

**American College of Radiology  
ACR Appropriateness Criteria®  
Abdominal Aortic Aneurysm Follow-up (Without Repair)**

**Variant 1: Asymptomatic abdominal aortic aneurysm surveillance (without repair).**

Procedure	Appropriateness Category	Relative Radiation Level
US duplex Doppler aorta abdomen	Usually Appropriate	○
CTA abdomen and pelvis with IV contrast	Usually Appropriate	☼☼☼☼
MRA abdomen and pelvis with IV contrast	Usually Appropriate	○
CT abdomen and pelvis with IV contrast	May Be Appropriate	☼☼☼
CT abdomen and pelvis without IV contrast	May Be Appropriate	☼☼☼
MRA abdomen and pelvis without with IV contrast	May Be Appropriate	○
MRA abdomen and pelvis without IV contrast	May Be Appropriate	○
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☼☼☼☼
MRI abdomen and pelvis with IV contrast	May Be Appropriate	○
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	○
MRI abdomen and pelvis without IV contrast	May Be Appropriate (Disagreement)	○
Aortography abdomen	Usually Not Appropriate	☼☼☼
Radiography chest abdomen pelvis	Usually Not Appropriate	☼☼☼

## ABDOMINAL AORTIC ANEURYSM FOLLOW-UP (WITHOUT REPAIR)

Expert Panel on Vascular Imaging: Michael Collard, MD, MA<sup>a</sup>; Patrick D. Sutphin, MD, PhD<sup>b</sup>; Sanjeeva P. Kalva, MD<sup>c</sup>; Bill S. Majdalany, MD<sup>d</sup>; Jeremy D. Collins, MD<sup>e</sup>; Jens Eldrup-Jorgensen, MD<sup>f</sup>; Christopher J. Francois, MD<sup>g</sup>; Suvranu Ganguli, MD<sup>h</sup>; Andrew J. Gunn, MD<sup>i</sup>; A. Tuba Kendi, MD<sup>j</sup>; Minhajuddin S. Khaja, MD, MBA<sup>k</sup>; Piotr Obara, MD<sup>l</sup>; Stephen P. Reis, MD<sup>m</sup>; Kanupriya Vijay, MD, MBBS<sup>n</sup>; Karin E. Dill, MD.<sup>o</sup>

### Summary of Literature Review

#### **Introduction/Background**

Abdominal aortic aneurysm (AAA) is defined as an aneurysmal dilation of the abdominal aorta of at least 3 cm in diameter. This entity has a high degree of morbidity and mortality in the event of rupture [1,2]. To mitigate this risk, screening programs have been widely instituted to identify small, developing aneurysms. Such screening reduces morbidity and health care costs related to this disease [3-8]. An increasing number of aneurysms are identified incidentally on ultrasound (US) and cross-sectional imaging, creating a growing cohort of patients with known AAA [9-12]. The reported prevalence of AAA in persons >65 years of age ranges from 1.7% to 4.5% for men and 0.5% to 1.3% for women [11,13,14].

While there is some debate in regards to which aneurysms are most at risk for rupture, there is general agreement that AAA with a maximum diameter >5.4 cm in males and >4.9 cm in females [15] should undergo prophylactic repair [2,14,16,17]. In patients with small AAA (males, diameter 3–5.4 cm, and females, diameter 3–4.9 cm), the risk of rupture is lower; thus surgery and surveillance is indicated. The majority of small AAAs grow slowly, but there is substantial variation in growth rates between individuals. The intervals between US surveillance examinations used in randomized screening trials depend on aneurysm size [15,18-21]. However, no consensus exists regarding the optimal time intervals between US surveillance examinations [15]. Some studies have reported equivalent results for treatment of small aneurysms and surveillance, and there does not appear to be a clear preference for early operation [22,23].

Imaging surveillance provides 2 primary purposes. The first is to identify interval growth beyond the threshold for elective repair. The other is to monitor the growth trajectory and identify a potentially increasing rate of growth, with growth rates >2 mm per year associated with increased adverse events [20].

