

**American College of Radiology
ACR Appropriateness Criteria®**

Clinical Condition: Colorectal Cancer Screening

Variant 1: Average-risk individual: age >50 years.

Radiologic Procedure	Rating	Comments	RRL*
CT colonography every 5 years after negative screen	8		☼ ☼ ☼
X-ray barium enema double-contrast every 5 years after negative screen	7		☼ ☼ ☼
X-ray barium enema single-contrast every 5 years after negative screen	4	If cannot perform double-contrast BE or CTC.	☼ ☼ ☼
MR colonography every 5 years after negative screen	4		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 2: Average-risk individual after positive fecal occult blood test (FOBT), indicating a relative elevation in risk.

Radiologic Procedure	Rating	Comments	RRL*
CT colonography	8		☼ ☼ ☼
X-ray barium enema double-contrast	7		☼ ☼ ☼
X-ray barium enema single-contrast	4	If cannot perform double-contrast BE or CTC.	☼ ☼ ☼
MR colonography	4		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 3: Average-risk, moderate-risk or high-risk individual after incomplete colonoscopy.

Radiologic Procedure	Rating	Comments	RRL*
CT colonography	9		☼ ☼ ☼
X-ray barium enema double-contrast	7		☼ ☼ ☼
X-ray barium enema single-contrast	4	If cannot perform double-contrast BE or CTC.	☼ ☼ ☼
MR colonography	3		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: Colorectal Cancer Screening**Variant 4:** Moderate-risk individual: personal history of adenoma or carcinoma or first-degree family history of cancer or adenoma.

Radiologic Procedure	Rating	Comments	RRL*
CT colonography every 5 years after negative screen	8		☼ ☼ ☼
X-ray barium enema double-contrast every 5 years after negative screen	7		☼ ☼ ☼
X-ray barium enema single-contrast every 5 years after negative screen	4	If cannot perform double-contrast BE or CTC.	☼ ☼ ☼
MR colonography every 5 years after negative screen	4		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 5: High-risk individual: hereditary nonpolyposis colorectal cancer (HNPCC).

Radiologic Procedure	Rating	Comments	RRL*
CT colonography	3	Colonoscopy preferred.	☼ ☼ ☼
X-ray barium enema double-contrast	3	Colonoscopy preferred.	☼ ☼ ☼
X-ray barium enema single-contrast	2	If cannot perform colonoscopy, CTC, or double-contrast BE.	☼ ☼ ☼
MR colonography	2		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 6: High-risk individual: ulcerative colitis or Crohn's colitis.

Radiologic Procedure	Rating	Comments	RRL*
CT colonography	2	Colonoscopy preferred for ability to obtain biopsies to look for dysplasia.	☼ ☼ ☼
X-ray barium enema double-contrast	2	Colonoscopy preferred for ability to obtain biopsies to look for dysplasia.	☼ ☼ ☼
MR colonography	2	Colonoscopy preferred for ability to obtain biopsies to look for dysplasia.	O
X-ray barium enema single-contrast	1	Colonoscopy preferred for ability to obtain biopsies to look for dysplasia.	☼ ☼ ☼
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

COLORECTAL CANCER SCREENING

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Summary of Literature Review

Colorectal cancer is the second-leading cause of cancer deaths in the United States. An average-risk individual has a 5% lifetime risk of developing colorectal cancer. It has long been established that detection of the disease when localized is associated with a 5-year survival rate of approximately 80%. Also, evidence has accumulated to support the concept that almost all colorectal cancers develop from benign adenomas and that, in most cases, this process is slow, requiring an average of 10 years [1,2]. However, because screening involves the exposure of healthy asymptomatic individuals to tests with the potential for physical and psychological injury and imposes a financial burden on society, the decision to promote screening requires scientific evidence that mortality can be reduced relatively safely and cost-effectively. Information extrapolated from symptomatic populations is not sufficient because of the possible influence of lead-time and length-time bias. In addition, the determination of whom to screen, how to screen, and how often to screen requires a complex integration of an individual's level of risk, the performance characteristics (sensitivity, specificity), the safety and cost of the screening options, and the natural history and prevalence of the target lesions (adenomas and carcinomas).

