Instructions for use

The following coverage policy applies to health benefit plans administered by Cigna. Coverage policies are intended to provide guidance in interpreting certain standard Cigna benefit plans and are used by medical directors and other health care professionals in making medical necessity and other coverage determinations. Please note the terms of a customer’s particular benefit plan document may differ significantly from the standard benefit plans upon which these coverage policies are based. For example, a customer’s benefit plan document may contain a specific exclusion related to a topic addressed in a coverage policy.

In the event of a conflict, a customer’s benefit plan document always supersedes the information in the coverage policy. In the absence of federal or state coverage mandates, benefits are ultimately determined by the terms of the applicable benefit plan document. Coverage determinations in each specific instance require consideration of:

1. The terms of the applicable benefit plan document in effect on the date of service
2. Any applicable laws and regulations
3. Any relevant collateral source materials including coverage policies
4. The specific facts of the particular situation

Coverage policies relate exclusively to the administration of health benefit plans. Coverage policies are not recommendations for treatment and should never be used as treatment guidelines.

This evidence-based medical coverage policy has been developed by eviCore, Inc. Some information in this coverage policy may not apply to all benefit plans administered by Cigna.

These guidelines include procedures eviCore does not review for Cigna. Please refer to the Cigna CPT code list for the current list of high-tech imaging procedures that eviCore reviews for Cigna.

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# Procedure Codes Associated with Cardiac or PVD Imaging

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<thead>
<tr>
<th>MRI/MRA</th>
<th>CPT®</th>
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<tbody>
<tr>
<td>Cardiac MRI without contrast</td>
<td>75557</td>
</tr>
<tr>
<td>Cardiac MRI without contrast; with stress imaging</td>
<td>75559</td>
</tr>
<tr>
<td>Cardiac MRI without and with contrast</td>
<td>75561</td>
</tr>
<tr>
<td>Cardiac MRI without and with contrast; with stress imaging</td>
<td>75563</td>
</tr>
<tr>
<td>Cardiac magnetic resonance imaging for velocity flow mapping (list separately in addition to code for primary procedure)</td>
<td>75565</td>
</tr>
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<table>
<thead>
<tr>
<th>CT</th>
<th>CPT®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart CT with contrast for structure and morphology</td>
<td>75572</td>
</tr>
<tr>
<td>Heart CT with contrast for structure and morphology, for congenital heart disease</td>
<td>75573</td>
</tr>
<tr>
<td>Heart CT with contrast for coronary arteries &amp; bypass grafts</td>
<td>75574</td>
</tr>
<tr>
<td>Noninvasive estimated coronary fractional flow reserve (FFR) derived from coronary computed tomography angiography data using computation fluid dynamics physiologic simulation software analysis of functional data to assess the severity of coronary artery disease; data preparation and transmission, analysis of fluid dynamics and simulated maximal coronary hyperemia, generation of estimated FFR model, with anatomical data review in comparison with estimated FFR model to reconcile discordant data, interpretation and report</td>
<td>0501T</td>
</tr>
<tr>
<td>Data preparation and transmission</td>
<td>0502T</td>
</tr>
<tr>
<td>Analysis of fluid dynamics and simulated maximal coronary hyperemia, and generation of estimated FFR model</td>
<td>0503T</td>
</tr>
<tr>
<td>Anatomical data review in comparison with estimated FFR model to reconcile discordant data, interpretation and report</td>
<td>0504T</td>
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<thead>
<tr>
<th>CTA</th>
<th>CPT®</th>
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</thead>
<tbody>
<tr>
<td>CTA Abdominal Aorta with Bilateral Iliofemoral Runoff</td>
<td>75635</td>
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<table>
<thead>
<tr>
<th>Ultrasound</th>
<th>CPT®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transthoracic echocardiography for congenital cardiac anomalies; complete</td>
<td>93303</td>
</tr>
<tr>
<td>Transthoracic echocardiography for congenital cardiac anomalies; follow-up study</td>
<td>93304</td>
</tr>
<tr>
<td>Echocardiography, transthoracic, real time with image documentation (2D), includes M-mode recording, when performed, complete, with spectral Doppler echocardiography, and with color flow Doppler echocardiography</td>
<td>93306</td>
</tr>
<tr>
<td>Echocardiography, transthoracic, real time with image documentation (2D), includes M-mode recording, when performed, complete, without spectral or color Doppler echocardiography</td>
<td>93307</td>
</tr>
<tr>
<td>Echocardiography, transthoracic, real time with image documentation (2D), includes M-mode recording, when performed, complete</td>
<td>93308</td>
</tr>
<tr>
<td>Doppler echocardiography, pulsed wave and/or continuous wave with spectral display (List separately in addition to codes for echocardiographic imaging); complete</td>
<td>93320</td>
</tr>
<tr>
<td>Doppler echocardiography, pulsed wave and/or continuous wave with spectral display (List separately in addition to codes for echocardiographic imaging); follow-up or limited study</td>
<td>93321</td>
</tr>
<tr>
<td>Doppler echocardiography color flow velocity mapping (List separately in addition to codes for echocardiographic imaging)</td>
<td>93325</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>93312</td>
<td>Echocardiography, transesophageal, (TEE) real-time with image documentation (2D) (with or without M-mode recording); including probe placement, image acquisition, interpretation and report</td>
</tr>
<tr>
<td>93313</td>
<td>Echocardiography, transesophageal, (TEE) real-time with image documentation (2D) (with or without M-mode recording); placement of transesophageal probe only</td>
</tr>
<tr>
<td>93314</td>
<td>Echocardiography, transesophageal, (TEE) real-time with image documentation (2D) (with or without M-mode recording); image acquisition, interpretation &amp; report only</td>
</tr>
<tr>
<td>93315</td>
<td>Transesophageal echocardiography (TEE) for congenital cardiac anomalies; including probe placement, image acquisition, interpretation and report</td>
</tr>
<tr>
<td>93316</td>
<td>Transesophageal echocardiography (TEE) for congenital cardiac anomalies; placement of transesophageal probe only</td>
</tr>
<tr>
<td>93317</td>
<td>Transesophageal echocardiography (TEE) for congenital cardiac anomalies; image acquisition, interpretation &amp; report only</td>
</tr>
<tr>
<td>93350</td>
<td>Transthoracic echocardiography with contrast for congenital cardiac anomalies; complete</td>
</tr>
<tr>
<td>93351</td>
<td>Transthoracic echocardiography with contrast for congenital cardiac anomalies; f/u or limited study</td>
</tr>
<tr>
<td>+ 93352</td>
<td>Transthoracic echocardiography with contrast, real-time with image documentation (2d), with/without M-mode recording; complete</td>
</tr>
<tr>
<td>C8921</td>
<td>Transthoracic echocardiography with contrast for congenital cardiac anomalies; complete</td>
</tr>
<tr>
<td>C8922</td>
<td>Transthoracic echocardiography with contrast for congenital cardiac anomalies; f/u or limited study</td>
</tr>
<tr>
<td>C8923</td>
<td>Transthoracic echocardiography with contrast, real-time with image documentation (2d), with/without M-mode recording; complete</td>
</tr>
<tr>
<td>C8924</td>
<td>Transthoracic echocardiography with contrast, real-time with image documentation (2d), with/without M-mode recording; f/u or limited study</td>
</tr>
<tr>
<td>C8925</td>
<td>Transesophageal echocardiography (TEE) with contrast, or without contrast followed by with contrast, real time with image documentation (2D) (with or without M-mode recording); including probe placement, image acquisition, interpretation and report</td>
</tr>
<tr>
<td>C8926</td>
<td>Transesophageal echocardiography (TEE) with contrast, or without contrast followed by with contrast, for congenital cardiac anomalies; including probe placement, image acquisition, interpretation and report</td>
</tr>
<tr>
<td>C8928</td>
<td>Transthoracic echocardiography with contrast, real-time with image documentation (2d), with/without M mode recording, during rest and cardiovascular stress test, w/interpretation and report</td>
</tr>
<tr>
<td>C8929</td>
<td>Transthoracic echocardiography with contrast, or without contrast followed by with contrast, real-time with image documentation (2d), includes M-mode recording, when performed, complete, with spectral doppler echocardiography, and with color flow doppler echocardiography</td>
</tr>
<tr>
<td>C8930</td>
<td>Transthoracic echocardiography, with contrast, or without contrast followed by with contrast, real-time with image documentation (2d), includes M-mode recording, when performed, during rest and cardiovascular stress test using treadmill, bicycle exercise and/or pharmacologically induced stress, with interpretation and report; including performance of continuous electrocardiographic monitoring, with physician supervision</td>
</tr>
<tr>
<td>Description</td>
<td>Code</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Myocardial strain imaging (quantitative assessment of myocardial mechanics using image-based analysis of local myocardial dynamics) (List separately in addition to code for primary procedure)</td>
<td>+ 0399T</td>
</tr>
<tr>
<td>Myocardial contrast perfusion echocardiography, at rest or with stress, for assessment of myocardial ischemia or viability (List separately in addition to code for primary procedure)</td>
<td>+ 0439T</td>
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<td>PEDCD-1.1: Pediatric Cardiac Imaging Age Considerations</td>
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<td>PEDCD-1.3: Pediatric Cardiac Imaging Modality General Considerations</td>
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PEDCD-1.1: Pediatric Cardiac Imaging Age Considerations

