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ACR PRACTICE GUIDELINE FOR THE PERFORMANCE OF COMPUTED TOMOGRAPHY (CT) COLONOGRAPHY IN ADULTS

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations of available resources, or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment.

Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

Computed tomography colonography (CTC) is a minimally invasive structural examination of the colon and rectum to evaluate for colorectal polyps and neoplasms [1-12]. The goal of this examination is to establish the presence or absence of colorectal neoplasia by producing a diagnostic quality study at the lowest feasible radiation dose. This guideline outlines the performance of CTC in adult patients.

Individuals undergoing this examination may fall into one of several risk populations, and the examination may be designated as screening, surveillance, or diagnostic. There are several evidence-based guidelines that, with minor variations, categorize individuals into specific risk groups with correlated recommendations for management [13, 14].

Screening identifies individuals who have colorectal cancer or adenomatous polyps without signs or symptoms of the disease. Considering age related risk, all individuals without other risk factors who are 50 years of age or older are considered at average risk. Also considered average risk are those patients with a first-degree relative having colorectal cancer after the age of 60 or multiple second degree relatives at any age with colorectal neoplasia.

Those with a single first-degree relative (mother, father, sister, brother, or child) who have had colorectal neoplasia before age 60 or multiple first-degree relatives with colorectal neoplasia diagnosed at any age are defined as being at moderate risk. Individuals with a long-standing history of inflammatory bowel disease or from families with defined genetic syndromes are at high risk.

Surveillance involves the ongoing monitoring of people with previously diagnosed colorectal neoplasm identified as belonging to the high risk category. The degree of risk may be related to the underlying or prior pathology.

Diagnostic CTC examinations are performed on symptomatic individuals or as a follow-up to a prior but less definitive screening study. These individuals, by definition, are considered at greater risk of harboring colorectal neoplasia.

II. INDICATIONS AND CONTRAINDICATIONS

A. Indications

The indications for a CTC examination include, but are not limited to:

1. Screening examination in individuals who are at average or moderate risk for developing colorectal carcinoma.
2. Screening examinations in individuals who are at moderate risk for colorectal cancer based on family history (with no personal history of colon polyps or colon cancer) should be managed individually based on clinical context or local practice patterns.
3. Surveillance examination in patients with a history of previous colonic neoplasm, depending on the appropriate clinical context.
4. Diagnostic examination in symptomatic patients, particularly in the setting of incomplete colonoscopy, including, but not limited to, those with:
 - a. Abdominal pain.
 - b. Diarrhea.
 - c. Constipation.
 - d. Gastrointestinal bleeding.
 - e. Anemia.
 - f. Intestinal obstruction.
 - g. Weight loss.
5. Following incomplete screening, surveillance, or diagnostic colonoscopy and for characterization of colorectal lesions indeterminate on optical colonoscopy [15-19].
6. Patients who may be at increased risk for complications during optical colonoscopy (e.g., advanced age, anticoagulant therapy, sedation risk, prior incomplete colonoscopy).

B. Contraindications

1. The relative contraindications or conditions that require caution in performing a CTC examination include, but are not limited to:
 - a. Symptomatic acute colitis.
 - b. Acute diarrhea.
 - c. Recent acute diverticulitis.
 - d. Recent colorectal surgery.
 - e. Symptomatic colon-containing abdominal wall hernia.
 - f. Recent deep endoscopic biopsy or polypectomy/mucosectomy.
 - g. Known or suspected colonic perforation.
 - h. Symptomatic or high-grade small bowel obstruction.
2. CTC is not indicated for:
 - a. Routine follow-up of inflammatory bowel disease.
 - b. Hereditary polyposis or nonpolyposis cancer syndromes.
 - c. Evaluation of anal canal disease.
 - d. The pregnant or potentially pregnant patient. (Refer to the [ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation](#).)

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the [ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#).

A. Physician

The physician shall be responsible for all aspects of the study. The responsibilities include, but not limited to, reviewing all indications for the examination; specifying the appropriate imaging protocol, the methods of image reconstruction, and the use and dosage of contrast and pharmacologic agents; interpreting all resulting images and generating an official report; and assuring the quality of the images and the interpretation.

Initial Training

1. For physicians with prior qualifications in general and/or abdominal-pelvic CT interpretation:

The radiologist or other physician who meets the qualifications of the [ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#) will have substantial knowledge of radiation biology, the physics of CT scanning, the principles of CT

image acquisition and postprocessing, including the use of diagnostic workstations, and the design of CT protocols, including rate and timing of contrast administration. The physician also will have substantial experience in CT interpretation, including CT of extracolonic structures that will be included on the CTC examination.

