Cardiovascular Surgery or Procedure GRG

GRG: SG-CVS (ISC GRG)

MCG Health
General Recovery Care
30th Edition
Surgical Admission Case Management GRG GRG

Note: An appropriate Optimal Recovery Guideline (ORG) should be identified and used whenever possible. This General Recovery Guideline (GRG) is intended to aid only in situations in which no ORG appears applicable.

Care Planning - Inpatient Admission and Alternatives

Clinical Indications for Procedure

- Surgery or other procedure covered by this guideline is indicated for **1 or more** of the following:
  - Embolectomy, atherectomy, thrombectomy, thrombolysis, endarterectomy, angioplasty, arterialization, or bypass needed, as indicated by **1 or more** of the following (for lower limb indications, see Aortofemoral or Aortoiliac Bypass ISC, Femoral Popliteal Bypass ISC, or Percutaneous Revascularization, Lower Extremity ISC as appropriate)(1)(2)(3)(4)(5)(6)(7)(8):
    - Acute limb ischemia and salvageable limb (category I or II acute limb ischemia)[A](4)(9)
    - Severe disabling claudication or other severe disability from ischemia(10)

- Chronic limb-threatening ischemia[B] (also known as "critical limb ischemia"), as indicated by **ALL** of the following(1)(4)(5)(6)(10)(11):
  - Severe limb ischemia present for 2 weeks or longer and **1 or more** of the following:
    - Pain at rest
    - Nonhealing wound or ulcer from ischemia (eg, wound progresses or fails to reduce in size by 50% or more despite 4 weeks of appropriate medical therapy)
    - Gangrene
  - Documentation of significant occlusive arterial disease (eg, imaging, angiography)
  - Lesion(s) thought to be hemodynamically significant and likely limiting perfusion[C]
- Atheroembolic phenomena producing gangrene in one or more digits ("blue toe syndrome")(2)
- Popliteal artery aneurysm, as indicated by **1 or more** of the following(12):
  - Asymptomatic aneurysm that is 2.0 cm or greater
  - Aneurysm that is less than 2.0 cm with thrombus, suspicion of embolism, or imaging showing poor distal runoff
  - Symptomatic aneurysm (eg, pain, swelling, thromboembolism)
- Mural or floating aortic thrombus requiring open thrombectomy or repair(13)(14)(15)
- Femoral artery pseudoaneurysm repair needed (eg, endovascular stent or repair, excision with revascularization, or surgical ligation with debridement)[D](16)
- Pulmonary artery endarterectomy needed for chronic thromboembolic pulmonary hypertension, as indicated by **ALL** of the following(17)(18):
  - Chronic thromboembolic disease demonstrated (eg, CT angiogram, ventilation-perfusion SPECT scan, catheter-based pulmonary angiogram)
  - Significant pulmonary arterial hypertension present, as indicated by **1 or more** of the following:
    - Resting mean pulmonary artery pressure of 20 mm Hg or greater without elevated left ventricular end-diastolic pressure (eg, pulmonary artery wedge pressure less than 15 mm Hg, or no elevated left ventricular end-diastolic pressure by echocardiogram or left heart catheterization)
    - Exercise mean pulmonary artery pressure of 20 mm Hg or greater with no other attributable etiology (eg, cardiac or alternative pulmonary diagnoses have been excluded)
- Venous thrombectomy or thrombolysis needed (eg, limb-threatening thrombosis, thrombus resistant to thrombolysis, patient with contraindication to thrombolysis)[E](19)(20)(21)(22)(23)(24)
- Mesenteric ischemia(25)(26)
- Midaortic syndrome with refractory hypertension or ischemic symptoms (eg, postprandial pain, headache, claudication)(27)
- Other clinically significant vascular abnormality that requires intervention (eg, subclavian steal syndrome with cerebrovascular symptoms)(28)

- Transmyocardial laser revascularization needed,[F] as indicated by **ALL** of the following(29)(30)(31):
  - Canadian Cardiovascular Society class III or IV angina[G] despite maximally tolerated medical therapy (eg, beta-blockers, nitrates)
  - Procedure being performed in conjunction with CABG
- Percutaneous laser revascularization needed,[H] as indicated by **ALL** of the following(31)(33):
  - Canadian Cardiovascular Society class III or IV angina[G] despite maximally tolerated medical therapy (eg, beta-blockers, nitrates)
  - Surgical or percutaneous revascularization failed or not feasible
- Closure of patent ductus arteriosus needed (thoracoscopic or open approach), as indicated by **1 or more** of the following(34):
  - Neonate[I] with patent ductus arteriosus and **ALL** of the following(34)(36):
    - Age 14 days or older[J](34)
    - Failure to improve with 2 courses of pharmacologic therapy (eg, ibuprofen, acetaminophen, indomethacin) or contraindication to pharmacologic therapy(34)
    - Hemodynamically significant left-to-right shunt, as indicated by **ALL** of the following[K](34):

- Clinical sequelae of shunt (eg, hypotension requiring vasopressor, persistent oliguria or renal dysfunction, abdominal distention, poor growth, history of necrotizing enterocolitis, requirements for high FiO_2 or noninvasive or invasive ventilatory support)
- Echocardiogram criteria for left-sided volume overload, including **1 or more** of the following:
  - Ductus diameter greater than 1.5 mm
  - Unrestrictive left-to-right transductal flow (eg, patent ductus arteriosus maximum flow velocity (PDA maximum velocity) less than 2 m/sec)
  - Left atrial or ventricle enlargement
  - Decreased, absent, or reversed end-diastolic flow in descending abdominal aorta

- Transcatheter approach not feasible or not appropriate[L]

− Infant past neonatal age,[I] child, or adult with patent ductus arteriosus and **ALL** of the following(36)(39):

- No evidence of net right-to-left shunt[K]
- Net left-to-right shunt due to patent ductus arteriosus
- Transcatheter approach not feasible or not appropriate[L]

− Transcatheter closure of ventricular septal defect needed, as indicated by **1 or more** of the following:

- Pediatric (18 years or younger) patient weighing 5 kg (11 lb) or more with hemodynamically significant muscular ventricular septal defect and suitable anatomy for transcatheter closure(40)
- Neonate, infant, or child weighing less than 5 kg (11 lb) with hemodynamically significant muscular ventricular septal defect and associated cardiac defects suitable for transcatheter closure of ventricular septal defect in conjunction with cardiopulmonary bypass and repair of associated lesions (eg, hybrid procedure)(40)

− Defect in adult with **ALL** of the following(39)(40):

- Treatment needed, as indicated by **1 or more** of the following:
  - Left-to-right shunt and pulmonary to systemic flow ratio greater than or equal to 1.5(39)
  - Left-to-right shunt and left heart failure (eg, left ventricular volume overload)(39)
  - History of infective endocarditis(39)
  - Progressive aortic regurgitation(36)(39)
  - Postmyocardial infarction ventricular septal defect(41)
  - Supracristal (subaortic) defect with worsening aortic regurgitation[M](39)
- No contraindications (eg, Eisenmenger syndrome (net right-to-left shunt), severe irreversible pulmonary hypertension (pulmonary artery pressure or pulmonary vascular resistance greater than 2/3 systemic))[N](39)
- Anatomy suitable for transcatheter closure(40)(41)

- Creation or enlargement of atrial septal defect (eg, balloon septostomy, stent, atrial flow regulator device, or surgical intervention) for progressive pulmonary hypertension and right ventricular failure despite optimal anti-pulmonary hypertensive medications(18)(43)
- Transcatheter or surgical placement of pulmonary-to-systemic shunt needed, as indicated by **ALL** of the following(18)(43):
  - Child with progressive pulmonary hypertension despite optimal anti-pulmonary hypertensive medications
  - Suprasystemic right ventricular pressure (mean pulmonary artery pressure is greater than mean systemic arterial pressure, or right ventricular systolic pressure is greater than systemic systolic pressure)

− Transcatheter mitral valve replacement appropriate, as indicated by **ALL** of the following:

− Transcatheter replacement of mitral valve is appropriate, as indicated by **1 or more** of the following[O](44):

- Severe mitral stenosis (mitral valve area of 1.5 cm^2 or less or diastolic pressure half time of 150 msec or greater)

− Moderate-severe or severe mitral regurgitation, as indicated by **1 or more** of the following(45)(46):

- Documented echocardiogram reading of moderate-severe (3+) or severe (4+) mitral regurgitation
- Regurgitant volume 60 mL per beat or greater(47)

- Regurgitant fraction 50% or greater(47)
- Pulmonary vein systolic flow reversal(45)(46)
- Effective regurgitant orifice area 0.30 cm^2 or greater(45)(46)
- Effective regurgitant orifice area 0.20 cm^2 or greater and less than 0.30 cm^2 and **1 or more** of the following(45)(46):
  - Regurgitant volume 45 mL per beat or greater
  - Regurgitant fraction of 40% or greater
  - Vena contracta width 0.5 cm or greater
- Effective regurgitant orifice area less than 0.20 cm^2 or not measured and **2 or more** of the following(45)(46):
  - Regurgitant volume 45 mL per beat or greater
  - Regurgitant fraction of 40% or greater
  - Vena contracta width 0.5 cm or greater
  - Holosystolic jet 6.0 cm or greater around left atrium
  - Peak E velocity 150 cm/sec or greater

- Severe mitral annular calcification with combined moderate mitral regurgitation and moderate or greater mitral stenosis, as indicated by **ALL** of the following:
  - Moderate or greater mitral regurgitation, as indicated by **1 or more** of the following(46):
    - Effective regurgitant orifice area 0.20 cm^2 or greater
    - Regurgitant volume 30 mL per beat or greater
    - Regurgitant fraction of 30% or greater
  - Moderate or severe mitral stenosis, as indicated by mitral valve area of 2.0 cm^2 or less(48)
- Failed bioprosthetic mitral valve or annuloplasty ring (eg, valve-in-valve or valve-in-ring replacement for severe stenosis or moderate to severe regurgitation needed due to device failure)[P](49)(50)(51)

- New York Heart Association (NYHA) class II, III, or IV heart failure symptoms despite guideline-directed medical therapy (GDMT)
- High surgical risk (eg, Society of Thoracic Surgeons Predicted Risk of Mortality (STS-PROM) score greater than 8%)
- Valve anatomy not suitable for transcatheter mitral valve repair

− Transcatheter pulmonary valve replacement, as indicated by **1 or more** of the following[Q](39)(53):

- Moderate or severe stenosis or regurgitation of the right ventricle to pulmonary artery conduit (peak gradient greater than 36 mm Hg or peak velocity greater than 3 m/sec) with reduced exercise capacity or arrhythmia(39)
- Severe stenosis or regurgitation of the right ventricle to pulmonary artery conduit (peak gradient greater than 64 mm Hg or peak velocity greater than 4 m/sec) with reduced right ventricular ejection fraction or right ventricular dilation(39)

− Pulmonary valve stenosis, as indicated by **ALL** of the following(39)(52):

- Pulmonary stenosis ranked as severe, as indicated by **1 or more** of the following:
  - Maximal pulmonic jet velocity 4.0 m/sec or more
  - Valve area index less than 0.5 cm^2/m^2 indexed to body surface area
  - Peak instantaneous Doppler gradient of greater than 64 mm Hg
  - Mean Doppler gradient of greater than 35 mm Hg
  - Right ventricular systolic pressure of more than 80 mm Hg
- Patient is not candidate for percutaneous balloon valvotomy (eg, valve characteristics not suitable for valvotomy, significant regurgitation present).

− Pulmonary regurgitation after prior repair of pulmonary valve stenosis[R] (eg, balloon valvotomy or surgical repair), as indicated by **ALL** of the following(39)(54)(55):

- Severity of regurgitation is ranked as moderate or severe, as indicated by **1 or more** of the following(46):

- Documented echocardiogram reading of moderate or severe pulmonary valve regurgitation
- Regurgitant fraction by cardiac MRI 20% or greater
- Regurgitant jet width/annulus ratio 70% or greater
- Pressure half time less than 100 msec
- Early termination of regurgitant flow
- Diastolic flow reversal in pulmonary artery branches
- Dilated right ventricle with normal function

- Correction of regurgitation clinically appropriate, as indicated by **1 or more** of the following(39):
  - Symptoms due to regurgitation (eg, dyspnea, decreased exercise tolerance)
  - Progressive right ventricular dilation
  - Progressive right ventricular dysfunction
  - Progressive reduction in exercise tolerance(39)

− Pulmonary regurgitation after congenital heart disease (eg, Tetralogy of Fallot) repair,[R] as indicated by **ALL** of the following(39)(54)(55):

- Severity of regurgitation is ranked as moderate or severe, as indicated by **1 or more** of the following(46):
  - Documented echocardiogram reading of moderate or severe pulmonary valve regurgitation
  - Regurgitant fraction by cardiac MRI 20% or greater
  - Regurgitant jet width/annulus ratio 70% or greater
  - Pressure half time less than 100 msec
  - Early termination of regurgitant flow
  - Diastolic flow reversal in pulmonary artery branches
  - Dilated right ventricle with normal function
- Correction of regurgitation clinically appropriate, as indicated by **1 or more** of the following(39)(56):
  - Symptoms due to regurgitation (eg, dyspnea, decreased exercise tolerance)(39)(56)
  - Development of symptomatic or sustained atrial or ventricular arrhythmias(39)
  - Asymptomatic patient and **2 or more** of the following(39):
    - Mild or moderate right ventricular or left ventricular systolic dysfunction(39)
    - Severe right ventricular enlargement (eg, right ventricular end diastolic volume index 160 mL/m^2 or greater, right ventricular end systolic volume index 80 mL/m^2, or right ventricular end diastolic volume that is 2 or more times greater than the left ventricular end diastolic volume)(39)
    - Progressive right ventricular dilation or dysfunction(39)(56)
    - Right ventricular systolic pressure is at least 2/3 or greater than the systemic blood pressure
    - Progressive reduction in exercise tolerance(39)