- Heart disease in the pediatric population involves predominantly congenital lesions. Pediatric individuals can have acquired heart disease unique to children. For those diseases which occur in both pediatric and adult populations, differences exist in management due to individual age, comorbidities, and differences in disease natural history between children and adults.
- Individuals who are < 18 years old should be imaged according to the Pediatric Cardiac Imaging Guidelines, and individuals who are ≥ 18 years should be imaged according to the Cardiac Imaging Guidelines, except where directed otherwise by a specific guideline section.

PEDCD-1.2: Pediatric Cardiac Imaging Appropriate Clinical Evaluation

- A recent (within 60 days) face-to-face evaluation should be performed prior to considering advanced imaging, unless the individual is undergoing guideline-supported scheduled follow-up imaging evaluation. This evaluation should include:
  - A detailed history
  - Physical examination
  - Appropriate laboratory studies
- Unless otherwise stated in a specific guideline section, the use of advanced imaging to screen asymptomatic individuals for disorders involving the heart is not supported.
- Advanced imaging of the heart should only be approved in individuals who have documented active clinical signs or symptoms of disease involving the heart.
- Unless otherwise stated in a specific guideline section, repeat imaging studies of the heart are not necessary unless:
  - There is evidence for progression of disease
  - New onset of disease and/or documentation of how repeat imaging will affect individual management or treatment decisions.

PEDCD-1.3: Pediatric Cardiac Imaging Modality General Considerations

- MRI
  - MRI and MRA studies are frequently indicated for evaluation of complex congenital heart defects not well visualized on echocardiography, thoracic arteries and veins not visualized on echocardiography, cardiomyopathies, and right ventricular disease.
  - Due to the length of time for image acquisition and the need for stillness, anesthesia is required for almost all infants and young children (age < 7 years), as well as older children with delays in development or maturity. In this individual population, MRI imaging sessions should be planned with a goal of avoiding a short-interval repeat anesthesia exposure due to insufficient information using the following considerations:
    - MRI should always be performed without and with contrast unless there is a specific contraindication to gadolinium to avoid repeat anesthesia.
If multiple body areas are supported by eviCore guidelines for the clinical condition being evaluated, MRI of all necessary body areas should be obtained concurrently in the same anesthesia session.

CT
- CT is primarily used to evaluate the coronary and great vessels in congenital heart disease.
- Coding considerations are listed in PEDCD-10: CT Heart and Coronary Computed Tomography Angiography (CCTA- Other Indications)

Ultrasound
- Echocardiography is the primary modality used to evaluate the anatomy and function of the pediatric heart, and is generally indicated before considering other imaging modalities.
- Coding considerations are listed in PEDCD-8: Echocardiography- Other Indications.

The guidelines listed in this section for certain specific indications are not intended to be all-inclusive; clinical judgment remains paramount and variance from these guidelines may be appropriate and warranted for specific clinical situations.

References


# PEDCD-2: Congenital Heart Disease

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PEDCD-2.1: Congenital Heart Disease General Considerations

- Congenital heart disease accounts for the majority of cardiac problems occurring in the pediatric population. Individuals may be diagnosed any time spanning prenatal evaluation to adolescence.