For information on interventional planning and follow-up of AAA, please see the ACR Appropriateness Criteria<sup>®</sup> topic on “[Abdominal Aortic Aneurysm: Interventional Planning and Follow-Up](#)” [24].

#### **Special Imaging Considerations**

For the purposes of distinguishing between CT and CT angiography (CTA), ACR Appropriateness Criteria topics use the definition in the [Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography \(CTA\)](#) [25].

*“CTA uses a thin-section CT acquisition that is timed to coincide with peak arterial or venous enhancement. The resultant volumetric dataset is interpreted using primary transverse reconstructions as well as multiplanar reformations and 3-D renderings.”*

All elements are essential: 1) timing, 2) reconstructions/reformats, and 3) 3-D renderings. Standard CTs with contrast also include timing issues and recons/reformats. Only in CTA, however, is 3-D rendering a required element. This corresponds to the definitions that the CMS has applied to the Current Procedural Terminology codes.

<sup>a</sup>Research Author, UT Southwestern Medical Center, Dallas, Texas. <sup>b</sup>UT Southwestern Medical Center, Dallas, Texas. <sup>c</sup>Panel Chair, UT Southwestern Medical Center, Dallas, Texas. <sup>d</sup>Panel Vice-chair, University of Michigan Health System, Ann Arbor, Michigan. <sup>e</sup>Mayo Clinic, Rochester, Minnesota. <sup>f</sup>Tufts University School of Medicine, Boston, Massachusetts; Society for Vascular Surgery. <sup>g</sup>University of Wisconsin, Madison, Wisconsin. <sup>h</sup>Massachusetts General Hospital, Boston, Massachusetts. <sup>i</sup>University of Alabama at Birmingham, Birmingham, Alabama. <sup>j</sup>Mayo Clinic, Rochester, Minnesota. <sup>k</sup>University of Michigan Health System, Ann Arbor, Michigan. <sup>l</sup>Loyola University Medical Center, Maywood, Illinois. <sup>m</sup>Columbia University Medical Center, New York, New York. <sup>n</sup>UT Southwestern Medical Center, Dallas, Texas. <sup>o</sup>Specialty Chair, UMass Memorial Medical Center, Worcester, Massachusetts.

The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document.

Reprint requests to: [publications@acr.org](mailto:publications@acr.org)

## Discussion of Procedures by Variant

### Variant 1: Asymptomatic abdominal aortic aneurysm surveillance (without repair).

#### US Duplex Doppler Aorta Abdomen

US is the most widely studied and utilized imaging tool for evaluating an AAA, both for screening and during surveillance. US has been verified as having consistent measurement accuracy, which can approximate the accuracy demonstrated by CT and MRI or MR angiography (MRA) [17,18,26,27]. Studies have reported that US may underestimate the maximum AAA diameter by 4 mm, on average, and the interobserver measurement difference can range from 2 to 10 mm with US compared with <2 mm using CT [27-31]. Evidence is still lacking as to whether these differences are clinically impactful. Variation in accuracy is believed to be related to measurement technique. For example, there is debate as to whether to place the measurement caliper on the outer or inner edge of the vessel, without clear consensus on an ideal methodology [31]. Finally, no significant difference between rate of growth measurements between US and CT has been found [18,32]. US is also less capable of identifying specific aneurysm features beyond diameter, such as intraluminal thrombus or adjacent inflammation, both of which are more easily identified on CT [21,33,34].

#### CTA Abdomen and Pelvis

CTA of the abdomen and pelvis presents many benefits over the other modalities. Relative to US, CTA is considered slightly more accurate at determining aneurysm diameter [27,30,31]. The use of iodinated contrast carries its own risks and contraindications that require consideration [35].

#### CT Abdomen and Pelvis

The majority of evidence regarding AAA surveillance using CT is based on CTA data and is primarily related to contrast bolus timing. Contrast-enhanced CT is well established in the literature and is capable of identifying aortic aneurysms, with many papers discussing incidental AAA identification [9,11,13].