- Failed surgical bioprosthetic pulmonary valve (valve-in-valve replacement necessary due to severe stenosis or regurgitation from device failure)(52)(57)(58)(59)

− Transcatheter tricuspid valve replacement, as indicated by **ALL** of the following[S](60)(61)(62):

− Tricuspid regurgitation ranked as severe or greater,[T] as indicated by **1 or more** of the following(61):

- Central jet of tricuspid regurgitation 50% or more of right atrial area
- Vena contracta width of 0.7 cm or more
- Effective regurgitant orifice area 0.40 cm^2 or greater
- Regurgitant volume 45 mL per beat or greater
- Dense continuous wave signal with triangular shape
- Hepatic vein systolic flow reversal

- Symptoms of tricuspid regurgitation (eg, NYHA class II or greater, peripheral edema, ascites)
- Failure of, or inadequate response to, optimal medical therapy
- Left ventricle ejection fraction greater than 25%
- No severe pulmonary hypertension (eg, pulmonary artery systolic pressure less than 70 mm Hg by right heart catheterization or less than 60 mm Hg by echocardiogram, pulmonary vascular resistance 5 Wood units (400 dynes*sec/cm^5) or less (either baseline or after vasodilator trial))
- Intermediate or high surgical risk (eg, STS-PROM score 4% or higher)

− Transcatheter tricuspid valve repair, as indicated by **ALL** of the following[U](61)(63)(64)(65):

− Tricuspid regurgitation ranked as severe or greater,[T] as indicated by **1 or more** of the following(47):

- Central jet of tricuspid regurgitation 50% or more of right atrial area
- Vena contracta width of 0.7 cm or more
- Effective regurgitant orifice area 0.40 cm^2 or greater
- Regurgitant volume 45 mL per beat or greater
- Dense continuous wave signal with triangular shape
- Hepatic vein systolic flow reversal

- NYHA functional class II or higher symptoms despite optimal medical therapy
- Left ventricle ejection fraction greater than 20%
- Pulmonary artery systolic pressure less than 70 mm Hg
- Intermediate or high surgical risk (eg, STS-PROM score 4% or higher)

− Balloon dilation or angioplasty, transcatheter device insertion, or video-assisted thoracoscopic intervention needed, as indicated by **1 or more** of the following:

- Congenital vascular anomaly(66)(67)
- Congenital cardiac defect(39)(66)(68)
- Chronic thromboembolic pulmonary hypertension unable to undergo pulmonary endarterectomy(17)(69)
- Persistent pulmonary hypertension following endarterectomy
- Venous lesion after deep venous thrombosis treatment with catheter-directed thrombolysis or pharmacomechanical thrombolysis (ie, post-thrombotic syndrome)(22)
- Other vascular abnormality

− Blood vessel resection, anastomosis, or replacement needed, as indicated by **1 or more** of the following:

- Arteriovenous fistula or malformation(70)(71)
- Trauma(72)(73)(74)(75)
- Embolic phenomenon
- Peripheral artery aneurysm(12)(76)
- Infection(76)(77)
- Stenosis or occlusion of previously operated vessel

− Saphenous vein stripping, ligation, or ablation needed, as indicated by **ALL** of the following(78)(79)(80):

- Duplex ultrasound or other imaging with reflux duration of 500 msec or more
- Symptoms of venous disease (eg, skin changes, venous ulcer, leg fatigue or pain, leg edema)(81)
- No evidence of clinically significant lower extremity arterial disease

− Perforator vein ablation, division, or ligation needed, as indicated by **ALL** of the following(78)(79)(80):

- Vessel diameter greater than 3.5 mm
- Net outward flow duration of greater than 500 msec
- Findings associated with venous insufficiency, as indicated by **1 or more** of the following:

- Nonhealing, recurrent, or healed venous ulcer
- Vessel beneath area of impending skin breakdown
- Recurrent symptomatic varicose veins after complete ablation of superficial truncal veins

− Thoracoabdominal aneurysm repair needed, as indicated by **1 or more** of the following[V](13):

- Ruptured aneurysm
- Aneurysm 6.0 cm in diameter or larger
- Aneurysm 5.5 cm in diameter or larger and operation performed by experienced aortic surgical team and center[W]
- − Aneurysm less than 5.5 cm in diameter and **1 or more** of the following:
  - Increase in diameter of 0.5 cm per year or greater
  - Symptomatic aneurysm (eg, back, abdominal, or flank pain)
  - Change in aneurysm appearance on follow-up imaging
  - Saccular aneurysm
  - Infected (mycotic) aneurysm(13)
  - Penetrating atherosclerotic ulcer
  - Connective tissue disease (eg, Marfan, Loeys-Dietz, vascular Ehlers-Danlos syndrome)
- Aortic pseudoaneurysm[X](84)

− Hybrid open and endovascular thoracic aorta repair needed, as indicated by **1 or more** of the following[Y](84)(87):

- Aortic aneurysm involving the aortic arch and descending aorta(84)(87)
- Aortic dissection involving the aortic arch and descending aorta (eg, entry tear in the aortic arch)(84)(87)
- Descending (type B) aortic dissection with entry lesion less than 10 cm distal to the left subclavian artery(87)
- Descending (type B) aortic dissection with entry lesion in descending aorta and retrograde extension into the aortic arch(84)(87)
- Descending (type B) aortic dissection with anatomy not suitable for endovascular intervention alone (eg, entry lesion less than 10 cm distal to the left subclavian artery, large aortic arch)(87)

− Blood vessel repair (open or endovascular), occlusion, or embolization needed; indications include(75):

- Laceration
- Blunt trauma(88)
- Infection(13)(77)
- Intractable bleeding(89)(90)
- Arteriovenous fistula or malformation(70)(71)
- Visceral aneurysm(26)
- Treatment of malignancy (eg, hepatic artery embolization)[Z](91)

− Catheter or other vascular device procedure needed (eg, catheter or port placement, fistula creation, or related procedure), including **1 or more** of the following(92):

- Catheter placement for long-term access(93)
- Catheter or arteriovenous fistula placement for hemodialysis(94)(95)
- Arteriovenous fistula repair or removal (eg, malfunction, thrombosis, stenosis, infection)(95)
- Patient with peripheral arterial stenosis requiring large diameter vascular access for coronary, large vascular (eg, aortic stent), or valvular intervention (eg, transcatheter aortic valve replacement) and alternative access is unsuitable or unavailable(5)

- Inferior vena cava filter placement appropriate
- Cardiac arrhythmia or conduction defect requiring pacemaker(96)(97)(98)(99)

− Reinsertion, adjustment, replacement, or removal of pacemaker, defibrillator, ventricular assist device, or associated hardware (eg, wires), as indicated by **1 or more** of the following(96)(99):

- Device or intervention no longer desired or clinically indicated
- Device malfunction
- Lead malfunction, fracture, migration
- Infection (eg, pocket, endocarditis, lead or associated valve vegetation)(100)(101)
- Thrombosis
- Venous occlusion attributable to lead (eg, superior vena cava or upper extremity vein stenosis)
- Lead removal required for transvenous cardiac access
- Arrhythmia attributable to lead placement
- Severe pain attributable to device placement not controllable with other modalities
- Epicardial lead removal needed due to coronary artery compression or cardiac impingement
- Other dysfunction or complication necessitating intervention

- Intracardiac procedure needed (eg, tumor, mycotic aneurysm)(102)(103)(104)
- Surgical (rather than percutaneous transcatheter) left atrial appendage excision, exclusion, or occlusion needed in patient with atrial fibrillation undergoing cardiac surgery for another reason (eg, CABG, valve surgery)[AA](107)

− Surgical (rather than percutaneous transcatheter) ablation needed, as indicated by **1 or more** of the following:

- Patient with atrial fibrillation undergoing cardiac surgery (eg, CABG, valve surgery) for another reason(105)
- Hybrid epicardial and endocardial ablation pursued in a patient with persistent, symptomatic atrial fibrillation refractory to antiarrhythmic drug therapy(105)

− Surgical septal myectomy needed, as indicated by **ALL** of the following[BB](108):

- Obstructive hypertrophic cardiomyopathy
- Symptoms (NYHA class II or higher) refractory to negative inotropic agent (eg, beta-blocker, verapamil, disopyramide)
- Outflow gradient of 50 mm Hg either at rest or after exercise of provocative maneuvers (eg, Valsalva, amyl nitrite inhalation, sympathomimetic drug)

− Alcohol septal ablation needed, as indicated by **ALL** of the following[CC](108):

- Obstructive hypertrophic cardiomyopathy
- Symptoms (NYHA class III or IV) refractory to negative inotropic agent (eg, beta-blocker, verapamil, disopyramide)
- Outflow gradient of 50 mm Hg either at rest or after exercise of provocative maneuvers (eg, Valsalva, amyl nitrite inhalation, sympathomimetic drug)
- Surgical myectomy not preferred due to contraindication, high surgical risk (eg, advanced age, major comorbidities), or patient preference

− Cardiac contractility modulation device[DD] needed, as indicated by **ALL** of the following(109)(110):

- Heart failure NYHA functional class III or ambulatory class IV symptoms despite GDMT
- Reduced or mid-range ejection fraction (25% to 45%)
- Not candidate for cardiac resynchronization therapy

− Intra-aortic balloon pump or temporary (eg, nonimplanted) ventricular assist device[EE] needed, as indicated by **1 or more** of the following(111)(112)(113)(114)(115)(116):

- Life-threatening or severe cardiac dysfunction (eg, cardiogenic shock, acute heart failure) and **ALL** of the following:
  - Maximal medical therapy has failed to provide sufficient improvement.
  - Clinical improvement (ie, improved cardiac function) is anticipated (within reasonable degree of clinical certainty) with further medical or procedural treatment (care is not felt to be futile).
- Failure to wean off of cardiopulmonary bypass
- Cardiac or coronary intervention planned with particularly high risk for prolonged hypotension[FF]

- Long-term (eg, implanted) ventricular assist device[EE] appropriate, as indicated by **ALL** of the following(114)(115)(117)(124)(125):
  - Long-term ventricular assist device needed, as indicated by **1 or more** of the following:
    - Adult with heart failure with reduced ejection fraction and **1 or more** of the following(117)(125):
      - Continued NYHA class IIIb or IV symptoms despite maximally tolerated GDMT[GG](117)
      - Need for continuous intravenous inotropic support or temporary mechanical cardiac support (eg, intra-aortic balloon pump)(117)
      - Ejection fraction 25% or less and progressive end organ dysfunction(125)
      - Ejection fraction 25% or less and peak oxygen consumption less than 12 mL/kg/min on exercise testing(125)
    - Child with severe heart failure and **1 or more** of the following:
      - Congenital heart disease with NYHA or Ross class IV symptoms not responding to optimum medical management(126)
      - End organ failure despite optimum medical management (eg, progressive respiratory decompensation, liver or renal dysfunction due to congestion)(114)
      - Inotrope-dependent patient with reversible dysfunction of one or more major end organ(124)
      - Univentricular circulation requiring circulatory support (eg, as bridge to transplant or as destination therapy)(124)
    - Refractory ventricular arrhythmia with untreatable arrhythmogenic pathology (eg, giant cell myocarditis, scar, sarcoidosis)(114)(117)(125)
  - Long-term therapy appropriate, as indicated by **ALL** of the following:
    - No irreversible severe impairment of cognitive function
    - No recent or current psychiatric disease, drug abuse, or alcohol abuse that would be likely to impair treatment adherence
    - No condition (other than heart failure) that would limit survival to less than 1 year (eg, severe COPD, hepatic disease, malignancy)
    - No current systemic infection
    - No uncorrected moderate to severe aortic insufficiency
    - No severe right ventricular failure
    - No irreversible coagulopathy (ie, not correctable temporarily for procedure)
    - Patient appropriate for long-term anticoagulation
- Total artificial heart device appropriate (eg, as bridge to transplant), as indicated by **ALL** of the following(117)(125):
  - Total artificial heart device needed, as indicated by **1 or more** of the following:
    - Irreversible biventricular failure with failure to wean off temporary mechanical cardiac support or high-dose inotropic agents(117)
    - Massive myocardial infarction complicated by anatomic defects not amenable to surgical repair (eg, ventricular septal defect, wall rupture)(117)
    - End-stage heart failure with anatomy not amenable to left ventricular assist device placement (eg, restrictive or hypertrophic cardiomyopathy, cardiac tumor without atrial involvement, ventricular septal defect)(125)
    - Complex congenital heart disease with biventricular failure and difficult-to-repair or untreatable intracardiac shunt(117)(125)
    - Massive intracardiac thrombus not amenable to surgical or endovascular removal(117)
    - Refractory ventricular arrhythmia with untreatable arrhythmogenic pathology (eg, giant cell myocarditis, scar, sarcoidosis)(125)
  - Long-term therapy appropriate, as indicated by **ALL** of the following:
    - No irreversible severe impairment of cognitive function
    - No recent or current psychiatric disease, drug abuse, or alcohol abuse that would be likely to impair treatment adherence
    - No condition (other than heart failure) that would limit survival to less than 1 year (eg, severe COPD, hepatic disease, malignancy, irreversible end organ failure unless bridging to multiorgan transplant)
    - No current systemic infection
    - No irreversible coagulopathy (ie, not correctable temporarily for procedure)
    - Patient appropriate for long-term anticoagulation