- There are a number of variables that influence the modality and timing of imaging individuals with congenital heart disease, which results in a high degree of individuality in determining the schedule for imaging these individuals, including:
  - Gestational age
  - Individual age
  - Physiologic effects of the defect
  - Status of interventions (cath and surgical)
  - Rate of individual growth
  - Stability of the defect on serial imaging
  - Comorbid conditions
  - Activity level

PEDCD-2.2: Congenital Heart Disease Echocardiography Coding

- ANY of the following echocardiography code combinations are appropriate for re-evaluation of individuals with known congenital heart disease:
  - CPT® 93303, CPT® 93320, and CPT® 93325
  - CPT® 93304, CPT® 93321, and CPT® 93325
  - CPT® 93303
  - CPT® 93304

- CPT® 93306 is not indicated in the evaluation of known congenital heart disease.

- All requested CPT® combinations other than those listed in this section should be forwarded for Medical Director Review.

PEDCD-2.3: Congenital Heart Disease Modality Considerations

- Echocardiography is the primary imaging modality used for diagnosing and monitoring congenital heart disease and is generally required before other imaging modalities are indicated unless otherwise indicated in a specific guideline section.

- Cardiac MRI either without contrast (CPT® 75557) or without and with contrast (CPT® 75561) is indicated for the following, when a recent echocardiogram is inconclusive:
  - CPT® 75565 is also indicated for individuals with valvular disease or a need to evaluate blood flow through the chambers. These individuals will usually have CPT® 93320 and CPT® 93325 performed with their echocardiography studies.

- MRA Chest (CPT® 71555) may be added if the aorta or pulmonary artery needs to be visualized beyond the root, or if aortopulmonary collaterals, pulmonary veins, or systemic veins need to be visualized.
  - MRA Chest alone (CPT® 71555) should be performed if the individual cannot cooperate with full cardiac MRI exam.
MRA Chest (CPT® 71555) is indicated for the following:
- Coarctation of the aorta, tetralogy of Fallot, anomalous pulmonary veins, and other lesions of the great arteries, with inconclusive recent echocardiography findings.

CT imaging is indicated for the following:
- Report CPT® 75574 for evaluating coronary artery anomalies
- Report CPT® 75573 for congenital heart disease
- Determination of extra-cardiac anatomy in individuals with complex congenital heart disease
- Pulmonary artery (PA) and Pulmonary vein (PV) assessment
- Coarctation of the aorta or interruption of the aortic arch suspected on echocardiography.

PEDCD-2.4: Congenital Heart Disease Timing Considerations

- Echocardiography is repeated frequently throughout a child’s life, and the following intervals are within the standard of care:
  - Individuals age 0 to 2 years: every 3 months
  - Individuals age 3 to 12 years: every 6 months
  - Individuals age 13 years and older: every 12 months
  - Some congenital conditions may require more frequent testing, especially with more complex heart disease, changes in clinical status, repeat interventions, and/or in neonates.
  - Echocardiography is performed during the physician office visit, and these studies should not be denied because of lack of contact within 60 days.

References

8. Identifying newborns with critical congenital heart disease

Author: Carolyn A Altman, MD

Section Editors: David R Fulton, MD
Leonard E Weisman, MD
Deputy Editor: Carrie Armsby, MD, MPH

All topics are updated as new evidence becomes available and our peer review process is complete. Literature review current through: Jun 2018. | This topic last updated: Jun 14, 2018.
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</table>
PEDCD-3.1: Heart Murmur General

- The following echocardiography code combinations for evaluation of any pathologic murmur or any innocent murmur with associated cardiac signs or symptoms:
  - CPT® 93303, CPT® 93306, CPT® 93320, and CPT® 93325
  - CPT® 93303, CPT® 93306
  - CPT® 93306, CPT® 93320 and CPT® 93325 are included with CPT® 93306 and should not be approved separately.

- Repeat echocardiography is not indicated if the initial echocardiogram was normal and the murmur has not changed in quality.

Background and Supporting Information

Heart murmurs are extremely common in pediatric individuals. The thinner chest wall in children allows clearer auscultation of blood flowing through the chambers of the heart, which may result in a murmur on physical exam.

The majority of murmurs are innocent and do not require further evaluation. More than 30% of children may have an innocent murmur detected during physical examination. Innocent murmurs are typically systolic ejection murmurs with a vibratory or musical quality, and generally change in quality when the individual changes position.

Other types of murmurs can be pathologic and require additional evaluation, usually by a pediatric cardiologist. Echocardiography is indicated, and is performed as part of the office visit. When evaluating an individual with a murmur for the first time, it will not be known whether the individual has congenital heart disease or not. The cardiologist only submits charges for the procedure actually performed.

References

5. Allen, Hugh D.; Shaddy, Robert E.; Penny, Daniel J.; Feltes, Timothy F.; Cetta, FrankTitle: Moss and Adams’ Heart Disease in Infants, Children, and Adolescents: Including the Fetus and Young Adult, 9th Edition Copyright ©2016 Lippincott Williams & Wilkin.
6. Advances in Cardiovascular Imaging Multimodality Noninvasive Imaging for Assessment of Congenital Heart Disease Ashwin Prakash, MD; Andrew J. Powell, MD; Tal Geva.
7. Uptodate Approach to the infant or child with a cardiac murmur

Author: Robert L Geggel, MD

Section Editors: David R Fulton, MD

Martin I Lorin, MD

Deputy Editor: Carrie Armsby, MD, MPH

Literature review current through: Jun 2018. | This topic last updated: Jun 01, 2017.
PEDCD-4.1: Chest Pain General

A recent (within 60 days) face-to-face evaluation including a detailed history, physical examination, EKG, and appropriate laboratory studies should be performed prior to considering advanced imaging.

Echocardiography is indicated for pediatric individuals with chest pain and one or more of the following:
- Exertional chest pain
- Non-exertional chest pain with abnormal EKG
- First-degree relative with sudden unexplained death or cardiomyopathy
- Recent onset of fever
- Recent illicit drug use
- Other signs or symptoms of cardiovascular disease

Echocardiography is performed as part of the office visit. When evaluating an individual for the first time, it will not be known whether the individual has congenital heart disease or not. The cardiologist only submits charges for the procedure actually performed.

The following echocardiography code combinations for evaluation of chest pain:
- CPT® 93303, CPT® 93306, CPT® 93320, and CPT® 93325
- CPT® 93303, CPT® 93306
- CPT® 93306
  - CPT® 93320 and CPT® 93325 are included with CPT® 93306 and should not be approved separately.

