mental status (ie, different from baseline), as indicated by **1 or more** of the following(1)(2)(3)(4):
  - Confusional state (eg, disorientation, difficulty following commands, deficit in attention)
  - Lethargy (eg, awake or arousable, but with drowsiness; reduced awareness of self and environment)
  - Obtundation (ie, arousable only with strong stimuli, lessened interest in environment, slowed responses to stimulation)
  - Stupor (ie, may be arousable but patient does not return to normal baseline level of awareness)
  - Coma (ie, not arousable)

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Bradycardia

- Bradycardia[A], as indicated by **1 or more** of the following(1)(2)(3):
  - Heart rate less than 50 beats per minute in adult (age 18 years or older)[B]
  - Heart rate less than 55 beats per minute in adolescent 13 to 17 years of age
  - Heart rate less than 60 beats per minute in child or adolescent 6 to 12 years of age
  - Heart rate less than 65 beats per minute in child 3 to 5 years of age
  - Heart rate less than 70 beats per minute in child 1 to 2 years of age
  - Heart rate less than 80 beats per minute in infant 6 to 11 months of age
  - Heart rate less than 90 beats per minute in infant 3 to 5 months of age

References

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Footnotes

A. Criteria based upon clinician-acquired numeric values (eg, vital signs, oxygen saturation) should be used if they are accurate reflections of the patient's condition. Transitory findings (eg, abnormal only upon initial emergency department intake or only one time out of multiple readings) that rapidly improve with no or minimal treatment usually do not reflect disease severity or risk for deterioration. This does not imply that an initial or one-time reading cannot ever be applicable. The goal is to separate erroneous or incidental findings from those that truly represent the patient's clinical picture.

B. An evidence-based specialty society guideline has defined bradycardia in adults as less than 50 beats per minute.(1)

Hemodynamic instability

- Hemodynamic instability, as indicated by **1 or more** of the following:
  - Vital sign abnormality not corrected by appropriate treatment, as indicated by **1 or more** of the following[A]:
    - Tachycardia that persists despite appropriate treatment (eg, treatment of underlying cause, despite observation care)[A]
    - Hypotension that persists despite appropriate treatment (eg, treatment of underlying cause, despite observation care)[A]
    - Orthostatic hypotension that persists despite appropriate treatment (eg, treatment of underlying cause, despite observation care)[A]
  - Severe hypotension in adult patient, as indicated by **1 or more** of the following:
    - Systolic blood pressure less than 80 mm Hg(1)[A]
    - Shock index greater than 1.0 (shock index is the heart rate divided by systolic blood pressure)[A](2)(3)(4)
    - Mean arterial pressure[B] less than 65 mm Hg MAP Calculator[A](1)(6)
    - IV inotropic or vasopressor medication required to maintain adequate blood pressure or perfusion(3)(6)
    - Hypoperfusion due to hypotension, as indicated by **ALL** of the following:
      - Hypotension
      - Evidence of hypoperfusion, as indicated by **1 or more** of the following:
        - Lactate of 2.0 mmol/L (18 mg/dL) or more secondary to hypotension (ie, hypoperfusion)[C](3)(6)(8)
        - Metabolic acidosis (arterial or venous[D] pH less than 7.35) not otherwise explained(3)(6)(8)
        - Significant end organ dysfunction due to hypotension (eg, Altered mental status, myocardial ischemia, 2-fold or higher acute increase in serum creatinine)(3)(6)
  - Severe hypotension in pediatric patient, as indicated by **1 or more** of the following:
    - Systolic blood pressure less than 80 mm Hg in child 6 to 17 years of age[A](14)
    - Systolic blood pressure less than 75 mm Hg in child 6 months to 5 years of age[A](14)
    - Shock index greater than 0.9 in child 13 to 17 years of age (shock index is the heart rate divided by systolic blood pressure)[A](2)(15)
    - Shock index greater than 1.0 in child 7 to 12 years of age (shock index is the heart rate divided by systolic blood pressure)[A](2)(15)
    - Shock index greater than 1.2 in child 4 to 6 years of age (shock index is the heart rate divided by systolic blood pressure)[A](2)(15)
    - IV inotropic or vasopressor medication required to maintain adequate blood pressure or perfusion(5)(6)
    - Hypoperfusion due to hypotension, as indicated by **ALL** of the following:
      - Hypotension
      - Evidence of hypoperfusion, as indicated by **1 or more** of the following:
        - Lactate of 2.0 mmol/L (18 mg/dL) or more secondary to hypotension (ie, hypoperfusion)[C](6)(8)
        - Metabolic acidosis (arterial or venous pH less than 7.35) not otherwise explained[D](5)(6)(14)
        - Significant end organ dysfunction due to hypotension (eg, Altered mental status, myocardial ischemia, 2-fold or higher acute increase in serum creatinine)(5)(6)(14)