- Venoarterial or venovenous extracorporeal membrane oxygenation (ECMO)[HH] required, as indicated by **1 or more** of the following:
  - Neonate[II] with respiratory failure and **ALL** of the following(132):
    - ECMO required for life-threatening finding that persists despite maximal medical therapy, as indicated by **1 or more** of the following:
      - Inadequate tissue oxygen delivery (eg, rising lactate, worsening metabolic acidosis, signs of end organ dysfunction)
      - Severe hypoxic respiratory failure with acute decompensation (eg, PaO_2 less than 40 mm Hg (5.3 kPa))
      - Oxygenation index higher than 40(133)
      - Severe pulmonary hypertension with right or left ventricular dysfunction
    - No contraindications to ECMO, as indicated by **ALL** of the following:
      - Clinical assessment that there is potential for recovery or ECMO is bridge to transplant, corrective surgery, or ventricular assist device
      - Vessel size is adequate for cannulation.
      - No lethal chromosomal disorder
      - No severe brain damage
      - No significant intraventricular hemorrhage (grade III or IV)
      - No uncontrollable bleeding
  - Infant (age 29 days to 1 year (corrected for gestational age)[JJ]) or child (age 2 to 17 years) with respiratory failure and **ALL** of the following(134):
    - Severe respiratory failure persists despite optimized conventional therapies and maneuvers (eg, patient has required 2 or more weeks of mechanical ventilation).(133)
    - Risk of mortality from respiratory failure is estimated to be 50% or higher.
    - No contraindications to ECMO, as indicated by **ALL** of the following:
      - Clinical assessment that there is potential for recovery or ECMO is bridge to transplant, corrective surgery, or ventricular assist device
      - No intracranial bleed with mass effect or need for neurosurgical intervention
      - No history of hypoxic cardiac arrest without adequate CPR
      - No irreversible cardiac or lung pathology (unless candidate for transplant)
      - No chronic lung disease with pulmonary hypertension
      - No incurable malignancy
      - Not an allogeneic bone marrow recipient with pulmonary infiltrates
      - No hepatic or renal failure
  - Patient up to 17 years of age with cardiogenic shock and **ALL** of the following(135):
    - Severe cardiogenic shock despite standard medical therapy, as indicated by **1 or more** of the following:
      - Systemic systolic blood pressure less than 50 mm Hg
      - Urine output less than 1 mL/kg/hr
      - Lactic acidosis
      - Central venous oxygen saturation less than 60%
      - Arteriovenous oxygen saturation difference greater than 30% in cyanotic congenital heart disease
      - Altered mental status not otherwise explained (ie, attributed to cardiogenic shock)
    - No contraindications to ECMO, as indicated by **ALL** of the following:
      - Clinical assessment that there is potential for recovery or ECMO is bridge to transplant, corrective surgery, or ventricular assist device
      - No prolonged cardiogenic shock (over 6 hours)[KK]
      - No lethal chromosomal disorder
      - No severe brain damage
      - No significant intraventricular hemorrhage (grade III or IV)
      - No uncontrollable bleeding

- Patient 18 years or older with respiratory failure and **ALL** of the following(136):
  - ECMO required for life-threatening finding that persists despite optimized conventional therapies and maneuvers, as indicated by **1 or more** of the following:
    - Severe hypoxic respiratory failure (eg, PaO_2 to FiO_2 ratio less than 80 mm Hg)
    - Severe hypercapnic respiratory failure (eg, pH less than 7.25 due to respiratory acidosis)
    - Primary lung transplant graft dysfunction
  - No contraindications to ECMO, as indicated by **ALL** of the following:
    - Clinical assessment that there is potential for recovery or ECMO is bridge to transplant, corrective surgery, or ventricular assist device
    - No central nervous system hemorrhage, significant injury, or severe irreversible disease
    - No uncontrollable bleeding
    - No contraindication to anticoagulation
    - No current history of mechanical ventilation for more than 7 days with FiO_2 greater than 90% and end inspiratory airway pressure (Pplat) greater than 30 cm H_2O (2942 Pa)
- Patient 18 years or older with cardiogenic shock and **ALL** of the following(137):
  - Severe cardiogenic shock despite standard medical therapy, as indicated by **1 or more** of the following:
    - Systemic systolic blood pressure less than 90 mm Hg or inotrope-dependent
    - Urine output less than 30 mL/hour (despite adequate hydration)
    - Lactate over 2.0 mmol/L (18 mg/dL) attributed to hypoperfusion
    - Cardiac index less than 2.2 L/min/m^2 and pulmonary capillary wedge pressure greater than 15 mm Hg
    - Venous oxygen saturation less than 60%
    - Inability to separate from cardiopulmonary bypass after cardiac surgery(138)
    - Altered mental status not otherwise explained (ie, attributed to cardiogenic shock)
  - No contraindications to ECMO, as indicated by **ALL** of the following:
    - Clinical assessment that there is potential for recovery or ECMO is bridge to transplant, corrective surgery, or ventricular assist device
    - Life expectancy not poor (eg, due to malignancy, end-stage organ disease)
    - No severe aortic regurgitation
    - No severe vascular disease (eg, extensive aortic or peripheral vessel calcification, stenosis, or closure) that precludes safe cannulation
    - No acute type A or B aortic dissection with involvement of aortic branches (eg, ascending, supra-aortic, femoral)
    - No severe neurologic impairment (anoxic brain damage, extensive trauma, bleeding)
    - No significant coagulation disorder
    - No Child-Pugh class B or C liver cirrhosis
- Adjustment, replacement, or removal of ECMO circuit, as indicated by **1 or more** of the following(127):
  - Intervention no longer desired or clinically indicated
  - Addition or removal of components in ECMO circuit needed(127)
  - ECMO circuit cannulation complication (eg, malposition, bleeding, air embolism)(134)
  - Other ECMO dysfunction or complication necessitating intervention
- Significant cardiovascular trauma or injury requiring repair(72)(73)(74)
- Pericardial window or drain placement needed, as indicated by **1 or more** of the following(139)(140)(141):
  - Large (eg, greater than 20 mm by echocardiogram) or enlarging pericardial effusion
  - Recurrent effusion with failure of medical treatment
  - Malignant effusion
  - Bacterial pericarditis

- Pericardial tamponade

− Pericardiectomy needed; indications may include(142)(143):
- Constrictive pericarditis with heart failure(144)
- Chronic recurrent pericarditis with failure of medical treatment

− Pericardial biopsy needed, as indicated by **1 or more** of the following(139)(140)(141):
- Recurrent or persistent effusions despite medical therapy
- Constrictive pericarditis
- Suspected malignant effusion
- Suspected tuberculous pericarditis
- Diagnostic uncertainty despite less invasive testing (eg, imaging, serologies, pericardial fluid cytology and cultures)

− Wireless pulmonary artery pressure monitor insertion needed, as indicated by **ALL** of the following[LL](147):
- Symptomatic heart failure for 3 months or more(145)(146)(148)
- No major cardiovascular event within previous 2 months (eg, myocardial infarction, unstable angina, percutaneous coronary intervention, open heart surgery, or cerebrovascular event)(145)(146)
- No implantation of a cardiac device susceptible to lead displacement within previous 3 months (eg, cardioverter-defibrillator, cardiac resynchronization therapy device)(145)(146)(148)
- No contraindication to 1-month postprocedure treatment with dual antiplatelet or anticoagulation therapy(148)
- Wireless pulmonary artery pressure monitoring appropriate, as indicated by **1 or more** of the following:
  - One or more hospitalizations for heart failure within previous 12 months, with ongoing NYHA functional class III symptoms despite optimal GDMT[MM](145)(146)(147)
  - One or more outpatient visits (emergency department or other outpatient site) for heart failure requiring intravenous diuretic therapy within previous 12 months, with ongoing NYHA functional class III symptoms despite optimal GDMT[MM](146)
  - Heart failure with preserved ejection fraction (HFpEF) and cardiorenal syndrome[NN](147)
  - HFpEF and comorbid condition causing dyspnea (eg, severe obesity, chronic lung disease) that requires differentiation from heart failure(147)

− Dual heart-liver transplant in adult,[OO] as indicated by **ALL** of the following:

− Heart transplant, as indicated by **ALL** of the following:

− Need for transplant, as indicated by **1 or more** of the following:
- Cardiogenic shock or severe heart failure (eg, NYHA class IV) requiring continuous intravenous inotropic support or mechanical cardiac support (eg, intra-aortic balloon pump, ECMO, ventricular assist device)(117)(152)(153)(154)(155)(156)

− Severe chronic heart failure, as indicated by **ALL** of the following(115)(117)(153)(157)(158):
- NYHA class III or IV despite maximally tolerated GDMT(152)(153)(158)
- Peak metabolic oxygen consumption[PP] on cardiopulmonary exercise test less than 14 mL/kg/min or less than 12 mL/kg/min if patient on beta-blocker(158)(160)
- Peak metabolic oxygen consumption[PP] on cardiopulmonary exercise test less than 50% predicted based on patient age, sex, and weight(158)(160)

− Infiltrative (eg, amyloidosis), hypertrophic, or restrictive cardiomyopathy and **1 or more** of the following(152)(160):
- NYHA class III or IV symptoms despite GDMT and **1 or more** of the following(152):
  - Cardiac index less than 2.2 L/min/m^2
  - Pulmonary artery occlusion ("wedge") pressure, left or right atrial pressure, or left or right end diastolic pressure greater than 20 mm Hg

- Life-threatening arrhythmia refractory to (or not a candidate for) antiarrhythmic agents or device therapy(160)

- Severe cardiac ischemia (eg, angina) despite maximal feasible therapy (eg, revascularization, medication)(152)(153)
- Recurrent symptomatic or life-threatening arrhythmia unresponsive to medical therapy and interventional procedures (eg, catheter ablation, intracardiac defibrillator)(152)(153)(156)(157)(161)

− Severe congenital heart disease, as indicated by **1 or more** of the following(39)(66)(152)(153)(162)(163)(164):

- Single ventricle physiology(153)(164)
- Failed Fontan circulation[QQ](153)(160)(164)
- Eisenmenger syndrome(153)(160)
- Reactive pulmonary hypertension with risk for progression to a level of fixed pulmonary vascular resistance that may preclude future transplant(153)(160)
- Ventricular failure due to congenital heart disease that is not amenable to other surgical alternatives(152)(153)
- Severe oxygen desaturations not amenable to other surgical correction(153)
- Severe heart failure refractory to medical therapy not amenable to other surgical, interventional, or electrophysiologic intervention(153)(164)

− Low-grade myocardial tumor and **ALL** of the following(153):

- No evidence of metastatic disease(153)
- Tumor is otherwise unresectable.(153)

- Unresectable ventricular diverticula(153)

− Repeat transplant (ie, replacement of previously placed transplant) needed, as indicated by **1 or more** of the following:

- Acute or chronic rejection of transplanted heart resulting in insufficient cardiac function

− Redevelopment of need for heart transplant, as indicated by **1 or more** of the following:

- Cardiogenic shock or severe heart failure (eg, NYHA class IV) requiring continuous intravenous inotropic support or mechanical cardiac support (eg, intra-aortic balloon pump, ECMO, ventricular assist device)(117)(152)(153)(154)(155)(156)

− Severe chronic heart failure, as indicated by **ALL** of the following(115)(117)(153)(157)(158):

- NYHA class III or IV despite maximally tolerated GDMT(152)(153)(158)
- Peak metabolic oxygen consumption[PP] on cardiopulmonary exercise test less than 14 mL/kg/min or less than 12 mL/kg/min if patient on beta-blocker(158)
- Peak metabolic oxygen consumption[PP] on cardiopulmonary exercise test less than 50% predicted based on patient age, sex, and weight(158)

- Severe cardiac ischemia (eg, angina) despite maximal feasible therapy (eg, revascularization, medication)(152)(153)
- Recurrent symptomatic or life-threatening arrhythmia unresponsive to medical therapy and interventional procedures (eg, catheter ablation, intracardiac defibrillator)(152)(153)(156)(157)(161)

- No contraindications to heart transplant present [RR](152)(153)(160)

− Liver transplant, as indicated by **ALL** of the following[SS](151):

− Liver transplant needed, as indicated by **1 or more** of the following:

- Cardiac cirrhosis[TT]
- Congenital heart disease with associated hepatic injury (eg, Fontan-associated liver disease or other single-ventricle congenital disorders)(151)(165)(166)

− Metabolic liver disorder with associated cardiac complications, including **1 or more** of the following(151)(165):

- Familial hypercholesterolemia
- Variant transthyretin amyloidosis

- Hemochromatosis
- Glycogen storage disease
- Alcohol-associated cirrhosis with concurrent alcohol-associated cardiomyopathy

− Acute liver failure (also known as "fulminant liver failure"), as indicated by **ALL** of the following(152)(167):
- Acute liver disease (ie, 56 days' duration or less)[UU]
- Hepatic encephalopathy of any degree[VV]
- Severe manifestation of liver disease, as indicated by **1 or more** of the following:
  - Acute need for mechanical ventilation
  - Acute need for renal replacement therapy
  - International normalized ratio (INR) of 2.0 or more

− Severe chronic liver disease, as indicated by **1 or more** of the following(152)(169)(170)(171)(172):
- Model for End-Stage Liver Disease (MELD) score greater than or equal to 15[WW]
- − Complication of liver disease, as indicated by **1 or more** of the following(169)(175):
  - Budd-Chiari syndrome(169)
  - Spur cell hemolytic anemia not attributed to acute infection or alcohol use(169)
  - Chronic recurrent hepatic hydrothorax(169)
  - Variceal bleeding that persists despite treatment (eg, beta-blocker therapy, band ligation)(175)
  - Ascites that persists or recurs despite diuresis and low-sodium diet(175)
  - Hepatic encephalopathy that persists despite treatment (eg, lactulose, rifaximin)(175)
  - Hepatorenal syndrome(175)
  - Progressive protein-calorie malnutrition(175)