Repeat echocardiography is not indicated if the initial echocardiogram is normal unless one of the following conditions is present:
- Increased severity or change in quality of the chest pain
- New signs or symptoms of cardiovascular disease other than pain
- New abnormality on EKG

Background and Supporting Information

Chest pain in pediatric individuals is caused by a cardiac etiology in < 5% of cases, yet causes great anxiety for parents resulting in requests for testing.
References


4. Allen, Hugh D.; Shaddy, Robert E.; Penny, Daniel J.; Feltes, Timothy F.; Cetta, Frank Title: Moss and Adams’ Heart Disease in Infants, Children, and Adolescents: Including the Fetus and Young Adult, 9th Edition Copyright ©2016 Lippincott Williams & Wilkins.

5. Uptodate Nontraumatic chest pain in children and adolescents: Approach and initial management Authors:Robert L Geggel, MDErin E Endom, MDSection Editors:David R Fulton, MDGregory Redding, MDJan E Drutz, MDGary R Fleisher, MDDeputy Editor:James F Wiley, II, MD, MP.
**PEDCD-5.1: Syncope**

- A recent (within 60 days) face-to-face evaluation including a detailed history, physical examination, EKG, and appropriate laboratory studies should be performed prior to considering advanced imaging.

- Echocardiography is not indicated for most individuals with isolated syncope.

- Echocardiography is indicated for pediatric individuals with syncope and one or more of the following:
  - Exertional syncope
  - Unexplained post-exertional syncope
  - Abnormal EKG
  - First-degree relative with any of the following before age 50:
    - Sudden cardiac arrest or death
    - Pacemaker or implantable defibrillator placement
  - First-degree relative with cardiomyopathy
  - Known congenital heart disease
  - History of Kawasaki disease
  - Pathologic murmur, irregular rhythm, gallop, or click on physical examination

- Echocardiography is performed as part of the office visit. When evaluating an individual for the first time, it will not be known whether the individual has congenital heart disease or not. The cardiologist only submits charges for the procedure actually performed.

- The following echocardiography code combinations for evaluation of syncope:
  - CPT® 93303, CPT® 93306, CPT® 93320, and CPT® 93325
  - CPT® 93303, CPT® 93306
  - CPT® 93306
    - CPT® 93320 and CPT® 93325 are included with CPT® 93306 and should not be approved separately.

- Repeat echocardiography is not indicated if the initial echocardiogram is normal unless one of the following conditions is present:
  - Increased severity or change in quality of the syncope
  - New signs or symptoms of cardiovascular disease other than syncope
  - New abnormality on EKG

**Background and Supporting Information**

Syncope in pediatric individuals is common, with up to 15% of individuals experiencing at least one episode by age 21. Syncope is caused by neurocardiogenic syndrome (vasovagal syncope) in 75 to 80% of cases, which is a benign and self-limiting condition. Despite this, syncope causes great anxiety for parents resulting in requests for testing.
References
5. Uptodate Causes of syncope in children and adolescents Author:Jack C Salerno, MDSection Editors:George A Woodward, MDJohn K Triedman, MDDeputy Editor:James F Wiley, II, MD, MPH.
6. Allen, Hugh D.; Shaddy, Robert E.; Penny, Daniel J.; Feltes, Timothy F.; Cetta, Frank Title: Moss and Adams' Heart Disease in Infants, Children, and Adolescents: Including the Fetus and Young Adult, 9th Edition Copyright ©2016 Lippincott Williams & Wilkins.
PEDCD-6.1: Kawasaki Disease

- A recent (within 60 days) face-to-face evaluation including a detailed history, physical examination, and appropriate laboratory studies should be performed prior to considering advanced imaging.

- Echocardiography (CPT® 93306) is indicated for all individuals with suspected or known Kawasaki disease
  - Echocardiography is recommended at the time of diagnosis, 1 to 2 weeks later, and 4 to 6 weeks from diagnosis.
  - Individuals with recurrent or persistent fever or worsening cardiac symptoms should have echocardiogram repeated.
  - Individuals with no coronary abnormalities on the 4 to 6 week study should have a repeat echocardiogram 1 year from diagnosis.
  - Individuals with coronary abnormalities will require more frequent echocardiograms based on severity of disease and need for medical management.
  - Individuals with history of coronary artery aneurysms may require stress imaging—see below Long-Term Assessment and Counseling Algorithm

- Coronary CTA (CPT® 75574), Cardiac MRI without contrast (CPT® 75557), Cardiac MRI without and with contrast (CPT® 75561), or MRA Chest (CPT® 71555) is indicated for evaluation of inconclusive echocardiogram findings, or significant coronary artery abnormalities.

- Screening of other body areas for aneurysms is not routinely indicated in Kawasaki disease, but MRA or CTA (contrast as requested) of the affected body area can be approved for evaluation of signs or symptoms suggesting aneurysm development.

Background and Supporting Information

- Kawasaki disease (KD) is the leading cause of acquired pediatric cardiac disease in the developed world. It is an acute febrile illness characterized by a medium vessel vasculitis, which predominantly affects the coronary arteries.

- Individuals who do not fulfill the diagnostic criteria for classic KD may be considered to have incomplete (atypical) KD.

- If Kawasaki disease is strongly suspected, treatment will often begin even before cardiac evaluation, since early treatment is associated with a lower risk for coronary aneurysm development.
## Table 10. Long-Term Assessment and Counseling Algorithm