There is no specific literature regarding the use of noncontrast CT in the surveillance of AAA. One study reviewed the incidence of AAA incidentally found during CT colonography. This included patients who underwent CT imaging, some with and others without the use of intravenous (IV) contrast. This review did not distinguish the difference between those patients [11]. This technique could theoretically be of use in patients with chronic renal disease who have aneurysms less amenable to imaging by US. Noncontrast imaging can be employed in CTA protocols to evaluate for calcification, with spectral CT scanners offering virtual noncontrast reconstructions as an alternative.

#### MRA Abdomen and Pelvis

There are benefits of MRA that make it worth considering in the surveillance of AAA. MRA can be obtained without the use of IV contrast, making it preferable in patients with advanced chronic renal disease. A prospective evaluation of nonenhanced MRA compared with contrast-enhanced CTA demonstrated equivalent accuracy of measurements for preoperative planning of endovascular aneurysm repair suggesting adequacy for surveillance imaging [36]. Superparamagnetic iron oxide-enhanced MR may be an alternative for patients with chronic renal disease [37].

#### MRI Abdomen and Pelvis

There is no relevant literature regarding the use of MRI for AAA surveillance in this setting; although, MRI may be useful in some cases. Similar to CT, there is excellent reproducibility in measurements between MRI examinations, a critical characteristic in monitoring for subtle changes in AAA size.

#### Aortography Abdomen

There is no relevant literature regarding the use of conventional angiography in the surveillance of AAA. Noninvasive techniques to monitor aneurysm characteristics make this invasive option less reasonable.

#### Radiography Chest Abdomen Pelvis

There is no relevant literature regarding the use of radiography in the surveillance of AAA. Calcified aneurysms may be identifiable by radiography.

### Summary of Recommendations

- **Variant 1:** US duplex Doppler aorta of the abdomen, CTA of the abdomen and pelvis with IV contrast, or MRA of the abdomen and pelvis with IV contrast is usually appropriate for the surveillance of patients with an asymptomatic AAA not undergoing repair. These procedures are equivalent alternatives. The panel did not

agree on recommending MRI of the abdomen and pelvis without IV contrast for asymptomatic AAA surveillance without repair. There is insufficient medical literature to conclude whether or not these patients would benefit from this procedure. The use of MRI of the abdomen and pelvis without IV contrast in this patient population is controversial but may be appropriate.

### Supporting Documents

The evidence table, literature search, and appendix for this topic are available at <https://acsearch.acr.org/list>. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents go to [www.acr.org/ac](http://www.acr.org/ac).

### Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel’s recommendation. “May be appropriate” is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

### Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document [38].

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
○	0 mSv	0 mSv
⊕	<0.1 mSv	<0.03 mSv
⊕⊕	0.1-1 mSv	0.03-0.3 mSv
⊕⊕⊕	1-10 mSv	0.3-3 mSv
⊕⊕⊕⊕	10-30 mSv	3-10 mSv
⊕⊕⊕⊕⊕	30-100 mSv	10-30 mSv

\*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies”.