− Acute-on-chronic liver disease, as indicated by **1 or more** of the following(176):
- European Association for the Study of the Liver-Chronic Liver Failure Consortium (EASL-CLIF-C) score of 2 or 3[XX](176)
- Acute-on-Chronic Liver Failure grade of 3[YY](178)
- − Multiorgan failure, as indicated by **2 or more** of the following[ZZ](176):
  - Liver failure as indicated by bilirubin of 12 mg/dL (205 micromoles/L) or higher
  - Hepatic encephalopathy grade III or higher by West Haven criteria[AAA][VV]
  - Renal failure as indicated by serum creatinine of 2 mg/dL (177 micromoles/L) or greater, or need for renal replacement therapy
  - Coagulation failure as indicated by INR of 2.5 or greater
  - Circulatory failure with need for vasoconstrictor or inotropic agent
  - Respiratory failure with either a PaO_2 to FiO_2 ratio between 150 mm Hg and 200 mm Hg or an SpO_2 to FiO_2 ratio between 150 and 214[BBB]

− Hepatocellular carcinoma and **ALL** of the following(183)(184)(185):
- Alpha-fetoprotein 1000 ng/mL (mcg/L) or less
- Imaging is negative for extrahepatic disease and macrovascular involvement (eg, portal or hepatic vein invasion).
- Tumor size appropriate for transplant as indicated by a single lesion 2 to 5 cm in diameter or 2 or 3 lesions of 1 to 3 cm in diameter

− Cholangiocarcinoma and **ALL** of the following(183)(186)(187):
- Tumor 3 cm in diameter or smaller
- Unresectable due to location (eg, perihilar, vital vessel involvement), extent (eg, multifocal, bilobar disease), or severe underlying hepatic disease (eg, cirrhosis, primary sclerosing cholangitis)
- No metastatic or nodal disease

- Neoadjuvant chemoradiation planned prior to transplant

− Neuroendocrine tumor and **ALL** of the following(188)(189)(190)(191):
- Primary tumor and extrahepatic disease resected with curative intent 6 months or more prior to transplant
- Stable disease for 6 months or more prior to transplant
- Tumor not amenable to resection
- No evidence of extrahepatic metastases

− Polycystic liver disease and **ALL** of the following(169):
- Surgical therapy (removal of cysts, fenestration) not effective or not possible
- Severe disease, as indicated by **1 or more** of the following:
  - Hepatic decompensation (eg, ascites, hepatic encephalopathy)
  - Concurrent hemodialysis or GFR less than 20 mL/min/1.73m^2 (0.33 mL/sec/1.73m^2) eGFR - Adult Calculator
  - Prior kidney transplant
  - Moderate to severe protein-calorie malnutrition
  - Severe sarcopenia (eg, skeletal muscle index of less than 39 cm^2/m^2 in women or less than 50 cm^2/m^2 in men)

− Primary or secondary sclerosing cholangitis and **ALL** of the following(169)(192):
- Cirrhosis on imaging or liver biopsy
- In past year, 2 or more episodes of cholangitis leading to bacteremia or hypotension necessitating intravenous pressor support
- Transplant necessary due to **1 or more** of the following:
  - Biliary tract stricture not responsive to alternative intervention
  - Resistant organism causing cholangitis (eg, vancomycin-resistant *Enterococcus*, extended spectrum beta-lactamase (ESBL)-producing Gram-negative organisms, carbapenem-resistant *Enterobacteriaceae*, multidrug-resistant *Acinetobacter*)

− Hepatopulmonary syndrome and[CCC] **ALL** of the following(183):
- Sequelae of portal hypertension (eg, ascites, varices, splenomegaly, thrombocytopenia)
- Arterial partial pressure of oxygen of less than 60 mm Hg (8.0 kPa) (on room air) not otherwise explained by underlying pulmonary disease (eg, COPD)
- Right-to-left cardiac shunt demonstrated by contrast echocardiogram ("bubble study") or nuclear perfusion lung scan

− Wilson disease and **1 or more** of the following(183)(195)(196):
- Acute liver failure[DDD]
- Acute decompensated liver disease unresponsive to medical therapy (eg, chelation, zinc)[EEE]
- Progressive chronic liver failure (eg, jaundice, ascites, hepatic encephalopathy, varices)[FFF]

− Acute severe autoimmune hepatitis and **1 or more** of the following(178):
- Severe coagulopathy (INR 1.5 or greater) with severe hepatic encephalopathy (grade III or IV)
- Worsening liver function tests despite corticosteroid therapy
- New or worsening hepatic encephalopathy despite corticosteroid therapy

− Hepatic adenoma or multiple adenomas and **ALL** of the following(173):
- One or more adenoma not appropriate for resection or medical management
- Liver transplant necessary, as indicated by **1 or more** of the following:
  - Biopsy-proven malignant transformation of one or more adenomas
  - Glycogen storage disease-associated adenoma[GGG]
  - High risk for malignancy or malignant transformation (eg, increasing size, positive beta-catenin nuclear staining)
  - Hemorrhagic complication in one or more adenoma

- Hereditary hemorrhagic telangiectasia and **ALL** of the following(169):
  - Intrahepatic arteriovenous malformations on imaging
  - High-output heart failure on echocardiogram
- Acute hepatic porphyria with recurrent intractable symptoms despite pharmacotherapy (eg, prophylactic hemin or givosiran therapy)(197)
- Other hepatic disorder associated with increased mortality that can be addressed with liver transplant (eg, primary biliary cholangitis, hemochromatosis, alpha-1 antitrypsin deficiency)

- No contraindications to liver transplant present

Dual heart-renal transplant in adult,[HHH] as indicated by **ALL** of the following:

Heart transplant, as indicated by **ALL** of the following:

Need for transplant, as indicated by **1 or more** of the following:

- Cardiogenic shock or severe heart failure (eg, NYHA class IV) requiring continuous intravenous inotropic support or mechanical cardiac support (eg, intra-aortic balloon pump, ECMO, ventricular assist device)(117)(152)(153)(154)(155)(156)

Severe chronic heart failure, as indicated by **ALL** of the following(115)(117)(153)(157)(158):

- NYHA class III or IV despite maximally tolerated GDMT(152)(153)(158)
- Peak metabolic oxygen consumption[PP] on cardiopulmonary exercise test less than 14 mL/kg/min or less than 12 mL/kg/min if patient on beta-blocker(158)(160)
- Peak metabolic oxygen consumption[PP] on cardiopulmonary exercise test less than 50% predicted based on patient age, sex, and weight(158)

Infiltrative (eg, amyloidosis), hypertrophic, or restrictive cardiomyopathy and **1 or more** of the following(152)(160):

- Adult with NYHA class III or IV symptoms despite GDMT and **1 or more** of the following(152):
  - Cardiac index less than 2.2 L/min/m^2
  - Pulmonary artery occlusion ("wedge") pressure, left or right atrial pressure, or left or right end diastolic pressure greater than 20 mm Hg
- Life-threatening arrhythmia(160)

- Severe cardiac ischemia (eg, angina) despite maximal feasible therapy (eg, revascularization, medication)(152)(153)
- Recurrent symptomatic or life-threatening arrhythmia unresponsive to medical therapy and interventional procedures (eg, catheter ablation, intracardiac defibrillator)(152)(153)(156)(157)(161)

Severe congenital heart disease, as indicated by **1 or more** of the following(39)(66)(152)(153)(162)(163)(164):

- Single ventricle physiology(153)(164)
- Failed Fontan circulation[QQ](153)(164)
- Eisenmenger syndrome(153)
- Reactive pulmonary hypertension with risk for progression to a level of fixed pulmonary vascular resistance that may preclude future transplant(153)
- Ventricular failure due to congenital heart disease that is not amenable to other surgical alternatives(152)(153)
- Severe oxygen desaturations not amenable to other surgical correction(153)
- Severe heart failure refractory to medical therapy not amenable to other surgical, interventional, or electrophysiologic intervention(153)(164)

Low-grade myocardial tumor and **ALL** of the following(153):

- No evidence of metastatic disease(153)
- Tumor is otherwise unresectable.(153)

- Unresectable ventricular diverticula(153)

- Repeat transplant (ie, replacement of previously placed transplant) needed, as indicated by **1 or more** of the following:
  - Acute or chronic rejection of transplanted heart resulting in insufficient cardiac function
  - Redevelopment of need for heart transplant, as indicated by **1 or more** of the following:
    - Cardiogenic shock or severe heart failure (eg, NYHA class IV) requiring continuous intravenous inotropic support or mechanical cardiac support (eg, intra-aortic balloon pump, ECMO, ventricular assist device)(117)(152)(153)(154)(155)(156)
    - Severe chronic heart failure, as indicated by **ALL** of the following(115)(117)(153)(157)(158):
      - NYHA class III or IV despite maximally tolerated GDMT(152)(153)(158)
      - Peak metabolic oxygen consumption[PP] on cardiopulmonary exercise test less than 14 mL/kg/min or less than 12 mL/kg/min if patient on beta-blocker(158)(160)
      - Peak metabolic oxygen consumption[PP] on cardiopulmonary exercise test less than 50% predicted based on patient age, sex, and weight(158)
    - Severe cardiac ischemia (eg, angina) despite maximal feasible therapy (eg, revascularization, medication)(152)(153)
    - Recurrent symptomatic or life-threatening arrhythmia unresponsive to medical therapy and interventional procedures (eg, catheter ablation, intracardiac defibrillator)(152)(153)(156)(157)(161)
- No contraindications to heart transplant present [RR](152)(153)(160)

- Kidney transplant needed, as indicated by **ALL** of the following(151)(152):
  - End-stage renal disease, as indicated by **1 or more** of the following(198):
    - Need for renal replacement therapy due to irreversible renal disease (ie, end-stage renal disease)
    - Impending end-stage renal disease (ie, diagnosed with irreversible renal disease or pathology whose natural history is progression to a need for renal replacement therapy)
  - No contraindications to renal transplant present, as indicated by **ALL** of the following(198):
    - No multiple myeloma or monoclonal immunoglobulin deposition disease (light or heavy chain deposition) unless in stable remission
    - No inability to comply with ongoing medical care
    - No uncontrolled HIV infection, as indicated by **1 or more** of the following:
      - No HIV infection
      - No uncontrolled HIV infection, as indicated by **ALL** of the following:
        - CD4 T-cell count has been greater than 200/mm^3 (0.2 x10^9/L) for at least 3 months.
        - Viral load is undetectable.
        - No opportunistic infection within last 6 months
        - No history of progressive multifocal leukoencephalopathy
        - No history of central nervous system lymphoma
        - No cognitive impairment attributable to HIV infection
        - Patient is adherent to antiretroviral drug regimen.
    - No stroke within last 6 months or transient ischemic attack within last 3 months
    - No active gastrointestinal disease including symptomatic peptic ulcers, diverticulitis, inflammatory bowel disease, or gallbladder disease
    - No acute pancreatitis within last 3 months
    - No acute hepatitis (eg, elevated INR or transaminitis)
    - No active malignancies[III]
    - No surgical contraindications to renal transplant (eg, urologic or vascular problems)

Alternatives to Procedure

- Alternatives include(1)(3)(95):
  - Anticoagulation(199)(200)
  - Compression therapy(201)(202)
  - Catheter-directed thrombolytic therapy(7)(23)(203)
  - Vasodilator infusion(115)
  - Inotrope infusion(115)
  - Medical management(2)(6)(13)(17)(77)(96)(97)(98)(115)(139)
  - Supervised or structured exercise rehabilitation(2)(204)(205)
  - Alternative surgical procedure (eg, heart transplant, valve replacement)
  - Percutaneous drainage and prolonged antibiotics for infected vascular graft or endograft(77)
  - Amputation procedure; examples include(4)(73):
    - Toe or distal amputation
    - Panmetatarsal head resection
    - Ray amputations
    - More proximal amputation
  - Palliative care(206)

Operative Status Criteria

Search by CPT® code for specific procedure Benchmark Length of Stay (BLOS).

Note: The definition of an ambulatory procedure depends on payer-provider contractual agreement or regulatory language (eg, CMS' Two-Midnight Rule). An ambulatory procedure may include one postoperative overnight stay in a facility; therefore, a Benchmark Length of Stay (BLOS) of ambulatory refers to patients discharged the day of or the day after the procedure. Depending on various patient and procedural factors, some patients undergoing a procedure with an ambulatory BLOS require inpatient care (eg, medical necessity for hospital-based care across 2 or more postoperative midnights).

The Ambulatory Surgery Exception Criteria GRG can help with this determination.