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Frequency of Cardiology Assessment</th>
<th>Assessment for Inducible Myocardial Ischemia</th>
<th>Type and Frequency of Additional Cardiology Assessment</th>
<th>Cardiovascular Risk Factor Assessment and Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: No involvement</td>
<td>May discharge between 4 wk and 12 mo</td>
<td>None</td>
<td>None</td>
<td>Assess at 1 y</td>
</tr>
<tr>
<td>2: Dilation only</td>
<td>May discharge after 1 y if normal; assess every 2–5 y if persists</td>
<td>None</td>
<td>None</td>
<td>Assess at 1 y</td>
</tr>
<tr>
<td>3.1: Small aneurysm, current or persistent</td>
<td>Assess at 6 mo, then yearly</td>
<td>Every 2–3 y</td>
<td>May consider every 3–5 y</td>
<td>Assess at 1 y</td>
</tr>
<tr>
<td>3.2: Small aneurysm, regressed to normal or dilation only</td>
<td>Assess every 1–3 y (may omit echocardiography)</td>
<td>Every 3–5 y</td>
<td>May consider if there is inducible ischemia</td>
<td>Assess at 1 y, then every 2 y</td>
</tr>
<tr>
<td>4.1: Medium aneurysm, current or persistent</td>
<td>Assess at 3, 6, and 12 mo, then yearly</td>
<td>Every 1–3 y</td>
<td>May consider every 2–5 y</td>
<td>Assess at 1 y</td>
</tr>
<tr>
<td>4.2: Medium aneurysm, regressed to small aneurysm</td>
<td>Yearly</td>
<td>Every 2–3 y</td>
<td>May consider every 3–5 y</td>
<td>Yearly</td>
</tr>
<tr>
<td>4.3: Medium aneurysm, regressed to normal or dilation only</td>
<td>Every 1–2 y (may omit echocardiography)</td>
<td>Every 2–4 y</td>
<td>May consider if there is inducible ischemia</td>
<td>Every 2 years</td>
</tr>
<tr>
<td>5.1: Large or giant aneurysm, current or persistent</td>
<td>Assess at 3, 6, 9, and 12 mo, then every 3–6 mo</td>
<td>Every 6–12 mo</td>
<td>Baseline within 2–6 mo; may consider every 1–5 y</td>
<td>Every 6–12 mo</td>
</tr>
<tr>
<td>5.2: Large or giant aneurysms, regressed to medium aneurysm</td>
<td>Every 6–12 mo</td>
<td>Yearly</td>
<td>May consider every 2–5 y</td>
<td>Yearly</td>
</tr>
<tr>
<td>5.3: Large or giant aneurysm, regressed to small aneurysm</td>
<td>Every 6–12 mo</td>
<td>Every 1–2 y</td>
<td>May consider every 2–5 y</td>
<td>Yearly</td>
</tr>
<tr>
<td>5.4: Large or giant aneurysm, regressed to normal or dilation only</td>
<td>Every 1–2 y (may omit echocardiography)</td>
<td>Every 2–3 y</td>
<td>May consider every 2–5 y</td>
<td>Every 2 years</td>
</tr>
</tbody>
</table>

References


**PEDCD-7: Pediatric Pulmonary Hypertension General**

- A recent (within 60 days) face-to-face evaluation including a detailed history, physical examination, and appropriate laboratory studies should be performed prior to considering advanced imaging.

- Chest x-ray, EKG, and echocardiography (CPT® 93306, or CPT® 93303 with CPT® 93320, and CPT® 93325, See PEDCD-8.1: Transthoracic Echocardiography (TTE) Coding for echocardiography coding considerations) for initial evaluation if pulmonary hypertension is suspected.

- Repeat echocardiography intervals are variable depending on age of individual, etiology, and severity.
  - After a comprehensive initial evaluation, echocardiograms using PH-specific protocols may be performed every 4 to 6 months.
  - Echocardiography is indicated at any time for new or worsening symptoms or to evaluate a recent change in therapy.
  - Right heart and/or left heart catheterization may be utilized for PAH individuals, including before and after initiation of PAH-targeted therapy, and for individuals with concomitant congenital heart disease.

- Chest CT (CPT® 71250) may be indicated in addition to Chest CTA (CPT® 71275) or Chest MRA (CPT® 71555) for initial evaluation of all pediatric individuals with pulmonary hypertension to evaluate for pulmonary vascular or interstitial disease or other intrathoracic causes.

- Cardiac MRI without and with contrast (CPT® 75561) is indicated for evaluation of inconclusive echocardiogram findings, or for monitoring right ventricular function during follow-up.

- Stress echocardiograms may be indicated (as in adult guidelines) See CD-2.7: Stress Echocardiography – Indications, other than ruling out CAD.

**Background and Supporting Information**

Pulmonary hypertension in children can be caused by cardiac, pulmonary, or systemic diseases, and idiopathic disease occurs as well.
References
3. UPtoDATE. Pulmonary hypertension in children: Classification, evaluation, and diagnosis Authors: Mary P Mullen, MD, PhD Thomas Kulik, MD Authors: Section Editors: David R Fulton, MD George B Mallory, MDDeputy Editor: Carrie Armsby, MD, MPH Literature review current through: Jun 2018. | This topic last updated: Mar 14, 2018.
4. Allen, Hugh D.; Shaddy, Robert E.; Penny, Daniel J.; Feltes, Timothy F.; Cetta, Frank Title: Moss and Adams’ Heart Disease in Infants, Children, and Adolescents: Including the Fetus and Young Adult, 9th Edition Copyright ©2016 Lippincott Williams & Wilkin.
### PEDCD-8: Echocardiography-Other Indications

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PEDCD-8.1: Transthoracic Echocardiography (TTE) Coding

- CPT® codes for echocardiography are listed in PEDCD-1: General Guidelines

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<thead>
<tr>
<th>Echocardiogram coding Notes</th>
<th>CPT®</th>
</tr>
</thead>
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<tr>
<td>The most commonly performed study is a complete transthoracic echocardiogram with spectral and color flow Doppler (CPT® 93306).</td>
<td>93306</td>
</tr>
<tr>
<td>- CPT® 93306 includes CPT® 93320 and CPT® 93325, so those codes should not be approved along with CPT® 93306.</td>
<td></td>
</tr>
</tbody>
</table>
| Doppler codes (CPT® 93320, CPT® 93321, and CPT® 93325) are add-on codes and are assigned in addition to code for the primary procedure, and should not be approved alone. | +93320  
  +93321  
  +93325 |
| For a 2D transthoracic echocardiogram without Doppler, report CPT® 93307. | 93307 |
| A limited transthoracic echocardiogram is reported with CPT® 93308. | 93308 |
| - Limited transthoracic echocardiogram should be billed if the report does not "evaluate or document the attempt to evaluate" all of the required structures. |   |
| - Unlike CPT® 93306, the Doppler CPT® 93321 and CPT® 93325 are not included with CPT® 93308. |   |
| - CPT® 93321 (not CPT® 93320) should be reported with CPT® 93308 if Doppler is included in the study. |   |
| - CPT® 93325 should also be reported with CPT® 93308 if color flow Doppler is included in the study. |   |
| For individuals with known congenital heart disease, a limited transthoracic echocardiogram is reported with CPT® 93304, +/- CPT® 93321 and CPT® 93325. | 93304 |

- Providers performing an initial echo on a pediatric individual will not know what procedure codes they will be reporting until the initial study is completed.
  - If congenital heart disease is found on the initial echo, a complete echo is reported with codes CPT® 93303, CPT® 93320, and CPT® 93325 because CPT® 93303 does NOT include Doppler and color flow mapping.
  - If no congenital issue is discovered, then CPT® 93306 is reported alone and includes 2-D, Doppler and color flow mapping.