## References

- Ahmed R, Ghoorah K, Kunadian V. Abdominal Aortic Aneurysms and Risk Factors for Adverse Events. *Cardiol Rev* 2016;24:88-93.
- Lim J, Wolff J, Rodd CD, Cooper DG, Earnshaw JJ. Outcome in Men with a Screen-detected Abdominal Aortic Aneurysm Who are not Fit for Intervention. *Eur J Vasc Endovasc Surg* 2015;50:732-6.
- Chun KC, Teng KY, Van Spyk EN, Carson JG, Lee ES. Outcomes of an abdominal aortic aneurysm screening program. *J Vasc Surg* 2013;57:376-81.
- Giardina S, Pane B, Spinella G, et al. An economic evaluation of an abdominal aortic aneurysm screening program in Italy. *J Vasc Surg* 2011;54:938-46.
- Macdonald AJ, Faleh O, Welch G, Kettlewell S. Missed opportunities for the detection of abdominal aortic aneurysms. *Eur J Vasc Endovasc Surg* 2008;35:698-700.
- Schmidt T, Muhlberger N, Chemelli-Steingruber IE, et al. Benefit, risks and cost-effectiveness of screening for abdominal aortic aneurysm. *Rofo* 2010;182:573-80.
- Stather PW, Dattani N, Bown MJ, Earnshaw JJ, Lees TA. International variations in AAA screening. *Eur J Vasc Endovasc Surg* 2013;45:231-4.
- Wild JB, Stather PW, Biancari F, et al. A multicentre observational study of the outcomes of screening detected sub-aneurysmal aortic dilatation. *Eur J Vasc Endovasc Surg* 2013;45:128-34.
- Al-Thani H, El-Menyar A, Shabana A, Tabeb A, Al-Sulaiti M, Almalki A. Incidental abdominal aneurysms: a retrospective study of 13,115 patients who underwent a computed tomography scan. *Angiology* 2014;65:388-95.
- Dell'Atti L. Incidence of abdominal aortic aneurysm during diagnostic ultrasound for urologic disease: our experience. *Arch Ital Urol Androl* 2012;84:230-3.
- Khashram M, Jones GT, Roake JA. Prevalence of abdominal aortic aneurysm (AAA) in a population undergoing computed tomography colonography in Canterbury, New Zealand. *Eur J Vasc Endovasc Surg* 2015;50:199-205.
- Trompeter AJ, Paremain GP. Incidental abdominal aortic aneurysm on lumbosacral magnetic resonance imaging - a case series. *Magn Reson Imaging* 2010;28:455-7.
- Claridge R, Arnold S, Morrison N, van Rij AM. Measuring abdominal aortic diameters in routine abdominal computed tomography scans and implications for abdominal aortic aneurysm screening. *J Vasc Surg* 2017;65:1637-42.
- Lo RC, Schermerhorn ML. Abdominal aortic aneurysms in women. *J Vasc Surg* 2016;63:839-44.
- Chaikof EL, Dalman RL, Eskandari MK, et al. The Society for Vascular Surgery practice guidelines on the care of patients with an abdominal aortic aneurysm. *J Vasc Surg* 2018;67:2-77 e2.
- Hirsch AT, Haskal ZJ, Hertzner NR, et al. ACC/AHA 2005 Practice Guidelines for the management of patients with peripheral arterial disease (lower extremity, renal, mesenteric, and abdominal aortic): a collaborative report from the American Association for Vascular Surgery/Society for Vascular Surgery, Society for Cardiovascular Angiography and Interventions, Society for Vascular Medicine and Biology, Society of Interventional Radiology, and the ACC/AHA Task Force on Practice Guidelines (Writing Committee to Develop Guidelines for the Management of Patients With Peripheral Arterial Disease): endorsed by the

American Association of Cardiovascular and Pulmonary Rehabilitation; National Heart, Lung, and Blood Institute; Society for Vascular Nursing; TransAtlantic Inter-Society Consensus; and Vascular Disease Foundation. *Circulation* 2006;113:e463-654.