- Ambulatory: Benchmark Length of Stay (BLOS) = A
- Inpatient, as indicated by **1 or more** of the following:
  - Benchmark Length of Stay (BLOS) = 2 or more days postoperative (eg, medical necessity for hospital-based care across 2 or more postoperative midnights)
  - Procedure is usually performed on ambulatory basis, but inpatient stay is needed. See Ambulatory Surgery Exception Criteria GRG.
  - Medicare patient, and specific procedure is on CMS Inpatient Only List

Hospitalization

General Recovery Course

Stage	Level of Care	Clinical Status	Interventions
1	• OR to ICU or intermediate care[JJJ] • Social Determinants of Health Assessment	• **Clinical Indications met[KKK]** • **Procedure completed**	• Inpatient interventions as needed • Vascular and neurologic checks

	• Discharge planning. See Discharge Planning Tool SR.		
2	• Floor • Social Determinants of Health Assessment	• **No ICU or intermediate care needs**	• Inpatient interventions continue • Transition to oral routes • Taper off IV medications • Vascular and neurologic checks as appropriate
3	• **Activity level acceptable** • Social Determinants of Health Assessment • Floor to discharge • Complete discharge planning	• **Hemodynamic stability** • **Cardiovascular status acceptable** • **Cardiac inflammation absent or controlled (eg, pericarditis)** • **Operative site and other wounds acceptable** • **Vascular, soft tissue, and wound status acceptable** • **No blood loss, or problem resolved** • **No infection, or status acceptable** • **Pain and nausea absent or adequately managed** • **General Discharge Criteria met**	• **Vascular access established or not needed** • **Arteriovenous fistula absent or functioning adequately** • **Intake acceptable** • **No inpatient interventions needed**

(1)(3)(13)(47)(66)(73)(88)(96)(97)(98)(117)(125)(139)(207)(208)(209)

Recovery Milestones are indicated in **bold**.

Benchmark Length of Stay (BLOS): Access diagnosis and procedure code-specific BLOS via Search functions.

Discharge Criteria

- Continued inpatient stay is needed until **1 or more** of the following are present:
  - Acceptable patient status for next level of care is achieved.
  - **ALL** of the following are present:
    - Hemodynamic stability, as indicated by **1 or more** of the following:
      - Hemodynamic abnormalities at baseline or acceptable for next level of care
      - Patient hemodynamically stable, as indicated by **ALL** of the following(210)(211):
        - Tachycardia absent
        - Hypotension absent
        - No evidence of inadequate perfusion (eg, no myocardial ischemia)
        - No other hemodynamic abnormalities (eg, no Orthostatic hypotension)
    - Cardiovascular status acceptable, as indicated by **ALL** of the following:
      - Cardiac rhythm acceptable, as indicated by **1 or more** of the following(212):

- Normal sinus or paced rhythm
- Sinus arrhythmia or supraventricular arrhythmia (eg, atrial fibrillation) with ventricular rate controlled, and no need for cardioversion(105)

- No severe cardiac arrhythmias noted (eg, sustained ventricular tachycardia, ventricular fibrillation)(212)
- No severe cardiac or peripheral ischemia(213)(214)
- Heart failure or other cardiovascular disease is **1 or more** of the following(115):
  - Not present
  - At baseline
  - Manageable at next level of care

− Respiratory status acceptable, as indicated by **ALL** of the following(215)(216)(217)(218):

- Patient breathing comfortably (or near baseline) and able to protect airway (eg, able to handle secretions)
- Tachypnea absent
- Oxygen saturation greater than 90%, near baseline, or measurement not indicated for condition
- Supplemental oxygen or respiratory treatments not needed or are performable at next level of care
- Airflow measurements greater than 60% of predicted, at stable baseline, or measurement not indicated for condition
- Partial pressure of carbon dioxide and pH normal, at stable baseline, or measurement not indicated for condition

- Cardiac inflammation absent or controlled (eg, pericarditis)

− Operative site and other wounds acceptable, as indicated by **1 or more** of the following(219):

- Wounds absent
- Wound site clean and intact, with minimal to no drainage and without signs of infection
- Current wound care performable at next level of care

− Vascular, soft tissue, and wound status acceptable, as indicated by **1 or more** of the following(220)(221)(222)(223):

- No vascular, soft tissue, or wound problems
- Status acceptable, as indicated by **ALL** of the following:
  - No significant ischemia
  - No Bacteremia
  - No evidence of compartment syndrome
  - Neuromotor function at baseline or expected level of recovery and appropriate for management at next level of care
  - No new wound dehiscence or hematoma that cannot be managed at next level of care
  - Tissue necrosis absent, or treatment plan appropriate for next level of care
  - Vascular, soft tissue, and wound management appropriate for next level of care

− No blood loss, or problem resolved, as indicated by **1 or more** of the following(224)(225)(226)(227):

- No blood loss problem
- Repeat evaluation shows blood loss resolved sufficiently (eg, hemoglobin at acceptable level and stable)

− No infection, or status acceptable, as indicated by **1 or more** of the following(228)(229)(230)(231)(232):

- No infection present
- Infection status acceptable for next level of care, as indicated by **ALL** of the following(233):
  - WBC count normal, stable, or declining with treatment
  - Adequate treatment performable at next level of care
  - Organism and sensitivities identified, or adequate clinical response to empiric therapy
  - Repeat cultures negative or not needed

− Pain and nausea absent or adequately managed, as indicated by **1 or more** of the following(234)(235)(236)(237)(238):

- No pain or nausea

- Minimal discomfort on oral medications
- Pain and nausea managed on regimen performable at next level of care

- Vascular access established or not needed
- Arteriovenous fistula absent or functioning adequately
- Patient and family education complete (eg, on care for device)

Activity level acceptable, as indicated by **1 or more** of the following:

- Patient ambulatory and can perform ADL as appropriate for age and development
- Activity at baseline
- Activity level acceptable for next level of care

Intake acceptable, as indicated by **1 or more** of the following(239):

- Oral hydration, medications, and diet
- Enteral hydration, medications, and diet
- Administration routes performable at next level of care

No inpatient interventions needed; examples include:

- Vital signs, neurologic signs, or vascular checks more often than feasible at next level of care
- Urgent procedure (eg, embolization, thrombectomy, amputation) planned within 24 hours
- Wound care needed not feasible at next level of care
- IV anticoagulation or platelet inhibitors. See Anticoagulation Requirement: Common Complications and Conditions ISC for further information.

General Discharge Criteria GRG met or Pediatric General Discharge Criteria GRG met (if either is relevant or necessary for patient's condition)

Case Management

See Surgical Admission Case Management GRG GRG for further information.

Discharge Destination

- Post-hospital levels of admission may include:
  - Home.
  - Home healthcare. See Surgical Admission Home Care GRG HC or Geriatric Admission Home Care GRG HC for further information.
  - Recovery facility care. See Surgical Admission Recovery Facility Care GRG RFC or Geriatric Admission Recovery Facility Care GRG RFC for further information.
  - Inpatient rehabilitation facility. See Inpatient Rehabilitation Facility (IRF) Admission Recovery Facility Care GRG RFC for further information.

Evidence Summary

Criteria

The evidence for the clinical indications found in this guideline includes 133 published peer reviewed articles, 38 specialty society or other evidence-based guidelines, 2 Cochrane systematic reviews, and 19 book sections.

Rationale

Use of this MCG care guideline helps the clinician identify, for a given procedure, which patient-specific factors and clinical conditions are appropriate for that procedure. The evidence-based clinical criteria assist the clinician in the decision to appropriately perform a procedure, evaluating whether the potential benefits of a procedure outweigh the potential risks. For Medicare enrollees, surgical MCG care guidelines also identify which procedures CMS has designated as inpatient only.

Use of these evidence-based clinical criteria to support decision making around the need for a given procedure is of benefit to the patient, as all procedures come with inherent risk that must be balanced by anticipated clinical benefit. Utilizing evidence-based clinical criteria enables a more accurate and patient-specific decision-making process. In addition, the use of evidence-based guidelines can help reduce unwarranted variation in care, such as divergent clinical thresholds to perform a procedure for clinically similar patients that vary across geographic regions, between facilities, and among individual clinicians.

Related CMS Coverage Guidance

This guideline supplements but does not replace, modify, or supersede existing Medicare regulations or applicable National Coverage Determinations (NCDs) or Local Coverage Determinations (LCDs).

Code of Federal Regulations (CFR): 42 CFR 412.3(240); 42 CFR 419.22(241); 42 CFR 422.101(242)

Internet-Only Manual (IOM) Citations: CMS IOM Publication 100-02, Medicare Benefit Policy Manual, Chapter 1 - Inpatient Hospital Services Covered Under Part A(243); CMS IOM Publication 100-02, Medicare Benefit Policy Manual, Chapter 6 - Hospital Services Covered Under Part B(244); CMS IOM Publication 100-02, Medicare Benefit Policy Manual, Chapter 15 - Covered Medical and Other Health Services(245); CMS IOM Publication 100-08, Medicare Program Integrity Manual, Chapter 6, Section 6.5 - Medical Review of Inpatient Hospital Claims for Part A Payment(246)

Medicare Coverage Determinations: Medicare Coverage Database(247)

References

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Footnotes

[A] Acute limb injury (ALI) is defined as an acute (less than 14 days) severe hypoperfusion of the limb characterized by signs and symptoms of poikilothermia (cold), pain, pallor, and pulselessness.(4) ALI is categorized by findings on arterial and venous Doppler: category I (viable) has audible arterial and venous signals, category II (threatened) has inaudible arterial and audible venous signals with variable sensory loss and muscle weakness, and category III (irreversible) has inaudible arterial and venous signals with complete motor and sensory loss.(4) A specialty society guideline recommends that patients with category III irreversible ischemia should undergo amputation of nonviable tissue instead of a revascularization procedure because the procedural risks of revascularization outweigh any potential benefit and because reperfusion of irreversibly ischemic tissue can result in multiorgan failure and shock due to circulation of ischemic metabolites.(4) [A in Context Link 1]

[B] Chronic limb-threatening ischemia (also known as "critical limb ischemia") is defined as a condition characterized by chronic (2 weeks or longer) ischemic rest pain, nonhealing wound/ulcer, or gangrene in one or both legs attributable to objectively proven arterial occlusive disease.(1)(5)(6) The term "chronic limb-threatening ischemia" is preferred over "critical limb ischemia" as it includes a broader spectrum of patients with chronic atherosclerotic disease who are at risk for limb-threatening ischemia and excludes nonatherosclerotic conditions (eg, embolism, trauma, neoplasm, vasculitis).(1)(6) [B in Context Link 1, 2]

[C] A stenotic lesion seen by angiography (eg, lumen occluded 50% to 70%) may not be hemodynamically significant (ie, the cause of limited perfusion). Multiple evaluations, including resting or provoked intravascular pressure measurements and segmental studies, may be needed to determine whether lesions are hemodynamically significant.(4) [C in Context Link 1]

[D] Femoral artery pseudoaneurysms result from traumatic puncture of common, superficial, or profunda femoral arteries, usually due to iatrogenic injury from femoral catheter-directed interventional procedure or from recreational intravascular drug injection. They present as a pulsatile mass in the groin and are at risk of rupture, infection, limb loss, and catastrophic hemorrhage.(16) [D in Context Link 1]

[E] Thrombectomy may be indicated for critical venous thrombosis, for thrombus resistant to thrombolysis, or for those with contraindications to anticoagulation or thrombolysis.(19)(20)(21)(22) [E in Context Link 1]

[F] Transmyocardial laser revascularization (TLR) is performed via thoracotomy or thoracostomy under general anesthesia. A laser probe is placed directly on or in the myocardium and is used to burn channels into the myocardium.(29) A systematic review and meta-analysis of 7 randomized controlled trials (1137 patients) comparing TLR with usual care in patients with severe angina who were not candidates for percutaneous coronary intervention or CABG found that although TLR reduced angina, short-term mortality was increased.(29) The authors noted that since patients and clinicians were not blinded (and angina is a very subjective outcome), the risk of bias was high, and they concluded that the risks of TLR outweigh the potential clinical benefits; the authors also suggested that the procedure may pose unacceptable risks.(29) In any event, performance of TLR as a stand-alone procedure is rare, as a database analysis of 10,684 patients who underwent TLR found that 92% of procedures were performed in conjunction with CABG.(30) [F in Context Link 1, 2]

[G] Class III angina is defined by a marked limitation of ordinary activity, and class IV angina means that a patient is unable to carry on any physical activity without discomfort, or angina is present at rest.(32) [G in Context Link 1, 2]

[H] Percutaneous laser revascularization (PLR) is the application of laser energy to the inner surface of the left ventricle via a percutaneously inserted catheter that is advanced into position.(33) A systematic review and meta-analysis examining the use of PLR in patients with severe angina who were not candidates for percutaneous coronary intervention or CABG found, when limited to outcomes with randomized sham procedure-controlled data (2 trials, 279 patients), that PLR reduced angina frequency and improved physical limitations, but it did not affect angina severity, treatment satisfaction, exercise duration, or overall mortality.(33) [H in Context Link 1, 2]

[I] A neonate is an infant age 28 days or less, adjusted for gestational age. Gestational age is the time elapsed between the first day of the last normal menstrual period and the day of delivery. For example, a preterm baby born at 35 weeks would be a neonate until 5 weeks + 28 days after birth.(35) [I in Context Link 1, 2, 3, 4]

[J] Most patent ductus arteriosus (PDA) in neonates will close spontaneously.(36)(37)(38) There are no consensus criteria to define when a PDA is hemodynamically significant enough to warrant pharmacologic or mechanical closure.(36)(37)(38) Clinical factors that increase the likelihood that a PDA is hemodynamically significant include hemodynamic compromise, pulmonary edema, acute kidney injury, and gestational age less than 38 weeks.(36)(37) The determination of hemodynamic significance is a judgment made by considering echocardiographic findings along with the clinical presentation.(36)(37)(38) [J in Context Link 1]

[K] Patients with pulmonary hypertension causing a net right-to-left shunt (Eisenmenger syndrome) are at high risk for severe pulmonary hypertension and mortality after ductal closure and should not undergo the procedure.(36)(37) [K in Context Link 1, 2]