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1. Schriger DL. Approach to the patient with abnormal vital signs. In: Goldman L, Cooney KA, editors. Goldman-Cecil Medicine. 27th ed. Elsevier; 2024:32-35.
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Footnotes

A. Criteria based upon clinician-acquired numeric values (eg, vital signs, oxygen saturation) should be used if they are accurate reflections of the patient's condition. Transitory findings (eg, abnormal only upon initial emergency department intake or only one time out of multiple readings) that rapidly improve with no or minimal treatment usually do not reflect disease severity or risk for deterioration. This does not imply that an initial or one-time reading cannot ever be applicable. The goal is to separate erroneous or incidental findings from those that truly represent the patient's clinical picture.
B. The mean arterial pressure (MAP) takes into account both SBP and DBP readings.(3)(5)
C. There are numerous causes of an elevated lactate level. The most common are cardiogenic or hypovolemic shock, severe heart failure, severe trauma, or sepsis. However, there are also other etiologies to consider such as vigorous exercise, seizures, liver disease, or medication use (eg, metformin, beta2-agonists); therefore, interpretation of elevated lactate levels requires consideration of the clinical context (eg, well-appearing post exercise vs hypotensive). The severity and persistence of the elevation can sometimes be helpful in this differentiation. In most instances of lactic acidosis, blood pH is less than 7.35, with a serum bicarbonate level of 20 mEq/L (mmol/L) or lower. However, a coexisting respiratory or metabolic alkalosis can mask these findings.(7)(8)
D. Analyses have concluded that venous and arterial pH measurements are highly correlated, with small differences between them that are usually not clinically significant.(9)(10)(11)(12)(13) If a mixed acid-base disorder is suspected, an arterial blood gas is indicated.(10)

Hypotension

- Hypotension, as indicated by **1 or more** of the following:
  - Hypotension in adult patient, as indicated by **1 or more** of the following:
    - Systolic blood pressure less than 90 mm Hg[A][B](1)
    - Mean arterial pressure[C] less than 70 mm Hg[A][B] MAP Calculator(1)(2)
    - Decrease in baseline systolic blood pressure of 30 mm Hg or more, with significant signs or symptoms due to lower blood pressure (eg, near syncope, syncope, chest pain)[A][B](1)
  - Hypotension in pediatric patient, as indicated by **1 or more** of the following:
    - Systolic blood pressure less than 110 mm Hg in child 13 to 17 years of age[A][D](3)
    - Systolic blood pressure less than 100 mm Hg in child 6 to 12 years of age[A][D](3)
    - Systolic blood pressure less than 95 mm Hg in child 3 to 5 years of age[A][D](3)
    - Systolic blood pressure less than 90 mm Hg in child 1 or 2 years of age[A][D](3)
    - Systolic blood pressure less than 80 mm Hg in infant 6 to 11 months of age[A][D](3)
    - Systolic blood pressure less than 70 mm Hg in infant 3 to 5 months of age[A][D](3)
    - Systolic blood pressure less than 65 mm Hg in infant 1 or 2 months of age[A][D](3)

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B. Interpretation of blood pressure requires clinical judgment and consideration of several patient-specific factors, such as the patient's baseline blood pressure, medications, and clinical impact. For example, an elderly patient with heart failure may be prescribed medication with the intentional goal of a reduced pressure. If the patient's baseline SBP is 92 mm Hg to 96 mm Hg, absent signs or symptoms of hypotension, an emergency department SBP of 86 mm Hg should not automatically be categorized as hypotensive. This would hold for mean arterial pressure (MAP) as well. The numeric values included in this definition are provided to allow for consistency in terms of a technical definition of the term hypotension. Whether a blood pressure below the technical threshold is clinically meaningful is a matter of persistence, context, and clinical judgment.

C. The mean arterial pressure (MAP) takes into account both SBP and DBP readings.

D. Interpretation of blood pressure requires clinical judgment and consideration of several patient-specific factors, such as the patient's baseline blood pressure, medications, and clinical impact. The numeric values included in this definition are provided to allow for consistency in terms of a technical definition of the term hypotension. Whether a blood pressure below the technical threshold is clinically meaningful is a matter of persistence, context, and clinical judgment.