17. Kitagawa A, Mastracci TM, von Allmen R, Powell JT. The role of diameter versus volume as the best prognostic measurement of abdominal aortic aneurysms. *J Vasc Surg* 2013;58:258-65.
18. Bown MJ, Sweeting MJ, Brown LC, Powell JT, Thompson SG. Surveillance intervals for small abdominal aortic aneurysms: a meta-analysis. *JAMA* 2013;309:806-13.
19. Mell MW, Baker LC. Payer status, preoperative surveillance, and rupture of abdominal aortic aneurysms in the US Medicare population. *Ann Vasc Surg* 2014;28:1378-83.
20. Thompson AR, Cooper JA, Ashton HA, Hafez H. Growth rates of small abdominal aortic aneurysms correlate with clinical events. *Br J Surg* 2010;97:37-44.
21. van Walraven C, Wong J, Morant K, et al. Radiographic monitoring of incidental abdominal aortic aneurysms: a retrospective population-based cohort study. *Open Med* 2011;5:e67-76.
22. Cao P, De Rango P, Verzini F, et al. Comparison of surveillance versus aortic endografting for small aneurysm repair (CAESAR): results from a randomised trial. *Eur J Vasc Endovasc Surg* 2011;41:13-25.
23. Ouriel K, Clair DG, Kent KC, Zarins CK, Positive Impact of Endovascular Options for treating Aneurysms Early I. Endovascular repair compared with surveillance for patients with small abdominal aortic aneurysms. *J Vasc Surg* 2010;51:1081-7.
24. Francois CJ, Skulborstad EP, Majdalany BS, et al. ACR Appropriateness Criteria® Abdominal Aortic Aneurysm: Interventional Planning and Follow-Up. *J Am Coll Radiol* 2018;15:S2-S12.
25. American College of Radiology. ACR–NASCI–SIR–SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography (CTA). Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/body-cta.pdf>. Accessed November 30, 2018.
26. Hafez H, Druce PS, Ashton HA. Abdominal aortic aneurysm development in men following a "normal" aortic ultrasound scan. *Eur J Vasc Endovasc Surg* 2008;36:553-8.
27. Keefer A, Hislop S, Singh MJ, Gillespie D, Illig KA. The influence of aneurysm size on anatomic suitability for endovascular repair. *J Vasc Surg* 2010;52:873-7.
28. Beales L, Wolstenhulme S, Evans JA, West R, Scott DJ. Reproducibility of ultrasound measurement of the abdominal aorta. *Br J Surg* 2011;98:1517-25.
29. Gurtelschmid M, Bjorck M, Wanhainen A. Comparison of three ultrasound methods of measuring the diameter of the abdominal aorta. *Br J Surg* 2014;101:633-6.
30. Kauffmann C, Tang A, Therasse E, et al. Measurements and detection of abdominal aortic aneurysm growth: Accuracy and reproducibility of a segmentation software. *Eur J Radiol* 2012;81:1688-94.
31. Wanhainen A, Mani K, Golledge J. Surrogate Markers of Abdominal Aortic Aneurysm Progression. *Arterioscler Thromb Vasc Biol* 2016;36:236-44.
32. Sweeting MJ, Thompson SG, Brown LC, Powell JT. Meta-analysis of individual patient data to examine factors affecting growth and rupture of small abdominal aortic aneurysms. *Br J Surg* 2012;99:655-65.
33. Labruto F, Blomqvist L, Swedenborg J. Imaging the intraluminal thrombus of abdominal aortic aneurysms: techniques, findings, and clinical implications. *J Vasc Interv Radiol* 2011;22:1069-75; quiz 75.
34. Martufi G, Forneris A, Appoo JJ, Di Martino ES. Is There a Role for Biomechanical Engineering in Helping to Elucidate the Risk Profile of the Thoracic Aorta? *Ann Thorac Surg* 2016;101:390-8.
35. American College of Radiology. *Manual on Contrast Media*. Available at: <https://www.acr.org/Clinical-Resources/Contrast-Manual>. Accessed November 30, 2018.
36. Goshima S, Kanematsu M, Kondo H, et al. Preoperative planning for endovascular aortic repair of abdominal aortic aneurysms: feasibility of nonenhanced MR angiography versus contrast-enhanced CT angiography. *Radiology* 2013;267:948-55.
37. Ichihashi S, Marugami N, Tanaka T, et al. Preliminary experience with superparamagnetic iron oxide-enhanced dynamic magnetic resonance imaging and comparison with contrast-enhanced computed tomography in endoleak detection after endovascular aneurysm repair. *J Vasc Surg* 2013;58:66-72.
38. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: <https://www.acr.org/-/media/ACR/Files/Appropriateness-Criteria/RadiationDoseAssessmentIntro.pdf>. Accessed November 30, 2018.

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.