[L] The interventional treatment of choice, when feasible, is transcatheter closure, due to equivalent outcomes, reduced resource utilization, and fewer untoward effects.(36)(37) Surgical closure may be performed in patients with a patent ductus arteriosus that is too large for device closure.(36)(37) Surgical closure may be performed by open thoracotomy techniques (eg, ligation, clipping, or patch angioplasty) or by thoracoscopic clipping.(36)(37) [L in Context Link 1, 2]

[M] A supracristal defect is a ventricular septal defect occurring above the crista supraventricularis, which is a muscular ridge between the tricuspid and pulmonary valves. This particular kind of defect can be associated with aortic insufficiency and is less common than other ventricular septal defects.(36) [M in Context Link 1]

[N] The use of preoperative pulmonary hypertension therapy (eg, vasodilator drugs and endothelin receptor blockers) or a fenestrated patch closure may allow for repair in some patients with pulmonary hypertension.(39)(42) [N in Context Link 1]

[O] A study of 191 patients (mean age 74 years) with moderate to severe mitral regurgitation and New York Heart Association (NYHA) functional class II or higher symptoms despite guideline-directed medical therapy at high or prohibitive surgical risk undergoing transcatheter mitral valve replacement with a dedicated mitral valve device reported that 97% had successful implantation, mitral regurgitation was eliminated to none or trace in 96.3% at 2 years (with no patient having more than mild regurgitation), NYHA class improved (70% were NYHA class III or IV at baseline vs 80% of survivors were class I or II at 2 years), and quality-of-life scores improved; however, 2-year cardiovascular and all-cause mortality were 34% and 39%, respectively.(44) [O in Context Link 1]

[P] FDA approval for the use of an aortic valve transcatheter heart valve system (Edwards SAPIEN 3) for mitral valve replacement for failed bioprosthetic valves in patients at high surgical risk was based in part on data from off-label compassionate use from a specialty society registry, which showed substantial improvements in regurgitation, decreases in New York Heart Association heart failure stage, and improvements in symptom score with acceptable mortality rates for this high-risk population. A summary of safety and effectiveness endpoints is available at www.accessdata.fda.gov/cdrh_docs/pdf14/P140031S125B.pdf. [P in Context Link 1]

[Q] Transcatheter pulmonary valve replacement may be performed in conjunction with right ventricle-to-pulmonary artery conduit implantation or as a separate procedure for right ventricle-to-pulmonary artery conduit dysfunction.(39)(52) [Q in Context Link 1]

[R] Pulmonary regurgitation in adults is often a consequence of previous surgical correction of Tetralogy of Fallot, or surgical valvotomy or balloon valvuloplasty of pulmonary stenosis.(39)(47)(52) [R in Context Link 1, 2, 3]

[S] A study of 400 patients (mean age 79 years) with symptomatic severe or greater tricuspid regurgitation randomized to transcatheter tricuspid valve replacement or medical management found, at 1-year follow-up, that more patients in the repair group had a reduction in regurgitation severity to moderate or less (99.1% vs 6.1%), fewer heart failure hospitalizations (20.9% vs 26.1%), more patients with an improvement of at least one New York Heart Association functional class (23.1% vs 6.0%), more patients with a 10-point or greater increase in quality-of-life scores (KCCQ-OS, 23.1% vs 6.0%, minimum clinically important difference is 5 points); however, no difference in all-cause mortality was seen and more patients in the intervention group received a new pacemaker or implantable cardiac device (17.4% vs 3%).(60) [S in Context Link 1]

[T] Tricuspid regurgitation severity grades including mild, moderate, severe, massive, and torrential based on echocardiographic criteria including vena contracta width, effective regurgitant orifice area, and vena contracta area.(61) [T in Context Link 1, 2, 3, 4]

[U] A study of 572 patients (mean age 78 years) with severe symptomatic tricuspid regurgitation randomized to tricuspid valve transcatheter end-to-end repair plus optimal medical therapy vs optimal medical therapy alone found, at 2-year follow-up, that the tricuspid repair group experienced fewer heart failure exacerbations (hazard ratio 0.72, 95% confidence interval 0.53 to 0.98) and greater improvements in quality-of-life scores.(63) In the same study, more patients in the repair group had a reduction in severity to moderate or less at 1 year (88% vs 8%).(64) [U in Context Link 1]

[V] A specialty society guideline recommends open repair over endovascular repair for thoracoabdominal aneurysms that are ruptured and for patients who have connective tissue disease (eg, Marfan, Loeys-Dietz, vascular Ehlers-Danlos syndrome).(13) Endovascular repair is a reasonable alternative for ruptured aneurysms if performed at an expert center (eg, for high surgical risk patient) and may be used as a bridge to open repair for patients who are hemodynamically unstable.(13) Endovascular repair at an expert center can also be appropriate for patients with intact aneurysms with amenable anatomy, using fenestrated or branched stent grafts as needed to maintain flow to aortic side branch vessels.(13) Staged open, endovascular, or hybrid repairs (eg, one open and one endovascular repair of thoracic and abdominal aortic aneurysms) have also been performed at expert centers, with a goal of reducing the rate of postoperative spinal cord ischemia.(82) [V in Context Link 1]

[W] Surgical outcomes of complex aortic repair have been shown to be better at high-volume centers (30 or more aortic procedures per year) and when delivered by multidisciplinary aortic teams.(13) Components of multidisciplinary aortic teams may include dedicated cardiovascular surgeons, endovascular specialists, radiologists, anesthesiologists, and critical care specialists, who have extensive collaborative experience managing complex aortic diseases.(13) A specialty society guideline recommends that certain indications and clinical thresholds for surgery (eg, borderline aortic diameters or complex procedures) be reserved for performance by experienced surgeons working within a multidisciplinary aortic team, based on lower mortality risk and improved treatment outcomes.(13) [W in Context Link 1]

[X] Pseudoaneurysms are characterized by a breach of the vessel wall with blood containment by the surrounding connective tissue.(83) Causes include trauma, infection, iatrogenic from surgical or endovascular procedures, or may be the result of a contained rupture of a penetrating aortic ulcer.(83)(84) A clinical guideline suggests open or endovascular repair for all aortic pseudoaneurysms, but also suggests that close monitoring by serial imaging can be considered for selected asymptomatic patients.(84) [X in Context Link 1]

[Y] Hybrid procedures include the 2-stage "elephant trunk" procedure (surgical graft replacement of the ascending aorta and arch with placement of a free-floating prosthesis (the "elephant trunk"), with subsequent endograft placed up through the descending aorta to the "elephant trunk"), the single-stage "frozen elephant trunk" procedure (surgically reconstructed aortic arch with Dacron graft, the endograft is then inserted through the descending aorta and sutured to the surgical graft), and a hybrid aortic arch repair involving surgically rerouting the great vessels of the aortic arch to the proximal ascending aorta ("debranching" procedure), allowing subsequent placement of the endograft into a region of the aortic arch that otherwise would have obstructed flow to these vessels.(13)(85)(86) [Y in Context Link 1]

[Z] Hepatic tumors in any location may be treatable by embolization therapy if arterial embolization can be isolated to the target lesion without excessive exposure to normal tissue. Embolization may be performed using inactive agents (transarterial embolization, or TAE), chemotherapeutic agents (transarterial chemoembolization, or TACE), or radioactive microspheres (radioembolization).(91) [Z in Context Link 1]

[AA] The benefit of surgical left atrial appendage occlusion (S-LAAO) in the absence of continued anticoagulation is uncertain.(105) In a randomized controlled trial demonstrating a benefit to S-LAAO, more than 75% of patients were receiving oral anticoagulation 3 years after surgery.(106) [AA in Context Link 1]

[BB] A specialty society guideline recommends that septal myectomy be performed by experienced surgeons at high-volume centers experienced in management of hypertrophic cardiomyopathy because of lower surgery-related mortality.(108) [BB in Context Link 1]

[CC] A specialty society guideline recommends that alcohol septal ablation be performed by experienced surgeons at high-volume centers experienced in management of hypertrophic cardiomyopathy.(108) [CC in Context Link 1]

[DD] Cardiac contractility modulation (CCM) is delivered by an implantable device that applies pulsed electrical impulses during the cardiac refractory period. This causes an influx of calcium into the cardiac myocyte cells which increases contractility during systole. Because the stimulation occurs during the heart's refractory period, it does not affect the cardiac rhythm or increase the risk of arrhythmia.(109) A study of 160 patients with New York Heart Association (NYHA) class III or ambulatory class IV heart failure and reduced or mid-range ejection fraction randomized to CCM plus guideline-directed medical therapy vs medical therapy alone found that CCM improved peak energy consumption (a measure of exercise capacity), NYHA functional class, quality-of-life scores, and 6-minute walk distance.(110) [DD in Context Link 1, 2]

[EE] Intra-aortic balloon pumps (IABP) and ventricular assist devices (VAD) are considered forms of mechanical circulatory support for use in patients with severe cardiac dysfunction (ie, pump failure). IABPs and temporary VADs are used in patients with cardiogenic shock or severe acute decompensated heart failure as a temporizing measure to allow time for other treatments (medical, surgical) to work. Conversely, some types of VADs (eg, implanted) can be used for longer-term therapy (eg, bridge to transplant, destination therapy).(111)(112)(113)(114)(115)(116)(117) [EE in Context Link 1, 2, 3, 4]

[FF] Evidence does not support the routine use of a prophylactic mechanical circulatory assist device for patients not in shock undergoing high-risk percutaneous coronary intervention (PCI).(118)(119)(120)(121)(122)(123) A randomized trial of 301 patients with severe left ventricular function and extensive coronary disease randomized to routine intra-aortic balloon pump (IABP) support or no mechanical support during PCI found that IABP provided no significant reduction in major adverse cardiac events (MACE) or in 6-month mortality.(119) A randomized study of 452 patients undergoing high-risk PCI (3-vessel or complicated left main coronary disease) found no benefit in mortality or MACE at 30 days or 90 days for routine left ventricular assist device (LVAD) support compared with IABP.(120) A post hoc analysis of the same study also found no significant differences in 90-day MACE on intention-to-treat analysis but did find fewer MACE among LVAD patients on per-protocol analysis.(121) In a propensity matched registry study comparing routine prophylactic LVAD support with PCI without device assist for 504 patients undergoing high-risk PCI, 90-day MACE and mortality were higher in the LVAD group.(122) A specialty society guideline states that elective insertion of a prophylactic hemodynamic support device may be reasonable in select patients with severe left ventricular dysfunction undergoing PCI for multivessel disease, left main disease, or disease of the last patent conduit.(118) [FF in Context Link 1]

[GG] A specialty society guideline recommends 4 medication classes as guideline-directed medical therapy for patients with heart failure with reduced ejection fraction: beta-blockers, renin-angiotensin inhibitors (angiotensin receptor-neprilysin inhibitor preferred), aldosterone blockers, and sodium-glucose cotransporter-2 inhibitors.(115) [GG in Context Link 1]

[HH] An extracorporeal membrane oxygenation (ECMO) circuit receives blood from a vein, circulates it through an oxygenator and a heat exchanger, and then returns the blood through a vein (venovenous ECMO circuit) or artery (venoarterial ECMO circuit).(127) Additional access ports may allow continuous renal replacement therapy and administration of medications.(127) [HH in Context Link 1, 2]

[II] A neonate is an infant age 28 days or less, adjusted for gestational age. Gestational age is the time elapsed between the first day of the last normal menstrual period and the day of delivery. For example, a preterm baby born at 35 weeks would be a neonate until 5 weeks + 28 days after birth.(35) Length of stay in a neonatal unit may extend past the age of a neonate and into infancy depending on the severity of illness and the time to reach clinical stability for safe discharge.(128)(129)(130)(131) [II in Context Link 1, 2]

[JJ] Gestational age is the time elapsed between the first day of the last normal menstrual period and the day of delivery. For example, a preterm baby born at 35 weeks would be a neonate until 5 weeks + 28 days after birth.(35) [JJ in Context Link 1, 2]

[KK] Patients in cardiogenic shock for over 6 hours are unlikely to benefit from initiation of extracorporeal membrane oxygenation circuit.(135) [KK in Context Link 1]

[LL] A single-blind randomized controlled trial of patients with New York Heart Association (NYHA) class III heart failure and prior heart failure hospitalization (550 patients, mean age 62 years, 73% male, 78% with ejection fraction below 40%) compared treatment guided by an implantable pulmonary artery pressure sensor with usual care (sensor implantation without providing sensor guidance to the treating physician) and found a lower risk of heart failure hospitalizations among the sensor-guided group (0.46 hospitalizations per patient-year vs 0.68 hospitalizations per patient-year; hazard ratio (HR) 0.67 (95% confidence interval (CI) 0.55 to 0.80)) over an average 18 months of follow-up.(145) In the same trial, device-guided patients had fewer all-cause hospitalizations (1.38 hospitalizations per patient-year vs 1.65 hospitalizations per patient-year; HR 0.84 (95% CI 0.75 to 0.95)).(145) An open-label trial performed in the Netherlands included 348 patients with NYHA class III heart failure and either prior heart failure hospitalization or an urgent visit requiring IV diuretics (median age 69 years, median ejection fraction 30%, 76% male) who were randomized to care guided by implantable pulmonary artery pressure sensor monitoring or usual care and found that sensor-guided patients had a lower risk of heart failure hospitalizations (0.38 per patient-year vs 0.68 per patient-year; HR 0.56 (95% CI 0.38 to 0.84)) and greater improvements in heart failure-related quality-of-life and health status scores.(146) [LL in Context Link 1]