Evidence from three randomized controlled trials in average-risk individuals (age >50 years) using fecal occult blood testing (FOBT) demonstrated a 15%-33%

mortality reduction [3-5]. A nonrandomized trial with historical controls reported a reduction in the incidence of colon cancer through the removal of adenomas [2]. A case-control study demonstrated that screening sigmoidoscopy decreased colorectal cancer mortality by two-thirds for cancers within reach of the sigmoidoscope [6], and another case-control study reported a reduction in incidence of and mortality from colorectal cancer after the removal of adenomas in patients who had undergone colonic endoscopy because of symptoms [7]. Results from these case-control studies have suggested a protective effect from direct structural examination of the colon lasting 5-10 years [6,7]. The issue that remains to be clarified is the potential benefit from the various screening options, the magnitude of which is highly dependent on test sensitivity, recommended test intervals, and the necessity of detecting and removing all adenomas.

The prevalence of adenomas in the general population is 30%-50%, increasing with age. The vast majority of adenomas are <1 cm and these lesions frequently remain small. Lesions <1 cm, in diameter have about a 1% likelihood of containing invasive cancer. Only 1%-3% of all adenomas progress to cancer. On the other hand, adenomas >1 cm have a 10% chance of containing invasive cancer or a 25% chance of progressing to invasive cancer over 20 years [8,9]. Approximately 8% may undergo malignant degeneration within 10 years. Furthermore, individuals with a history of such neoplasms appear to have an increased probability of developing colorectal cancer in the future, whereas those who have had fewer than three small adenomas have a subsequent cancer risk similar to that of the general population.

Recent guidelines have divided colorectal cancer risk levels into three categories: 1) average (>50 years of age), 2) moderate (first-degree relative with a history of adenoma or carcinoma, or personal history of large adenoma or carcinoma), and 3) high (hereditary syndromes — hereditary nonpolyposis colorectal cancer (HNPCC) and familial polyposis, or personal history of ulcerative colitis or Crohn's disease). The magnitude of risk for an individual with a single first-degree relative with colorectal cancer is approximately 2-3 times that of the general population [10]. Risk increases with the number of such first-degree relatives. In addition, the development of cancer tends to occur at a younger age, depending on the age at which the relative developed a neoplasm. The degree of risk of individuals with a personal history of neoplasm is unclear because all the information on this subject was derived from the precolonoscopy era, when complete colonic clearing was not performed and, theoretically, residual synchronous lesions could have evolved. There is no evidence to indicate that the natural history of the disease in the two moderate-risk groups differs from that of the average-risk group. The probability of an individual with a hereditary nonpolyposis syndrome developing colorectal cancer may be as high as 50%.

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The natural history of the disease in such individuals is uncertain. A nonrandomized controlled trial of such a population screened at 3-year intervals with double-contrast barium enema (DCBE) and sigmoidoscopy or colonoscopy reported a significant reduction in cancer incidence [11]. The risk of cancer in individuals with ulcerative colitis increases after the disease has been present 8-10 years and correlates with disease extent. Best estimates of risk are 5% after 10-20 years of disease and 9% per year thereafter. The risk for individuals with Crohn's colitis may be comparable. Unlike the other forms of colorectal cancer screening, screening of ulcerative colitis patients focuses on the detection of dysplasia (which may be flat and identified only by random biopsies or may be macroscopically visible) and subsequent prophylactic colectomy. There is no evidence of mortality reduction from colorectal cancer screening in these patients, although a shift to early stages has been demonstrated with annual colonoscopy. For patients at high risk due to known ulcerative colitis or Crohn's colitis, colonoscopy is preferred over computed tomography colonography (CTC), magnetic resonance imaging (MRI), or barium studies due to the ability of colonoscopy to obtain biopsies to look for dysplasia.

Current Colorectal Cancer Screening Recommendations

A discussion of the nonradiologic tests for colorectal cancer screening is beyond the scope of this document. However, of the structural tests available, colonoscopy currently is considered to be the most sensitive and specific for detecting colorectal polyps and cancers. A number of organizations — including the World Health Organization (WHO), the U.S. Agency for Health Care Policy and Research (USAHCPR) [12], and the U.S. Preventive Service Task Force (USPSTF) [13,14] — have issued or endorsed guidelines for colorectal cancer screening, which are presented as lists of options. For average-risk individuals the options include annual or biennial FOBT, flexible sigmoidoscopy every 5 years, DCBE every 5 years, and colonoscopy every 10 years. A recent revision of the American Cancer Society (ACS) guidelines for colorectal cancer screening was jointly issued with the U.S. Multi-Society Task Force on Colorectal Cancer (USMSTF) and the American College of Radiology (ACR) [10] included CTC every 5 years to the list of options for average-risk individuals. These guidelines also separated colorectal cancer screening tools into two categories: 1) those that can screen for both adenomatous polyps and cancer (flexible sigmoidoscopy, DCBE, CTC, and colonoscopy) and 2) those that can screen for cancer (FOBT, fecal immunochemical test, and stool DNA test). More specific recommendations are made for individuals who are at increased risk for colorectal neoplasia.