- Since providers may not know the appropriate code/s that will be reported at the time of the pre-authorization request, they may request multiple codes.
  - The following echocardiography code combinations for any initial echocardiogram:
    - CPT® 93303, CPT® 93306, CPT® 93320, and CPT® 93325
    - CPT® 93303, CPT® 93306
    - CPT® 93306
      - CPT® 93320 and CPT® 93325 are included with CPT® 93306 and should not be approved separately.
  - Post-service audits may be completed to ensure proper claims submission
PEDCD-8.2: Initial Transthoracic Echocardiography (TTE) Indications

In addition to indications listed in previous guideline sections, initial TTE evaluation is indicated for any of the following:

- Any signs/symptoms that are possibly cardiac in nature, including (but not limited to) central cyanosis, dyspnea, edema, poor peripheral pulses, feeding difficulty, decreased urine output, hepatomegaly, or desaturation on pulse oximetry.
- Abnormal EKG or cardiac biomarkers
- Abnormal chest x-ray suggesting cardiovascular disease
- Palpitations and one of the following:
  - Abnormal EKG
  - First-degree relative with any of the following before age 50:
    - Sudden cardiac arrest or death
    - Pacemaker or implantable defibrillator placement
  - First-degree relative with cardiomyopathy
- Supraventricular Tachycardia (SVT), Ventricular Tachycardia, or Premature Ventricular Contractions (PVCs)
- Known or suspected valvular dysfunction
- Persistent systemic hypertension
- Obesity (BMI > 30) with additional cardiovascular risk factors
- Stroke
- Renal failure
- Preoperative evaluation of individuals with chest wall deformities or scoliosis
- Known or suspected vascular ring
- Planned administration of cardiotoxic chemotherapy
  - Generally anthracyclines (doxorubicin, daunorubicin, mitoxantrone, idarubicin, epirubicin)
- Planned radiation therapy involving heart muscle or hematopoietic stem cell transplant
- Sickle cell disease or other hemoglobinopathy causing chronic anemia
- Known or suspected vasculitis, acute rheumatic fever, or other systemic autoimmune disease
- Muscular dystrophy
- Metabolic, mitochondrial, and storage disorders
- Abnormalities of cardiac or other viscera situs
- Signs, symptoms, or blood culture suggestive of endocarditis
- Known or suspected mass lesion involving heart or great vessels
- Known or suspected clot in atrium or ventricle
- Known or suspected pulmonary hypertension
- Known or suspected pericardial effusion
- Complications during prenatal development:
  - Known or suspected cardiovascular abnormality on fetal echocardiogram
  - Maternal phenylketonuria (PKU)
  - Maternal diabetes with no fetal echo
  - Maternal teratogen exposure
  - Maternal infection during pregnancy with potential cardiac sequelae
- Genetic abnormality known to be associated with cardiovascular disease
First-degree relative family history of:
- Unexplained sudden death before age 50
- Hypertrophic cardiomyopathy
- Non-ischemic dilated cardiomyopathy
- Genetic abnormality known to be associated with cardiovascular disease
- Congenital left-sided heart lesion
- Heritable pulmonary arterial hypertension

**PEDCD-8.3: Repeat Transthoracic Echocardiography Indications**
- Repeat echocardiograms are not necessary for most individuals with clinically stable syndromes.
- In addition to indications listed in previous guideline sections, repeat TTE evaluation is indicated for any of the following:
  - New or worsening symptoms in an individual with known cardiac disease, previously normal echocardiogram with one of the following:
    - New or worsening cardiac symptoms
    - New EKG abnormality
    - Newly recognized family history suggestive of heritable heart disease
  - Every 12 months for individuals age 12 to 18 years with first-degree family history of hypertrophic cardiomyopathy.
  - Every 12 months for individuals receiving active therapy for ventricular hypertrophy, valvular dysfunction, cardiomyopathy.
    - One time repeat TTE can be approved at 6 months to assess response to a change in therapy.
  - Every 12 months for individuals with chronic pericardial effusions
  - Every 12 months for sickle cell disease or other hemoglobinopathy causing chronic anemia and one of the following:
    - High risk genotype (Hgb SS or S$$^{0}$$ or severe thalassemia, etc.)
    - History of acute chest syndrome or intrinsic lung disease
    - History of stroke
    - Receiving chronic transfusion therapy
  - As needed for monitoring cardiotoxicity during chemotherapy administration
  - After completion of chemotherapy and/or radiation therapy. See **PEDONC-19.2: Cardiotoxicity and Echocardiography** for imaging guidelines.

**PEDCD-8.4: Transesophageal Echocardiography (TEE)**
- Transesophageal echocardiography imaging indications in pediatric individuals are identical to those for adult individuals. See **CD-2.5: Transesophageal Echocardiography (TEE)** in the Cardiac Imaging Guidelines.
References


5. Allen, Hugh D.; Shaddy, Robert E.; Penny, Daniel J.; Feltes, Timothy F.; Cetta, Frank Title: Moss and Adams’ Heart Disease in Infants, Children, and Adolescents: Including the Fetus and Young Adult, 9th Edition Copyright ©2016 Lippincott Williams & Wilkins.
## PEDCD-9: Cardiac MRI-Other Indications

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| PEDCD-9.2: Cardiac MRI - Coding | 36 |
| PEDCD-9.3: Indications for Cardiac MRI | 36 |
| PEDCD-9.4: Aortic Root and Proximal Ascending Aorta | 37 |
| PEDCD-9.5: Evaluation of Pericardial Effusion or Diagnosis of Pericardial Tamponade | 38 |
**PEDCD-9.1: General Guidelines**

- Requests for cardiac MRI that contain only one CPT® code can be completed by the Nurse Reviewer. If the request contains more than one cardiac/chest MRI CPT® code, it should be forwarded for Medical Director Review.