[MM] A specialty society guideline recommends 4 medication classes as guideline-directed medical therapy (GDMT) for patients with heart failure with reduced ejection fraction: beta-blockers, renin-angiotensin inhibitors (angiotensin receptor-neprilysin inhibitor preferred), aldosterone blockers, and sodium-glucose cotransporter-2 inhibitors.(115) Vericiguat further reduces the risk of adverse cardiac outcomes in heart failure and may either be started with the standard quadruple therapy outlined above for severe worsening heart failure, used as a substitute agent for patients with contraindication or intolerance to one or more standard medications, or used as an add-on therapy for inadequate response to optimal quadruple therapy.(149) For heart failure with preserved ejection fraction, an expert panel recommends sodium-glucose cotransporter-2 inhibitors, aldosterone blockers, and either an angiotensin receptor-neprilysin inhibitors (preferred) or an angiotensin receptor blocker as GDMT, with the addition of beta-blockers reserved for specific indications, including comorbid atrial fibrillation, myocardial infarction within 3 years, or angina.(147) [MM in Context Link 1, 2]

[NN] Cardiorenal syndromes may be acute or chronic and can manifest as either an alteration in renal flow due to primary heart failure or as a result of primary renal dysfunction causing secondary heart failure via volume overload and sodium retention.(150) [NN in Context Link 1]

[OO] A specialty society guideline identifies combined heart-liver transplant as appropriate for patients meeting criteria for liver transplant who also have either cardiac cirrhosis (hepatic cirrhosis and fibrosis caused by hepatic congestion from primary heart failure), congenital heart disease with associated hepatic injury (eg, single-ventricle cardiac disorder such as Fontan-associated liver disease), or a metabolic liver disorder with associated heart disease (ie, familial hypercholesterolemia, variant transthyretin amyloidosis, hemochromatosis, glycogen storage disease, or alcohol-associated liver disease and cardiomyopathy).(151) [OO in Context Link 1, 2]

[PP] Peak metabolic oxygen consumption should be measured on patients receiving maximally tolerated guideline-directed medical therapy.(159) [PP in Context Link 1, 2, 3, 4, 5, 6, 7, 8]

[QQ] Fontan palliation surgery (cavopulmonary anastomosis) is performed in childhood for single ventricle congenital heart disease.(160) Failed Fontan circulation can manifest as heart failure with either reduced systolic function or elevated filling pressures, protein losing enteropathy, or Fontan-associated liver or kidney

disease due to congestion.(160) Failed Fontan circulation with cirrhosis or portal hypertension is an indication for combined heart-liver transplant.(160) [QQ in Context Link 1, 2]

[RR] A specialty society guideline does not list obesity as a contraindication, but recommends weight loss for patients with pretransplant BMI of 35 or greater as there is improved survival in recipients with BMI less than 35.(160) The use of a BMI threshold for pediatric heart transplant has not been established because outcome data for obese pediatric transplant recipients is conflicting.(160) For some obese patients, pretransplant bariatric surgery may be considered.(160) The same guideline notes that age older than 70 years is not a contraindication to transplant, but such patients should be carefully selected based on functional status and comorbidities.(160) For patients with a history of malignancy, there are cancer-specific recommendations for the length of observation following presumed curative treatment prior to transplant listing.(160) [RR in Context Link 1, 2]

[SS] Concomitant heart-liver transplants may be performed sequentially using 2 separately procured organs, or as an en bloc simultaneous transplant with the heart and liver implanted together with an intact connecting inferior vena cava.(151) [SS in Context Link 1]

[TT] Hepatic congestion from primary heart failure can cause hepatic congestion and inflammation, ultimately leading to hepatic fibrosis and cirrhosis. Cardiac causes include restrictive or dilated cardiomyopathy, hypertrophic cardiomyopathy, and congenital heart disease.(165) [TT in Context Link 1]

[UU] The standard medical definition of acute liver failure is the onset of acute liver disease of less than 26 weeks' duration with an INR greater than 1.5 attributable to liver disease plus any degree of hepatic encephalopathy.(167) However, for purposes of liver transplant, the Organ Procurement and Transplantation Network defines acute liver failure (also known as "fulminant liver failure") as the onset of hepatic encephalopathy within 56 days (8 weeks) of the first signs or symptoms of liver disease.(152) [UU in Context Link 1]

[VV] Hepatic encephalopathy is graded by West Haven criteria for patients age 3 years or older.(168) A calculator for West Haven criteria is available at www.mdcalc.com/hepatic-encephalopathy-grades-stages. [VV in Context Link 1, 2]

[WW] The Model for End-Stage Liver Disease (MELD) score is used for patients 12 years or older and may be calculated at the Organ Procurement and Transplantation Network website at https://optn.transplant.hrsa.gov/resources/allocation-calculators/meld-calculator/.(152) In cases in which the calculated Model for End-Stage Liver Disease (MELD) score or Pediatric Model for End-Stage Liver Disease (PELD) score does not reflect the urgent need for a liver transplant, an appeal may be made to the Regional Review Board for a score exception.(152)(169)(173)(174) Examples of conditions eligible for MELD or PELD score exclusions include hepatopulmonary syndrome, primary hyperoxaluria, metabolic disorders (eg, organic acidemia, urea cycle disorder), hepatocellular carcinoma, and cystic fibrosis with FEV_1 less than 40% predicted.(152)(169)(173)(174) [WW in Context Link 1]

[XX] A specialty society notes that the European Association for the Study of the Liver-Chronic Liver Failure Consortium (EASL-CLIF-C) score may be used to help prioritize patients for liver transplant.(177) A calculator is available at https://efclif.com/research-infrastructure/score-calculators/clif-c-of-aclf-ad/#calculator. [XX in Context Link 1]

[YY] A specialty society recommends that patients with Acute-on-Chronic Liver Failure (ACLF) grade of 3 be considered for liver transplant.(178) A calculator is available at www.aclf.in/?page=doctor_aarc_grade_cal. [YY in Context Link 1]

[ZZ] Patients who have organ failure that has stabilized or improved may be better candidates for transplant.(179) [ZZ in Context Link 1]

[AAA] Grade III encephalopathy is characterized by confusion, incoherent speech, and sleepiness but is arousable to voice. Grade IV is a comatose patient, unresponsive to pain, with decerebrate or decorticate posturing.(168) [AAA in Context Link 1]

[BBB] Severe acute respiratory distress syndrome (ARDS) (PaO_2 to FiO_2 ratio less than 150 mm Hg (SpO_2 to FiO_2 ratio less than 150)) is predictive of worse post-transplant outcomes and may be considered a barrier to transplant.(179) SpO_2 to FiO_2 ratios generally correlate well with PaO_2 to FiO_2 ratios after mathematical

correction when SpO_2 levels are 97% or less.(180) However, this ratio should be used with caution due to limitations in accuracy of pulse oximetry, especially in patients who are poorly perfused or have acidosis.(180)(181) 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.(180) Where appropriate, pulse oximetry should be measured after warming fingers or removing nail polish.(182) [BBB in Context Link 1]

[CCC] Hepatopulmonary syndrome is characterized by hypoxemia due to intrapulmonary vascular dilation in the setting of portal hypertension or cirrhosis.(172)(193)(194) [CCC in Context Link 1]

[DDD] A clinical guideline recommends liver transplant as lifesaving therapy for all patients with Wilson disease and acute liver failure.(195) Patients with acute liver failure due to Wilson disease may present with hemolysis, hepatic encephalopathy, and (in contrast to other causes of acute liver failure) relatively small elevations of serum aminotransferases.(195) [DDD in Context Link 1]

[EEE] Some patients with acute liver injury due to Wilson disease will respond to aggressive medical therapy while others may progress to acute liver failure.(195) A New Wilson Index score of 11 or greater (available at www.pediatriconcall.com/calculators/hepatology/wilsons-disease-scoring-system) is predictive of high mortality without liver transplant; however, it may be less reliable in children than in adults.(195) [EEE in Context Link 1]

[FFF] Patient may have chronic liver disease due to failure of medical management or due to disease progression in a previously undiagnosed and untreated patient.(195) [FFF in Context Link 1]

[GGG] Glycogen storage disease increases the risk for malignant transformation.(169) [GGG in Context Link 1]

[HHH] Specialty society guidelines identify combined heart-kidney transplant as appropriate for patients with advanced heart failure and concomitant renal failure (either acute kidney injury lasting 6 weeks or more, or irreversible chronic kidney disease as evidenced by either the need for chronic renal replacement therapy or severely reduced creatinine clearance (creatinine clearance of 30 mL/min/1.73m^2 (0.50 mL/sec/1.73m^2) or less)).(151)(152) [HHH in Context Link 1, 2]

[III] Treated and cured cancers, including any carcinoma in situ, nonmetastatic basal cell and squamous cell carcinoma of the skin, melanoma in situ, prostate cancer with Gleason score 6 or less, small (3 cm or less) renal tumors, superficial bladder cancer, and follicular or papillary thyroid cancer less than 2 cm with low-grade histology, are not contraindications to transplant. Patients with hematologic or solid tumor malignancies in remission and patients with myelodysplasias, chronic leukemia, or low-grade lymphomas may be transplant candidates after evaluation by a transplant hematologist.(198) [III in Context Link 1]

[JJJ] See Intensive, Intermediate, and Telemetry Care Guidelines ISC. [JJJ in Context Link 1]

[KKK] See Clinical Indications for Procedure in this guideline. [KKK in Context Link 1]

Definitions

Activity level acceptable

- Activity level acceptable, as indicated by **1 or more** of the following:
  - Patient ambulatory and can perform ADL as appropriate for age and development
  - Activity at baseline
  - Activity level acceptable for next level of care

Bacteremia

- Bacteremia refers to blood culture isolation of a bacterial species that is likely to be pathologic and not a contaminant.(1)(2)

References

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Cardiovascular status acceptable

- Cardiovascular status acceptable, as indicated by **ALL** of the following:
  - Cardiac rhythm acceptable, as indicated by **1 or more** of the following(1):
    - Normal sinus or paced rhythm
    - Sinus arrhythmia or supraventricular arrhythmia (eg, atrial fibrillation) with ventricular rate controlled, and no need for cardioversion(2)
  - No severe cardiac arrhythmias noted (eg, sustained ventricular tachycardia, ventricular fibrillation)(1)
  - No severe cardiac or peripheral ischemia(3)(4)
  - Heart failure or other cardiovascular disease is **1 or more** of the following(5):
    - Not present
    - At baseline
    - Manageable at next level of care

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General Discharge Criteria met

- General Discharge Criteria met or Pediatric General Discharge Criteria met (if either is relevant or necessary for patient's condition)

Hemodynamic stability

- Hemodynamic stability, as indicated by **1 or more** of the following:
  - Hemodynamic abnormalities at baseline or acceptable for next level of care
  - Patient hemodynamically stable, as indicated by **ALL** of the following(1)(2):
    - Tachycardia absent
    - Hypotension absent

- No evidence of inadequate perfusion (eg, no myocardial ischemia)
- No other hemodynamic abnormalities (eg, no Orthostatic hypotension)

References

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2. Ramgopal S, Sepanski RJ, Martin-Gill C. Empirically derived age-based vital signs for children in the out-of-hospital setting. Annals of Emergency Medicine 2023;81(4):402-412. DOI: 10.1016/j.annemergmed.2022.09.019.

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

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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.

Inferior vena cava filter placement appropriate

- Vena cava filter placement appropriate, as indicated by **1 or more** of the following[A][B](1)(3)(4)(5)(6)(7)(12):
  - Recurrence or progression of venous thromboembolism[C] while anticoagulated, as indicated by **ALL** of the following:
    - Confirmation of recurrence or progression while fully anticoagulated (eg, patient adherent, correct dosage)
    - Recurrence or progression occurred while being treated with low-molecular-weight heparin, or low-molecular-weight heparin is contraindicated (eg, heparin-induced thrombocytopenia, allergy to heparin).
    - Recurrence or progression occurred after treatment with increased dose of low-molecular-weight heparin (25% to 33% above usual dose), low-molecular-weight heparin is contraindicated (eg, heparin-induced thrombocytopenia, allergy to heparin), or risk of bleeding is too high to increase dose.
  - Venous thromboembolism and contraindication to anticoagulation, as indicated by **1 or more** of the following(2)(16)(17):
    - Active uncontrolled bleeding(16)(17)
    - Major bleeding diathesis (eg, coagulopathy, severe thrombocytopenia)(16)(17)
    - History of active bleeding while anticoagulated necessitating discontinuation of anticoagulant
    - Recent or planned surgery that increases risk of catastrophic bleeding (eg, neurosurgery, eye surgery)(16)(17)
    - Recent significant GI bleeding with high risk of recurrence (eg, esophageal varices, active peptic ulcer)(16)
    - Cerebral lesion at high risk of bleeding (eg, vascular malformation, recent large ischemic stroke, tumor)(17)
    - Intraspinal tumor(16)
    - History of intracranial bleeding (eg, hemorrhagic stroke)(16)(17)
    - Aortic dissection(16)(17)
    - Pericardial disease(17)
    - Endocarditis(17)
    - Threatened abortion(17)
    - Malignant hypertension, eclampsia, or preeclampsia that is not rapidly controlled(17)
    - Recent major trauma that increases risk of catastrophic bleeding (eg, liver or splenic laceration)
  - Acute pulmonary embolism and very poor cardiopulmonary reserve (eg, pulmonary hypertension), or massive pulmonary embolism[D](3)