Double-Contrast Barium Enema

A recent retrospective study evaluated the diagnostic yield of DCBE examinations performed for colorectal cancer screening in average-risk individuals >50 years of age [15]. The diagnostic yield was 5.1% for neoplastic

lesions ≥ 1 cm and 6.2% for advanced neoplastic lesions, regardless of size. These diagnostic yields fall within the lower range of those reported for screening colonoscopy (5.0%-9.5% for colonic neoplasms ≥ 1 cm [16-18] and 4.6%-11.7% for advanced colonic neoplasms, regardless of size [16,18,19]).

DCBE has also been assessed in the evaluation of individuals with a positive FOBT and in the surveillance of individuals with one or more adenomas. All other information about the effectiveness of DCBE in colorectal cancer screening is derived from symptomatic individuals. The best data on the effectiveness of the DCBE in detecting colorectal cancer come from studies in which the imaging history of patients with colorectal cancer was reviewed. Using this methodology, the sensitivity of DCBE ranges from 75%-95% [20-22]. When considering only localized cancer, the sensitivity varies from 58%-94% [21,23]. In studies comparing DCBE to proximate endoscopy, the sensitivity has been 80%-100% [24,25], and when used to evaluate individuals with a positive FOBT, most reports indicate a sensitivity of 75%-80% [26,27]. This correlates with a recent large population-based study that found that the overall rate of new or missed cancers following DCBE was 22% [28]. The sensitivity of DCBE for large adenomas has been best studied when all subjects have undergone both radiologic and endoscopic procedures. With this study design, sensitivity has ranged from 48%-81% [25,29-31].

It has been determined that the specificity of DCBE for large adenomas is 96% [25] and the negative predictive value is 98% [32]. It is frequently suggested that the DCBE is less effective at demonstrating polyps in the rectosigmoid colon. However, well-designed studies have shown that sensitivity figures for the DCBE in this anatomic region are comparable to those in other colonic sites [33]. The diagnostic yield of DCBE can be increased by supplementing it with flexible sigmoidoscopy. In the workup of a positive FOBT, the combination of the two procedures detected 98% of large polyps and cancers [26]. Whether the mortality benefit is sufficient to justify the cost, risk, and inconvenience of two tests is unknown, but that determination likely is affected by disease prevalence and risk level. As previously mentioned, screening with a DCBE and flexible sigmoidoscopy contributed to a reduction in cancer incidence in HNPCC kindred, a group with a higher lesion distribution proximal to the reach of flexible sigmoidoscopy [11]. Cost-effectiveness analysis has demonstrated that the DCBE performed every 5-10 years costs less than \$22,000 per life year saved for a possible range of natural history, far below the standard of \$40,000 [34]. DCBE is a safe procedure with a perforation rate of 1/25,000 [35]. The perforation rates associated with other colorectal examinations are 1/10,000 for the single-contrast barium enema (SCBE), 1/5,000 for flexible sigmoidoscopy, and 1/2,000 for diagnostic colonoscopy.

Single-Contrast Barium Enema

A preponderance of the literature portrays a dramatically inferior performance profile for the SCBE. However, most of these studies were performed before 1970 and were published in nonradiologic journals, or focused on patients with persistent symptoms after a normal barium enema. Recent studies suggest that SCBE has the potential to be as sensitive as DCBE for cancer and large polyps. The reported sensitivity for cancer ranges from 82%-95% [21,22] and is approximately 95% for large polyps [36]. However, because of the paucity of studies and the limitations of the study designs, questions arise about the reproducibility of the results, particularly for large polyps. In one of the FOBT trials, SCBE was used for diagnostic follow-up. The sensitivity for cancer was 80% [5]. Most authorities question the adequacy of SCBE for evaluating the rectum and recommend supplementation with sigmoidoscopy.

Computed Tomography Colonography

CTC (also known as “virtual colonoscopy”) was introduced in 1994 as a less invasive method of imaging the colon using helical CT. Early CTC trials performed with single-detector CT scanners demonstrated sensitivities of 68%-92% and specificities of 82%-98% for polyps ≥ 10 mm [37-43]. A meta-analysis of these early trials confirmed reasonably high pooled sensitivities by patient and by lesion of 88% and 81%, respectively, with a pooled specificity of 95% for polyps ≥ 10 mm [44]. More recent studies performed with 4-detector-row scanners have demonstrated sensitivities and specificities of 82%-100% and 90%-98%, respectively, for polyps ≥ 10 mm [45-48]. It is important to recognize, however, that these trials were not performed on screening populations but on individuals who were at increased risk for colorectal neoplasia.