Hypotension absent

- Hypotension absent,[A] as indicated by **1 or more** of the following:
  - Hypotension absent in adult patient, as indicated by **1 or more** of the following:
    - Systolic blood pressure greater than or equal to 90 mm Hg[A](1)
    - Mean arterial pressure[B] greater than or equal to 70 mm Hg MAP Calculator[A](1)(2)
    - Blood pressure at patient's baseline (eg, healthy adult with low systolic blood pressure), at intentional therapeutic goal (eg, patient with heart failure), or acceptable for next level of care (eg, blood pressure stable and no significant signs or symptoms due to low blood pressure)
  - Hypotension absent in pediatric patient, as indicated by **1 or more** of the following:
    - Systolic blood pressure greater than or equal to 110 mm Hg in child 13 to 17 years of age[A](3)
    - Systolic blood pressure greater than or equal to 100 mm Hg in child 6 to 12 years of age[A](3)
    - Systolic blood pressure greater than or equal to 95 mm Hg in child 3 to 5 years of age[A](3)
    - Systolic blood pressure greater than or equal to 90 mm Hg in child 1 or 2 years of age[A](3)
    - Systolic blood pressure greater than or equal to 80 mm Hg in infant 6 to 11 months of age[A](3)
    - Systolic blood pressure greater than or equal to 70 mm Hg in infant 3 to 5 months of age[A](3)
    - Systolic blood pressure greater than or equal to 65 mm Hg in infant 1 or 2 months of age[A](3)
    - Blood pressure at patient's baseline (eg, healthy child with low systolic blood pressure), at intentional therapeutic goal, or acceptable for next level of care (eg, blood pressure stable and no significant signs or symptoms due to low blood pressure)

References

1. Schriger DL. Approach to the patient with abnormal vital signs. In: Goldman L, Cooney KA, editors. Goldman-Cecil Medicine. 27th ed. Elsevier; 2024:32-35.
2. Puskarich MA, Jones AE. Shock. In: Walls RM, editor. Rosen's Emergency Medicine: Concepts and Clinical Practice. 10th ed. Elsevier; 2023:34-41.e1.
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Footnotes

A. Criteria based upon clinician-acquired numeric values (eg, vital signs, oxygen saturation) should be used if they are accurate reflections of the patient's condition. Transitory findings (eg, abnormal only upon initial emergency department intake or only one time out of multiple readings) that rapidly improve with no or minimal treatment usually do not reflect disease severity or risk for deterioration. This does not imply that an initial or one-time reading cannot ever be applicable. The goal is to separate erroneous or incidental findings from those that truly represent the patient's clinical picture.
B. The mean arterial pressure (MAP) takes into account both SBP and DBP readings.

Hypoxemia

- Hypoxemia, as indicated by **1 or more** of the following(1):
  - Patient without baseline need for supplemental oxygen with oxygen saturation (SpO_2) of less than 90% or arterial blood gas partial pressure of oxygen (PaO_2) of less than 60 mm Hg (8.0 kPa) on room air[A][B]
  - Patient without baseline need for supplemental oxygen who now requires supplemental oxygen to keep SpO_2 greater than 89% or PaO_2 greater than 59 mm Hg (7.9 kPa)[A]
  - Patient with baseline need for supplemental oxygen who now requires increased supplemental oxygen to maintain oxygenation at baseline or acceptable level

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Footnotes

A. Pulse oximetry (SpO_2) may underestimate arterial saturation (SaO_2), especially in people with dark skin pigmentation, thick skin, cold body temperature, or who are wearing colored nail polish, and thus may not accurately detect hypoxemia.(2) Where appropriate, pulse oximetry should be measured after warming fingers or removing nail polish. Pulse oximetry results should be assessed within the context of the patient's clinical presentation, and performance of an arterial blood gas considered for a more accurate assessment of oxygenation if indicated.(2) Specific target values may require adjustment when care is delivered at high altitude.(3)
B. Criteria based upon clinician-acquired numeric values (eg, vital signs, oxygen saturation) should be used if they are accurate reflections of the patient's condition. Transitory findings (eg, abnormal only upon initial emergency department intake or only one time out of multiple readings) that rapidly improve with no or minimal treatment usually do not reflect disease severity or risk for deterioration. This does not imply that an initial or one-time reading cannot ever be applicable. The goal is to separate erroneous or incidental findings from those that truly represent the patient's clinical picture.