- MRA coronary arteries is comparatively less accurate than CCTA or invasive coronary angiography in evaluating coronary disease and is considered investigational at this time.

**PEDCD-9.2: Cardiac MRI - Coding**

<table>
<thead>
<tr>
<th>Cardiac MRI</th>
<th>CPT®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac magnetic resonance imaging for morphology and function without contrast.</td>
<td>75557</td>
</tr>
<tr>
<td>Cardiac magnetic resonance imaging for morphology and function without and with contrast and further sequences.</td>
<td>75561</td>
</tr>
<tr>
<td>Cardiac magnetic resonance imaging for morphology and function without contrast; with stress imaging (rarely used in pediatrics).</td>
<td>75559</td>
</tr>
<tr>
<td>Cardiac magnetic resonance imaging for morphology and function without and with contrast and further sequences; with stress imaging (rarely used in pediatrics).</td>
<td>75563</td>
</tr>
<tr>
<td>Cardiac magnetic resonance imaging for velocity flow mapping (List separately in addition to code for primary procedure).</td>
<td>+75565</td>
</tr>
</tbody>
</table>

- Only one procedure code from the set: CPT® 75557, CPT® 75559, CPT® 75561, and CPT® 75563 should be reported per session.

- Only one flow velocity measurement (CPT® +75565) should be reported per session.

**PEDCD-9.3: Indications for Cardiac MRI**

- In addition to indications listed in previous guideline sections, Cardiac MRI evaluation is indicated for any of the following, when a recent TTE is inconclusive:
  - Assessment of global ventricular function and mass if a specific clinical question is left unanswered by recent TTE and the MRI results will affect management of the individual’s condition.
  - Clinical suspicion of arrhythmogenic right ventricular dysplasia (ARVD) or arrhythmogenic cardiomyopathy (ARVC).
    - MRI without contrast (CPT® 75557) is considered the optimal test for this disorder.
  - For pericardial disease (including constrictive pericarditis, restrictive pericarditis, and perimyocarditis), MRI should not be utilized to diagnose pericarditis but only to answer the question regarding possible constriction or restriction suggested clinically or by other techniques (TTE, etc.).
    - MRI without and with contrast (CPT® 75561) is considered the optimal test for this disorder.
Pediatric Cardiac Imaging

- Evaluate cardiac tumor or mass
  - MRI without and with contrast (CPT® 75561) is considered the optimal test for this disorder.
- Evaluate anomalous coronary artery
  - MRI without and with contrast (CPT® 75561) or CCTA (CPT® 75574), after echocardiogram, is considered the optimal test for this disorder.
- For Fabry’s disease, late enhancement MRI may predict the effect of enzyme replacement therapy on myocardial changes that occur with this disease.
  - MRI without and with contrast (CPT® 75561) is considered the preferred test for this disorder.
- For Cardiomyopathy, Cardiac MRI can be performed to evaluate individuals with congenital cardiomyopathy (muscular dystrophy, glycogen storage disease, fatty acid oxidation disorders, mitochondrial disorders, etc.) or unexplained cases of cardiomyopathy in order to characterize the myocardium.
- Cardiac stress perfusion study (CPT® 75559 or CPT® 75563) can be considered on a case by case basis for individuals with anomalous coronary artery, Kawasaki disease, or other disorder with the potential for coronary ischemia who cannot undergo other forms of stress testing (ETT, MPI, etc.).
- Assessment of cardiac iron overload in hemochromatosis (either CPT® 75557 or CPT® 71550, T2* MRI, contrast not necessary).
  - Screening imaging may be approved every 12 months
  - Imaging may be approved every 3 months for treatment response in individuals receiving active treatment (chelation +/- phlebotomy)
  - Frequently performed along with MRI Abdomen (CPT® 74181) to assess liver iron deposition. See PEDAB-18.2: Transfusion-Associated (Secondary) Hemochromatosis for additional imaging guidelines.

PEDCD-9.4: Aortic Root and Proximal Ascending Aorta

- For screening due to family history of aortic aneurysm or dissection, See CH-29: Thoracic Aorta in the adult Chest Imaging Guidelines.
- For individuals who have both cardiac and ascending aorta abnormalities, the following studies may be indicated following TTE:
  - Cardiac MRI (CPT® 75557 or CPT® 75561) for individuals with abnormalities involving the aortic root and/or proximal ascending aorta.
  - MRI Chest (CPT® 71552) or MRA Chest (CPT® 71555) if the distal ascending aorta is involved.
- For individuals with aortic abnormalities without cardiac abnormalities, ANY of the following studies is indicated:
  - MRI Chest (CPT® 71552)
  - MRA Chest (CPT® 71555)
PEDCD-9.5: Evaluation of Pericardial Effusion or Diagnosis of Pericardial Tamponade

- Echocardiogram is the initial imaging study of choice to evaluate pericardial effusions or diagnose pericardial tamponade.

- If a specific clinical question is left unanswered by another recent imaging study and the answer to the clinical question will affect the management of the individual’s clinical condition, contrast-enhanced cardiac MRI is useful for evaluating:
  - Pericarditis,
  - Neoplastic effusion,
  - Tamponade,
  - Myocardial infiltration

- Cancers that can metastasize to the pericardium or myocardium and can cause a malignant effusion include lung, breast, renal cell, lymphoma and melanoma.

References

4. Allen, Hugh D.; Shaddy, Robert E.; Penny, Daniel J.; Feltes, Timothy F.; Cetta, Frank Title: Moss and Adams’ Heart Disease in Infants, Children, and Adolescents: Including the Fetus and Young Adult, 9th Edition Copyright ©2016 Lippincott Williams & Wilkin.
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<tr>
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<td>PEDCD-10.2: Anomalous Coronary Artery</td>
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<tr>
<td>PEDCD-10.3: Indications for CCTA (CPT® 75574)</td>
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<tr>
<td>PEDCD-10.4: Indications for Cardiac CT (CPT® 75572)</td>
</tr>
<tr>
<td>PEDCD-10.5: Radiation Dose</td>
</tr>
</tbody>
</table>
**PEDCD-10.1: General Considerations**

- Metal artifact reduces the accuracy of CCTA. Devices that can cause this issue include, but are not limited to:
  - Surgical clips
  - Pacemaker devices
  - Defibrillator devices
  - Tissue expanders

- Cardiac testing that does not involve exposure to ionizing radiation should be strongly considered.