Supervising and interpreting physicians with prior qualifications in general and/or abdominal/pelvic CT interpretation shall also meet ONE of the following requirements:

- a. For physicians who receive their training in CTC in a training program approved by the Accreditation Council for Graduate Medical Education (ACGME), the Royal College of Physicians and Surgeons of Canada (RCPSC), the Collège des Médecins du Québec, or the American Osteopathic Association (AOA), such training shall include:
 - i. Education regarding patient preparation, bowel insufflation, and CT image acquisition.
 - and
 - ii. Formal hands-on interactive training using dedicated CTC software, including the interpretation, reporting, and/or supervised review of at least 50 endoscopically confirmed CTC cases using primary 2D and/or primary 3D search with application of routine problem-solving techniques.

Ideally this collection of training cases will be chosen to demonstrate the gamut of appearances of colonic polyps and CTC interpretation pitfalls. Additionally, the cases should include examinations performed for a variety of indications (e.g., screening, symptomatic, incomplete colonoscopy with subsequent validation) and acquisition techniques (e.g., with and without fluid tagging and intravenous contrast).

or

- b. For physicians who receive their training in CTC after completing their residency or fellowship, such training shall include:
 - i. Education regarding patient preparation, bowel insufflation, and CT image acquisition.
 - and

- ii. Formal hands-on interactive training using dedicated CTC software, including the interpretation, reporting, and/or supervised review of at least 50 endoscopically confirmed CTC cases using primary 2D and/or primary 3D search employing commonly used problem-solving techniques.

Ideally this collection of training cases will be chosen to demonstrate the gamut of appearances of colonic polyps and CTC interpretation pitfalls. Additionally, the cases should include examinations performed for a variety of indications (e.g., screening, symptomatic, incomplete colonoscopy with subsequent validation) and acquisition techniques (e.g., with and without fluid tagging and intravenous contrast).

2. For physicians who do not have prior qualifications in general and/or abdominal-pelvic CT interpretation:

A radiologist or other physician who does not meet the qualifications of the [ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#), or who meets these qualifications only for a specific anatomic area outside of the abdomen-pelvis, requires more extensive training and experience in CT scanning with an emphasis on the abdomen-pelvis and specific experience in CTC. In addition to specific training in imaging interpretation, this training must include knowledge of the principles of CT image acquisition and postprocessing, including the use of diagnostic workstations and the design of CT protocols, including rate and timing of contrast administration. The physician must also meet the same requirements, or document equivalent training, as those delineated in the [ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#) with regard to knowledge of the physics of CT scanning and radiation biology. Some physicians will also require additional education in colon anatomy, physiology, and pathology.

Supervising and interpreting physicians without prior qualifications in general and/or abdominal-pelvic CT interpretation shall meet the following requirements:

- a. Completion of sufficient training and experience to meet the qualifications of the

ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography (CT). For a physician who assumes responsibilities for CT imaging exclusively in a specific anatomical area such as abdominal-pelvic CT and CTC, this includes:

- i. Completion of an ACGME approved training program in their respective specialty in which they practice plus 200 hours of Category I CME in the performance and interpretation of abdominal-pelvic CT.
and
- ii. Supervision, interpretation, and reporting of 500 CT cases, at least 100 of which must be abdominal-pelvic CT during the past 36 months in a supervised situation.
and
- b. Education regarding patient preparation, bowel insufflation, and CT image acquisition.
and
- c. Formal hands-on interactive training using dedicated CTC software, including the interpretation, reporting, and/or supervised review of at least 75 endoscopically confirmed CTC cases using primary 2D and/or primary 3D search with routine problem-solving techniques [20].

Ideally this collection of training cases will be chosen to demonstrate the gamut of appearances of colonic polyps and CTC interpretation pitfalls. Additionally, the cases should include examinations performed for a variety of indications (e.g., screening, symptomatic, incomplete colonoscopy with subsequent validation) and acquisition techniques (e.g., with and without fluid tagging and intravenous contrast).

Maintenance of Competence

When feasible, CTC training should be followed by a period of mentored supervision and double-reading by an experienced CTC trained physician. A variety of other techniques may also be helpful for improving interpretive skills at CTC, including:

- Self-directed individual study of formal texts, atlases, review articles, and teaching files.
- Testing with feedback.
- Computer-aided detection algorithms, which can be used as a second-reader.

A total of 50 cases every 2 years should be reviewed to maintain skills in CTC. This can be accomplished in several ways, such as:

- Performance of CTC in local practice, with follow-up of positive findings with endoscopy or surgery.
- CME sponsored reviews on line, DVDs, or at review courses where case interpretation precedes disclosure of the correct answers.

B. Radiologic Technologist

Qualifications of the radiologic technologist should include familiarity with the technical requirements of performing CTC, including rectal tip insertion, proper patient positioning, colonic insufflation of room air and CO₂ with manual and automated techniques, and tube removal.