References

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Footnotes

A. There is limited and inconsistent evidence that inferior vena cava (IVC) filter placement is beneficial.(1)(2)(3)(4)(5)(6)(7) In general, employment of an IVC filter is justified for venous thromboembolism when there are absolute contraindications to anticoagulation, or venous thromboembolism recurs or progresses despite full, adequate anticoagulation with low-molecular-weight heparin.(1)(2)(3)(4)(5)(6)(7)(8) Filter use in other contexts, such as for primary prophylaxis or thrombus characteristics (eg, size, location, morphology), is unproven and not recommended by evidence-based guidelines, editorials, or reviews.(1)(3)(4)(5)(8)(9)(10)(11) An evidence-based guideline suggests anticoagulation alone and recommends against filter placement for patients with acute pulmonary embolism and hemodynamic compromise.(2) A systematic review and meta-analysis including 11 studies (6 randomized controlled trials, 5 prospective observational studies, 4204 patients) that examined the utility of IVC filter placement found that patients receiving filters had a lower risk for subsequent pulmonary embolism (1.9% vs 4.6%) and a higher risk of deep venous thrombosis (4.7% vs 2.7%), with no difference in pulmonary embolism mortality or overall mortality.(12) The authors concluded that the evidence base is limited and that, pending further evidence, use of IVC filters be directed to those with current guideline-recommended indications (ie, contraindications to anticoagulation, recurrence despite anticoagulation).(12) Considering the known potential adverse consequences of filter use (eg, increased rate of subsequent deep venous thrombosis, venous insufficiency, thrombus formation on filter, vessel or organ perforation, device migration or embolization(13)(14)) and the uncertainty of benefit in most contexts, whenever possible, a retrievable filter should be used (eg, patient with time-limited contraindications to anticoagulation), with arrangements made for retrieval when the contraindication to anticoagulation is no longer present.(1)(2)(3)(4)(5)(7)(8) Temporary (as opposed to retrievable) filters are tethered to a femorally placed central venous catheter; they can be placed if the contraindication to anticoagulation is expected to be brief and then removed when the catheter is pulled without requiring interventional radiology guidance.(5) Newer filter technologies with novel materials are also available that can spontaneously bioconvert filters to an open (nonfiltering) IVC stent configuration, or to completely absorb over a 32-week period for patients in whom the risk for venous thromboembolism or contraindication to anticoagulation is anticipated to be temporary.(5)

B. Several of the contraindications to anticoagulation require clinical judgment and patient-specific assessment of risk, as precise terms and quantification are not agreed upon or established (eg, what is meant by recent surgery or GI bleed).(1)(3)(4)(5) Filters cannot be placed in children weighing less than 22 lb (10 kg).(8)

C. True recurrence or progression while fully anticoagulated is unusual. Insufficient anticoagulation (eg, nonadherence or subtherapeutic heparin or warfarin dosing) is more common. If adherence is assured, an evidence-based specialty society guideline suggests that, prior to consideration of an inferior vena cava (IVC) filter, patients being treated with other than low-molecular-weight heparin be switched to low-molecular-weight heparin, at least temporarily. If already on low-molecular-weight heparin, an increase in dose by 25% to 33% is suggested.(1) For patients who have cancer and recurrent venous thromboembolism, a specialty society guideline suggests either continuing therapeutic low-molecular-weight heparin or increasing dosing to supratherapeutic levels, and recommends against placement of an IVC filter based on low-certainty evidence suggesting lack of benefit and potential harm.(15)

D. A precise definition of very poor cardiopulmonary reserve is not agreed upon. A proposed definition of massive pulmonary embolism is acute pulmonary embolism with sustained hypotension (SBP less than 90 mm Hg for at least 15 minutes or requiring inotropic support, and not due to a cause other than pulmonary embolism (eg, arrhythmia, hypovolemia, sepsis, or left ventricular dysfunction)).(3) This is an area of controversy, with one evidence-based specialty society guideline suggesting against filter placement for patients with acute pulmonary embolism and hemodynamic compromise due to questionable efficacy and the potential of harm from the procedure.(2)

Intake acceptable

- Intake acceptable, as indicated by **1 or more** of the following(1):
  - Oral hydration, medications, and diet
  - Enteral hydration, medications, and diet
  - Administration routes performable at next level of care

References

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No blood loss, or problem resolved

- No blood loss, or problem resolved, as indicated by **1 or more** of the following(1)(2)(3)(4):
  - No blood loss problem
  - Repeat evaluation shows blood loss resolved sufficiently (eg, hemoglobin at acceptable level and stable)

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No contraindications to heart transplant present

- No contraindications to heart transplant present, as indicated by **ALL** of the following(1)(2)(3)(4)(5)(6)(7)(8):
  - No severe systemic illness limiting life expectancy to less than 2 years (eg, malignancy, AIDS, autoimmune disease, Duchenne muscular dystrophy)(1)(9)(10)(11)
  - No congenital anomaly that would preclude successful cardiac transplant (eg, severe pulmonary artery hypoplasia, severe pulmonary vein stenosis or aplasia)(12)
  - No irreversible severe hepatic dysfunction if considered for only heart transplant (eg, INR greater than 1.5 off warfarin, cirrhosis on biopsy, elevated hepatic venous pressure gradient greater than 5 mm Hg, clinical signs of portal hypertension)(1)
  - No severe renal insufficiency if considered for only heart transplant (eg, GFR less than 30 mL/min/1.73m^2 (0.5 mL/sec/1.73m^2))(1)(8)(9)
  - No severe obstructive or restrictive pulmonary disease if considered only for heart transplant (eg, FEV_1 less than 1 L/minute, severe pulmonary fibrosis)
  - No severe fixed (ie, pharmacologically irreversible) pulmonary hypertension (may include pulmonary veno-occlusive disease) if considered only for heart transplant(1)(11)
  - No psychiatric illness or severe cognitive disability (eg, dementia) that may interfere with postoperative medical adherence(13)
  - No severe neurologic disorder inhibiting postoperative recovery (eg, severe amyloid peripheral neuropathy, severe dysautonomia)(9)
  - No active substance abuse[A][B](14)(15)
  - No active infection (except device-related infection in ventricular assist device recipients)
  - HIV infection status acceptable, as indicated by **1 or more** of the following(1):
    - No HIV infection
    - HIV infection and **ALL** of the following:
      - No opportunistic infection
      - No HIV-related malignancy (eg, Kaposi sarcoma, lymphoma)
      - Stable HIV antiretroviral regimen with undetectable viral load
      - CD4 count greater than 200/mm^3 (0.2 x10^9/L) over prior 3 months
  - No clinically severe symptomatic cerebrovascular disease
  - No active peptic ulcer disease
  - No other potentially reversible contraindications (eg, poorly controlled severe hypertension)

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Footnotes

A. Recipient eligibility regarding substance abuse may vary between transplant programs and may be based on health insurer requirements as well as state legislation.(14)
B. A structured drug or alcohol rehabilitative program may be appropriate in patients with a recent history of alcohol or drug abuse.(15)

No contraindications to liver transplant present

- No contraindications to liver transplant present, as indicated by **ALL** of the following(1)(2)(3)(4)(5)(6)(7)(8):
  - No sustained increases of intracranial pressure greater than 50 mm Hg
  - Cerebral perfusion pressure not less than 40 mm Hg for more than 2 hours
  - No irreversible brain damage
  - No advanced HIV disease[A](6)
  - No uncontrolled systemic infection (eg, cholangitis, bacterial peritonitis)
  - No active alcohol or illicit substance use[B]
  - No advanced cardiac or pulmonary disease (eg, untreated coronary artery stenosis of 70% or greater, severe valvular disease, severe chronic lung disease) if considered only for liver transplant
  - No severe portopulmonary hypertension (mean pulmonary artery pressure of greater than 45 mm Hg) following pulmonary vasodilator or vasomodulator treatment(8)(14)
  - No unaddressed barriers to ability to comply with immunosuppression protocol and follow-up requirements (eg, adequate social support)
  - No history of persistent nonadherence
  - No anatomic abnormalities precluding liver transplant
  - No active extrahepatic malignancy[C](8)
  - No hemangiosarcoma
  - No Niemann-Pick disease type C

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Footnotes

A. HIV-positive liver transplant candidates should have CD4 counts greater than 100/mm^3 (0.1 x10^9/L) and plasma HIV RNA levels that are expected to be undetectable at the time of liver transplant.(6)
B. The duration of the period of sobriety required prior to liver transplant is controversial with no universally accepted time period. An arbitrarily picked duration of 6 months is the most commonly employed duration.(9) Because studies have shown that mortality is high in patients with severe alcoholic hepatitis who do not undergo transplant, and that patients undergoing earlier liver transplant for severe alcoholic hepatitis have similar survival and alcohol relapse rates as those who have completed a 6-month waiting period, shorter durations of abstinence may be appropriate.(9)(10)(11)(12) Specialty society guidelines recommend against basing the liver transplant candidacy on a fixed abstinence interval.(8)(13) Use of controlled substances as directed by a clinician (eg, medical marijuana, prescription opiates) should not be labeled as a substance use disorder.
C. Liver transplant candidates with a history of extrahepatic malignancy should have received definitive treatment with an adequate tumor-free survival period. The determination of what constitutes an adequate tumor-free survival period varies depending on the type of malignancy and efficacy of the treatment received.(6)(8)

No infection, or status acceptable

- No infection, or status acceptable, as indicated by **1 or more** of the following(1)(2)(3)(4)(5):
  - No infection present
  - Infection status acceptable for next level of care, as indicated by **ALL** of the following(6):
    - WBC count normal, stable, or declining with treatment
    - Adequate treatment performable at next level of care
    - Organism and sensitivities identified, or adequate clinical response to empiric therapy
    - Repeat cultures negative or not needed

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No inpatient interventions needed

- No inpatient interventions needed; examples include:
  - Vital signs, neurologic signs, or vascular checks more often than feasible at next level of care
  - Urgent procedure (eg, embolization, thrombectomy, amputation) planned within 24 hours
  - Wound care needed not feasible at next level of care
  - IV anticoagulation or platelet inhibitors. See Anticoagulation Requirement: Common Complications and Conditions for further information.

Operative site and other wounds acceptable

- Operative site and other wounds acceptable, as indicated by **1 or more** of the following(1):
  - Wounds absent
  - Wound site clean and intact, with minimal to no drainage and without signs of infection
  - Current wound care performable at next level of care

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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.

Pain and nausea absent or adequately managed

- Pain and nausea absent or adequately managed, as indicated by **1 or more** of the following(1)(2)(3)(4)(5):
  - No pain or nausea
  - Minimal discomfort on oral medications
  - Pain and nausea managed on regimen performable at next level of care

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Social Determinants of Health Assessment

- Risk of poor health outcomes may be increased by the presence of **1 or more** of the following social determinants of health(1)(2)(3):
  - Housing insecurity, as indicated by **1 or more** of the following:
    - Individual or caregiver's current living situation is **1 or more** of the following(4):

    - Does not have own housing (eg, staying in a hotel, shelter, or with others)
    - Has own housing (eg, house, apartment), but at risk of losing it in the future (ie, behind on rent or mortgage)
    - Has own housing (eg, house, apartment), but has lived in 3 or more places in past year
  - Current housing has **1 or more** of the following:
    - Electrical appliances (eg, stove, refrigerator) not working or unavailable
    - Insufficient heating or cooling
    - Insufficient ventilation
    - Lead paint or pipes
    - Mold
    - Pests (eg, bugs) or rodents
    - Smoke detectors not working or unavailable
- Food insecurity, as indicated by **1 or more** of the following(5):
  - In the past year, individual or caregiver ran out of food and did not have money to buy more food.
  - In the past year, individual or caregiver worried that they would run out of food before they received money to buy more food.
- Insufficient transportation, as indicated by **1 or more** of the following(6):
  - In the past year, individual or caregiver missed medical appointments or could not get medications due to lack of transportation.
  - In the past year, individual or caregiver missed nonmedical activities, work, or could not get things needed for daily living due to lack of transportation.
- Insufficient utilities, as indicated by **1 or more** of the following(7):
  - Utilities (eg, electricity, water, gas, or oil) are currently shut off or unavailable.
  - In the past year, electric, water, gas, or oil company threatened to shut off services.
- Personal safety risk, as indicated by **2 or more** of the following(5):
  - Individual is sometimes or frequently physically hurt by another person (including family member).
  - Individual is sometimes or frequently insulted or talked down to by another person (including family member).
  - Individual is sometimes or frequently threatened with physical harm by another person (including family member).
  - Individual is sometimes or frequently screamed or cursed at by another person (including family member).
- Insufficient dependent care, as indicated by **1 or more** of the following:
  - In the past year, individual or caregiver was unable to work due to lack of dependent care.
  - In the past year, individual or caregiver was unable to work more (additional) hours due to lack of dependent care.
  - In the past year, individual or caregiver missed medical appointments or could not get medications due to lack of dependent care.
  - In the past year, individual or caregiver missed nonmedical activities (eg, school, church, social activity) due to lack of dependent care.
- Depression risk, as indicated by **ALL** of the following(8):
  - In the past 2 weeks, individual had little interest or pleasure in normal activities on at least several days.
  - In the past 2 weeks, individual felt down, depressed, or hopeless on at least several days.

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Tachycardia absent

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

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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. 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.

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)

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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. 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)

Vascular, soft tissue, and wound status acceptable

- Vascular, soft tissue, and wound status acceptable, as indicated by **1 or more** of the following(1)(2)(3)(4):
  - No vascular, soft tissue, or wound problems
  - Status acceptable, as indicated by **ALL** of the following:
    - No significant ischemia
    - No Bacteremia
    - No evidence of compartment syndrome
    - Neuromotor function at baseline or expected level of recovery and appropriate for management at next level of care
    - No new wound dehiscence or hematoma that cannot be managed at next level of care
    - Tissue necrosis absent, or treatment plan appropriate for next level of care
    - Vascular, soft tissue, and wound management appropriate for next level of care

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