- Contraindications to CCTA include:
  - Very obese individuals (body mass index > 40 kg/m$^2$)
  - Elevated calcium score: CCTA should not be performed if there is extensive coronary calcification (calcium score > 1000).
  - Renal insufficiency
  - Inability to follow breath holding instructions

**PEDCD-10.2: Anomalous Coronary Artery**

- CCTA is indicated for evaluating coronary artery anomalies and other complex congenital heart disease of cardiac chambers or great vessels.
  - Report CPT® 75574 for evaluating coronary artery anomalies
  - Report CPT® 75573 for congenital heart disease
  - Chest CTA (CPT® 71275) can be added to evaluate great vessels
  - CT abdomen and pelvis with contrast (CPT® 74177) can be added in cases of anomalous pulmonary venous return.
  - Partial anomalous pulmonary venous return (PAPVR), or total anomalous pulmonary venous return (TAPVR) could require cardiac CT, chest CTA, and abdomen/pelvis CT, or Cardiac MRI, chest MRA, abdominal MRA, and pelvis MRA.

- Congenital anomalies of the coronary arteries are an important cause of sudden death in pediatric individuals. Coronary arteries may arise from the wrong coronary artery cusp leading to ischemic changes during exercise. These lesions may be found incidentally during a murmur evaluation. Anomalous coronary arteries may be seen on echocardiogram during an evaluation for chest pain or syncope or palpitations. In addition individuals with no echocardiographic findings, but symptoms concerning for angina chest pain may require stress testing. Individuals who have positive echocardiographic findings, regardless of symptoms, and individuals who have angina chest pain regardless of echocardiographic findings, may require treadmill stress testing, stress imaging, of advanced imaging such as Cardiac MRI, Cardiac CT, and/or cardiac catheterization.

- Individuals with congenital heart disease such as TOF, Truncus Arteriosus, and TGA have increased incidence of coronary artery anomalous and may require the above imaging as well.
Individuals with confirmed coronary artery anomalies may require repeat imaging based on the clinical scenario.

CCTA to rule out anomalous coronary artery should be limited to one of the following:
- Individuals who need to have an anomalous coronary artery mapped prior to an invasive procedure.
- Individuals who have not had a previous imaging study that clearly demonstrates an anomalous coronary artery.
- Individuals with a history that includes one or more of the indications in PEDCD-10.3: Indications for CCTA (CPT® 75574)

**PEDCD-10.3: Indications for CCTA (CPT® 75574)**

- In addition to indications listed in previous guideline sections, CCTA is indicated for any of the following, when a recent TTE and/or MRI is inconclusive:
  - Persistent exertional chest pain and normal stress test
  - Full sibling(s) with history of sudden death syndrome before age 30 or with documented anomalous coronary artery
  - Resuscitated sudden death and contraindication to conventional coronary angiography
  - Unexplained new onset of heart failure if CCTA will replace conventional invasive coronary angiography
  - Documented ventricular tachycardia (6 beat runs or greater) if CCTA will replace conventional invasive coronary angiography
  - Equivocal coronary artery anatomy on conventional cardiac catheterization
  - In infants: otherwise unexplained dyspnea, tachypnea, wheezing, episodic pallor, irritability, sweating, poor feeding, and/or failure to thrive
    - The presence of other congenital heart disease is not a separate indication for CCTA to rule out anomalous coronary artery (except when coronary artery surgery is pending, i.e. Transposition of the great arteries, Tetralogy of Fallot, Truncus arteriosus, aortic root surgery)
  - Evaluation of the arterial supply and venous drainage in children with bronchopulmonary sequestration

**PEDCD-10.4: Indications for Cardiac CT (CPT® 75572)**

- In addition to indications listed in previous guideline sections, CCTA is indicated for any of the following, when a recent TTE and/or MRI is inconclusive:
  - Cardiac or pericardial mass
  - Pericarditis
  - Complications of cardiac surgery or evaluation of post-operative anatomy
  - Cardiac thrombus in individuals with technically limited TTE, TEE, or MRI
  - Clinical suspicion of arrhythmogenic right ventricular dysplasia (ARVD) or arrhythmogenic cardiomyopathy (ARVC)
  - Native aortic abnormalities if echocardiogram is indeterminate
PEDCD-10.5: Radiation Dose

- Radiation dosage for CCTA varies by facility and the particular protocol used. The American College of Radiology Clinical Statement on Noninvasive Cardiac Imaging states that “as a general rule a multi-detector CT encompassing the heart should not result in an effective dose of greater than 12 mSv.”*

- CT scanners can deliver a radiation dose from as low as 2-5 mSv.

- Prospective gating and other techniques can reduce the radiation dose of cardiac CT studies to less than 5 mSv.


References


5. ESC Guidelines for the management of grown-up congenital heart disease (new version 2010) The Task Force on the Management of Grown-up Congenital Heart Disease of the European Society of Cardiology (ESC) Endorsed by the Association for European Paediatric Cardiology (AEPC).


9. Indications for Cardiac Catheterization and Intervention in Pediatric Cardiac Disease A Scientific Statement From the American Heart Association Endorsed by the American Academy of Pediatrics and Society for Cardiovascular Angiography and Intervention Timothy F. Feltes, MD, FAHA, Chair; Emile Bacha, MD; Robert H. Beekman III, MD, FAHA; John P. Cheatham, MD; Jeffrey A. Feinstein, MD, MPH; Antoinette S. Gomes, MD, FAHA; Ziyad M. Hijazi, MD, MPH, FAHA; Frank F. Ing, MD; Michael de Moor, MBBC; W. Robert Morrow, MD; Charles E. Mullins, MD, FAHA; Kathryn A. Taubert, PhD, FAHA; Evan M. Zahn, MD; on behalf of the American Heart Association Congenital Cardiac Defects Committee of the Council on Cardiovascular Disease in the Young, Council on Clinical Cardiology, and Council on Cardiovascular Radiology and Intervention.


12. Publication Date March 11, 2016 Editors: Allen, Hugh D.; Shaddy, Robert E.; Penny, Daniel J.; Feltes, Timothy F.; Cetta, Frank Title: Moss and Adams' Heart Disease in Infants, Children, and Adolescents: Including the Fetus and Young Adult, 9th Edition, Copyright ©2016 Lippincott Williams & Wilkin.