Two other meta-analyses of CTC performance for the detection of ≥ 10 mm polyps showed pooled sensitivities by patient of 85% and 93%, with pooled specificities of 97% [49,50]. In one meta-analysis when seven studies using multidetector CT (MDCT) were analyzed separately there was high overall sensitivity of 95% for polyp detection compared to nine studies using single-detector CT, resulting in an overall sensitivity of 82% [50]. A large single-institution screening trial using single-detector CT demonstrated individual reader sensitivities of 59%-73% and specificities of 95%-98% for polyps ≥ 10 mm [51]. A smaller single-institution screening trial using MDCT demonstrated a sensitivity of 100% for polyps ≥ 10 mm, but in that study only three patients had polyps of that size [52].

Multiple, large multicenter trials comparing multidetector-row CTC and fiberoptic colonoscopy for detecting colorectal polyps and cancers have been published. In a study of 1,233 asymptomatic average-risk individuals undergoing colorectal cancer screening, the sensitivities of CTC and colonoscopy for adenomatous polyps ≥ 10 mm were 94% and 88%, respectively [53]. In the second study [54], which included 600 patients

referred for clinically indicated colonoscopy, the sensitivities of CTC and colonoscopy for detecting patients with polyps ≥ 10 mm were 55% and 100%, respectively, and in the third study [29], which included 614 individuals at increased risk for colorectal neoplasia, the sensitivities of CTC and colonoscopy were 59% and 98%, respectively. Thus, in the evaluation of a screening population, CTC had a very high sensitivity and outperformed colonoscopy, whereas in the other two studies CTC had a low sensitivity, and colonoscopy outperformed CTC by a significant margin. These discrepant results may be related to differences in study design and reader experience. In the study in which CTC outperformed colonoscopy [53], the readers used a primary 3-dimensional endoluminal evaluation of the colon, whereas all other studies have used a primary 2-dimensional evaluation. In addition, that study used stool and liquid tagging as part of the bowel preparation of all patients, whereas the other two studies did not. Furthermore, one of the other two large multicenter trials [54] suffered from inadequate reader training. Only one of the nine centers involved in that trial had substantial prior experience with CTC, and the only requirement to be a reader was performance of at least 10 CTC procedures (without any test of accuracy). For the institution in that study with prior CTC experience, the sensitivity for polyps ≥ 10 mm was 82%, compared with 24% for the other eight institutions.

In the largest multicenter trial to date, many of the issues regarding colonic preparation and reader training were addressed [55]. Fifteen sites recruited a total of 2,531 asymptomatic patients, who underwent multidetector-row CTC (16 rows or more) with stool and fluid tagging, and mechanical carbon dioxide insufflation of the colon. All participating radiologists had to complete a qualifying examination with a minimum accuracy of 90% for large polyps. Per-patient sensitivity, specificity, and positive and negative predictive values were 90%, 86%, 23%, and 99%, respectively, for detecting ≥ 10 mm adenomas or cancers. The per-patient sensitivity for detecting adenomas ≥ 6 mm was 78%. The per-polyp sensitivity for ≥ 10 mm adenomas or cancers was 84%. No difference in sensitivity was identified for the detection of large polyps comparing primary 2-dimensional and primary 3-dimensional interpretation methods. A recent multicenter trial performed in 937 individuals at increased risk for colorectal cancer (373 cases with positive family history, 343 cases with personal history of colonic adenoma, 221 cases of positive FOBT) reported similar per-patient sensitivity, specificity, and negative predictive values of 85%, 88%, and 96%, respectively, for advanced neoplasia ≥ 6 mm but with a higher positive predictive value of 62% [56].

The diagnostic yields of CTC and colonoscopy for advanced neoplasia were compared in parallel screening programs [57]. Primary CTC screening in 3,120 patients was compared with primary colonoscopy screening in 3,163 subjects. Similar detection rates were found for CTC and colonoscopy screening, which identified 123

and 121 advanced neoplasms, respectively. The referral rate for colonoscopy in the CTC group was 8%. The total numbers of polyps removed in the CTC and colonoscopy groups were 561 and 2,434, respectively. Seven perforations occurred in the colonoscopy group, with none in the CTC group. A review of a 1-year experience of CTC screening for colorectal neoplasia showed that 3.9% of individuals had a polyp ≥ 1 cm and 6.9% had one or more polyps 6-9 mm in diameter. Of the 71 patients who chose colonoscopy for further evaluation of these polyps, concordant lesions were found at colonoscopy in 65 (91.5% positive predictive value) [58].