Hypoxemia absent

- Hypoxemia absent, as indicated by **1 or more** of the following(1):
  - Arterial oxygen saturation (SpO_2) of 90% or greater or arterial partial pressure of oxygen (PaO_2) of 60 mm Hg (8.0 kPa) or greater on room air[A][B]
  - Oxygen requirements are stable and arranged for at next level of care.

References

1. Schriger DL. Approach to the patient with abnormal vital signs. In: Goldman L, Cooney KA, editors. Goldman-Cecil Medicine. 27th ed. Elsevier; 2024:32-35.
2. Rojas-Camayo J, et al. Reference values for oxygen saturation from sea level to the highest human habitation in the Andes in acclimatised persons. Thorax 2018;73(8):776-778. DOI: 10.1136/thoraxjnl-2017-210598.

Footnotes

A. Specific target values (ie, 90% or 60 mm Hg (8.0 kPa)) may require adjustment when care is delivered at high altitude.(2)
B. Criteria based upon clinician-acquired numeric values (eg, vital signs, oxygen saturation) should be used if they are accurate reflections of the patient's condition. Transitory findings (eg, abnormal only upon initial emergency department intake or only one time out of multiple readings) that rapidly improve with no or minimal treatment usually do not reflect disease severity or risk for deterioration. This does not imply that an initial or one-time reading cannot ever be applicable. The goal is to separate erroneous or incidental findings from those that truly represent the patient's clinical picture.

Orthostatic hypotension

- Orthostatic hypotension,[A][B] as indicated by **1 or more** of the following(1)(2)(3):

- Fall in SBP of 20 mm Hg or more 1 to 3 minutes after patient sits or stands from recumbent position
- Fall in DBP of 10 mm Hg or more 1 to 3 minutes after patient sits or stands from recumbent position

References

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Footnotes

A. Concomitant measurements of the heart rate are important to measure to help diagnose subtypes of orthostatic hypotension (eg, the lack of a compensatory increase in heart rate is typical of autonomic failure and an exaggerated tachycardia may be reflective of volume depletion). However, the heart rate is not a component of the definition of orthostatic hypotension, which relies upon blood pressure alone.(1)(2)(3)

B. Criteria based upon clinician acquired numeric values (eg, vital signs, oxygen saturation) should be used if they are accurate reflections of the patient's condition. Transitory findings (eg, abnormal only upon initial emergency department intake or only one time out of multiple readings) that rapidly improve with no or minimal treatment usually do not reflect disease severity or risk for deterioration. This does not imply that an initial or one-time reading cannot ever be applicable. The goal is to separate erroneous or incidental findings from those that truly represent the patient's clinical picture.

Tachycardia

- Tachycardia,[A][B] as indicated by **1 or more** of the following:
  - Heart rate greater than 100 beats per minute in adult[A][B](1)
  - Heart rate greater than 85 beats per minute in child 13 to 17 years of age[A][C](2)
  - Heart rate greater than 95 beats per minute in child 6 to 12 years of age[A][C](2)
  - Heart rate greater than 110 beats per minute in child 1 to 5 years of age[A][C](2)
  - Heart rate greater than 120 beats per minute in infant 3 to 11 months of age[A][C](2)
  - Heart rate greater than 150 beats per minute in infant 1 or 2 months of age[A][C](2)

References

1. Schriger DL. Approach to the patient with abnormal vital signs. In: Goldman L, Cooney KA, editors. Goldman-Cecil Medicine. 27th ed. Elsevier; 2024:32-35.
2. Anderson CC, Kapoor S, Mark TE. Pediatric parameters and equipment. In: Anderson CC, Kapoor S, Mark TE, editors. The Harriet Lane Handbook: A Manual for Pediatric House Officers. 23rd ed. Elsevier; 2024:i-iii.

Footnotes

A. Criteria based upon clinician acquired numeric values (eg, vital signs, oxygen saturation) should be used if they are accurate reflections of the patient's condition. Transitory findings (eg, abnormal only upon initial emergency department intake or only one time out of multiple readings) that rapidly improve with no or minimal treatment usually do not reflect disease severity or risk for deterioration. This does not imply that an initial or one-time reading cannot ever be applicable. The goal is to separate erroneous or incidental findings from those that truly represent the patient's clinical picture.

B. Interpretation of heart rate requires clinical judgment and consideration of several patient-specific factors, such as the patient's baseline heart rate, medications, and clinical impact. For example, an elderly patient on a beta-blocker medication with a baseline resting heart rate of 60 beats per minute may be clinically tachycardic at a heart rate of 94 beats per minute. Likewise, a patient who is upset, in pain, or nervous in the emergency department with a heart rate of 106 beats per minute may meet the technical definition of tachycardia, but this tachycardia (absent associated findings such as chest pain or hypotension) may not be clinically important. The numeric values included in this definition are provided to allow for consistency in terms of a technical definition of the term tachycardia. Whether a heart rate above or below the technical threshold is clinically meaningful is a matter of persistence, context, and clinical judgment.

C. Interpretation of heart rate requires clinical judgment and consideration of several patient-specific factors, such as the patient's baseline heart rate, medications, and clinical impact. A patient who is upset, in pain, or nervous in the emergency department with an elevated heart rate may meet the technical definition of tachycardia, but this tachycardia (absent associated findings such as hypotension) may not be clinically important. The numeric values included in this definition are provided to allow for consistency in terms of a technical definition of the term tachycardia. Whether a heart rate above or below the technical threshold is clinically meaningful is a matter of persistence, context, and clinical judgment.

Tachypnea

- Tachypnea,[A][B] as indicated by **1 or more** of the following:
  - Respiratory rate greater than 20 breaths per minute in adult[A][B](1)
  - Respiratory rate greater than 18 breaths per minute in child 13 to 17 years of age[A][B](2)
  - Respiratory rate greater than 22 breaths per minute in child 6 to 12 years of age[A][B](2)
  - Respiratory rate greater than 25 breaths per minute in child 3 to 5 years of age[A][B](2)
  - Respiratory rate greater than 30 breaths per minute in child 1 or 2 years of age[A][B](2)
  - Respiratory rate greater than 40 breaths per minute in infant 6 to 11 months of age[A][B](2)
  - Respiratory rate greater than 45 breaths per minute in infant 3 to 5 months of age[A][B](2)
  - Respiratory rate greater than 55 breaths per minute in infant 1 or 2 months of age[A][B](2)

References

1. Schriger DL. Approach to the patient with abnormal vital signs. In: Goldman L, Cooney KA, editors. Goldman-Cecil Medicine. 27th ed. Elsevier; 2024:32-35.
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B. Interpretation of respiratory rate requires clinical judgment and consideration of several patient-specific factors, such as the patient's baseline respiratory rate and whether the respiratory rate is indicative of significant underlying respiratory or other pathology. A mildly increased respiratory rate (eg, 20 to 22 breaths per minute in an adult), absent other indications of serious illness (eg, hypoxemia, metabolic acidosis, decreased tidal volume, pain), may be transitory and not clinically important. The numeric values included in this definition are provided to allow for consistency in terms of a technical definition of the term tachypnea. Whether a respiratory rate above the technical threshold is clinically meaningful is a matter of persistence, context, and clinical judgment. In addition, the measurement of the respiratory rate is subject to error. A medical textbook states that because there can be significant breath-to-breath variation in respiratory

rate, the rate should be assessed for at least 30 seconds, preferably for a full minute.(1) This same textbook also states that new technologies designed to measure the respiratory rate have not proved to be clinically useful.(1)

Tachypnea absent

- Tachypnea[A][B] absent, as indicated by **1 or more** of the following:
  - Respiratory rate less than or equal to 20 breaths per minute in adult[A][B](1)
  - Respiratory rate less than or equal to 18 breaths per minute in child 13 to 17 years of age[A][B](2)
  - Respiratory rate less than or equal to 22 breaths per minute in child 6 to 12 years of age[A][B](2)
  - Respiratory rate less than or equal to 25 breaths per minute in child 3 to 5 years of age[A][B](2)
  - Respiratory rate less than or equal to 30 breaths per minute in child 1 or 2 years of age[A][B](2)
  - Respiratory rate less than or equal to 40 breaths per minute in infant 6 to 11 months of age[A][B](2)
  - Respiratory rate less than or equal to 45 breaths per minute in infant 3 to 5 months of age[A][B](2)
  - Respiratory rate less than or equal to 55 breaths per minute in infant 1 or 2 months of age[A][B](2)

References

1. Schriger DL. Approach to the patient with abnormal vital signs. In: Goldman L, Cooney KA, editors. Goldman-Cecil Medicine. 27th ed. Elsevier; 2024:32-35.
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Codes

ICD-10 Diagnosis: I44.1, I44.2, I44.30, I45.3, I45.5, I45.6, I45.81, I45.89, I45.9, I47.0, I47.10, I47.19, I47.9, I48.3, I48.4, I48.92, I49.01, I49.02, I49.1, I49.2, I49.40, I49.5, I49.8, I49.9, I97.190, I97.191, I97.790, I97.791, I97.88, I97.89 [Hide]

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