A recent ACR practice guideline for the performance of CTC in adults has been released. Adherence to this guideline should help eliminate some of the performance variability reported in these previously published studies [59]. This guideline also includes suggestions regarding the interpretation and reporting of extracolonic findings. It is emphasized that caution is needed for reporting findings that are likely to be of low clinical significance, which will help to avoid unnecessary further work-up and patient anxiety. The incidence of patients who are found to have clinically important extracolonic findings on CTC ranges between 4.5% and 16% [53,55,60-64].

Currently, most third-party payers are providing reimbursement for screening CTC only after a failed colonoscopy or in some cases for individuals who have a contraindication to colonoscopy (eg, those on chronic anticoagulation or with severe chronic lung disease who are at risk for undergoing sedation). Several studies have demonstrated the usefulness of CTC in individuals who have undergone an incomplete colonoscopy [65-68]. In a study of 546 patients who underwent CTC after incomplete colonoscopy, 13% of patients were found to have 88 lesions ≥ 6 mm. Per-patient and per-lesion positive predictive values of CTC for masses and large polyps were 91% and 92%, respectively [69].

A meta-analysis comparing the performance of DCBE with CTC for the detection of polyps ≥ 6 mm included 11 studies of DCBE (5,995 patients, 1,548 polyps) and 30 studies of CTC (6,573 patients, 2,348 polyps) [70]. Estimates comparing pooled DCBE performance with pooled CTC performance showed statistically significant differences in favor of CTC for specificity and per-polyp sensitivity for polyps ≥ 6 mm. For polyps ≥ 10 mm there were a 0.121 per-patient sensitivity difference and a 0.031 per-polyp sensitivity difference, both favoring CTC, as well as a 0.104 specificity difference favoring CTC. One study directly comparing DCBE and CTC in 614 patients showed that CTC had higher per-patient sensitivity for lesions ≥ 10 mm compared to DCBE: 59% versus 48%, respectively [29]. CTC per-patient sensitivity for 6-9 mm lesions was 51% compared to 35% for DCBE.

Magnetic Resonance Colonography

Magnetic resonance colonography (MRC), which was introduced approximately 3 years after CTC, has the advantage that it does not use ionizing radiation. However, the spatial resolution of MRC is less than that

of CTC, and MRC requires colonic distension with liquid (a diluted gadolinium solution for “bright lumen” [T1-weighted]) imaging [71,72] or tap water for “dark lumen” (T1-weighted) imaging [73,74]. Clinical studies comparing MRC with optical colonoscopy have demonstrated excellent results, with sensitivities of 93%-100% for polyps ≥ 10 mm [71-74]. One study compared polyp detection rates between dark lumen and bright lumen MRC in 37 patients [75]. Dark lumen MRC was better than bright lumen MRC, with respective sensitivities for detecting polyps larger than 5 mm equal to 79% and 68%. Nevertheless, experience with MRC is extremely limited, especially outside of Europe.

Ultrasound

A study using ultrasound performed after colonic distension with rectally administered water demonstrated a sensitivity and specificity for carcinoma of 94% and 100%, respectively [76]. In that study, sensitivity and specificity for polyps >7 mm were 91% and 100%, respectively. No other published reports support the reproducibility of these findings, however, and another study using the same technique reported a sensitivity of 12.5% for polyps >7 mm [77]. Experience with this technique is extremely limited, and the procedure is not recommended for colorectal cancer screening at this time.

Role of Local Expertise

Overall, the most appropriate imaging tests for colorectal cancer screening are CTC and the DCBE. The choice between these two tests may depend largely on local imaging expertise and on physician and patient preference.

Summary

- CTC has emerged as the leading imaging technique for colorectal cancer screening.
- The DCBE remains an imaging test that is also appropriate for colorectal cancer screening, particularly when CTC is not available.
- CTC is the preferred test after incomplete colonoscopy.
- Imaging tests including CTC and barium enema are usually not appropriate for colorectal cancer screening in high-risk patients with hereditary nonpolyposis colorectal cancer and inflammatory bowel disease.

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, both because of

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 to 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.

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	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 NS (not specified).

Supporting Document(s)

- [ACR Appropriateness Criteria® Overview](#)
- [Procedure Information](#)
- [Evidence Table](#)

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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.