IV. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for CT colonography should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance and interpretation.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). Additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state scope of practice requirements. (ACR Resolution 35, adopted in 2006)

A. Colon Preparation

Preparation of the colon for CTC should consist of a combination of dietary restriction, hydration, osmotic laxatives such as saline cathartics, and contact laxatives. The intent is to achieve a colon that is free of fecal material and excess fluid or as close to this ideal as possible [21-23].

While most multicenter studies validating CTC as a screening technique have used routine oral contrast for labeling colonic stool and fluid ("tagging"), there is insufficient evidence to require the use of oral contrast in

all cases (especially following incomplete endoscopy). When feasible, the use of tagging is encouraged by many experts. The goal of tagging is to passively incorporate contrast into any residual fluid and stool in order to raise their inherent CT densities, which helps to discriminate these residua from the soft tissue density of polyps or advanced cancers. Noncathartic or reduced-cathartic approaches to CTC bowel preparation (also known as “prepress” or “minimal prep” CTC) aim to reduce patient discomfort associated with pre-examination bowel purgation. While pilot data for these approaches are encouraging, they remain under investigation and have not yet been validated in large clinical trials [24-27].

B. Examination Technique

1. The medical history should be reviewed.
2. The patient should evacuate prior to insertion of the rectal tube.
3. The rectal tube tip should be inserted by a physician or a trained assistant (radiologic technologist, nurse, or physician assistant). If a rectal retention balloon is used, inflation should be discontinued if the patient complains of pain. This may indicate an increased risk of perforation.
4. While some reports have suggested that use of glucagon or other spasmolytics may decrease insufflation-related discomfort, evidence for this remains relatively weak, and use of antispasmodics is not considered necessary for routine examination [28, 29].
5. A sufficient volume of room air and/or carbon dioxide should be administered either manually or with an automatic insufflator to provide full colon distention [30].
6. The adequacy of colon distention should be checked with a scout image to ensure a complete and full column of gas throughout the colon before each CT acquisition.
7. Complete anatomic imaging of the colon and rectum should be obtained in at least 2 patient positions (usually supine and prone) [23, 31]. Additional insufflation will usually be necessary before additional acquisitions.
8. Screening studies should be performed using a low-dose, nonenhanced CT technique on a multidetector CT scanner [3, 32-34]. Colonography studies should be performed such that there is appropriate adaptation of $CTDI_{vol}$ to patient size, using either technique charts or automatic exposure control. The recommended radiation output for routine screening CTC, quantified using $CTDI_{vol}$, should be less than or equal to one-half the diagnostic reference level for routine abdominal pelvic CT (2008 ACR CT Accreditation Program) or one-quarter of this

value per position (i.e., $CTDI_{vol}$ of 6.25 mGy per position or a total of 12.5 mGy for dual position CTC). Much lower doses for screening examinations can be achieved similar to ranges of the annual background radiation. Generally, for scans performed at a tube potential of 120 kVp, this requires an effective mAs value between 50 and 80 (where effective mAs is equal to the tube current-time product (mAs) divided by the spiral pitch value). Because these factors may not be appropriate for every CT scanner model, the scan protocol parameters should be adjusted as necessary to obtain the required image quality at or below the suggested $CTDI_{vol}$ values (6.25 mGy per scan position or 12.5 mGy total for the supine and prone position scans).

9. Additional imaging after repositioning and reinsufflation may be needed to adequately distend a colonic segment. Additional imaging (e.g., in left or right decubitus position) is appropriate when imaging in 2 positions fails to adequately display the colonic lumen and acquisition of additional data is likely to result in a diagnostic study.
10. For morbidly obese patients, radiation dose should be appropriately increased to maintain diagnostic image quality [35]. Phantom dose estimates are less accurate in estimating internal organ radiation dose in very obese patients. It should be realized that in these patients, phantom dose estimates do not reflect exposure to the internal organs [36].
11. Diagnostic CTC examinations should use the same CT parameters as screening CTC examinations. Diagnostic CTC will occasionally require intravenous contrast to characterize intracolonic or extracolonic structures or to address a second medical indication. When intravenous contrast is injected, CT acquisition parameters should be adjusted to match routine imaging techniques for standard noncolonography CT contrast-enhanced imaging of the abdomen and pelvis.
12. CTC is optimally performed on a multidetector (≥ 4 slice) CT (MDCT) scanner. Slice thickness of ≤ 3 mm with a reconstruction interval of ≤ 2 mm is optimal. The breathhold should not exceed 25 seconds.
13. Networking capability should be available to transfer the image data to a workstation with specialized software for CTC interpretation.
14. The quality controls specific to the CTC study are:
 - a. Complete anatomic coverage of the colon and rectum.
 - b. Adequate colon distention and overall image quality. The luminal surface of each

segment of the colon should be visualized in at least 1 position. Suboptimally visualized colonic segments should be reimaged. The use of decubitus views or reinsufflation may be helpful in cases of suboptimal distention or excessive fluid.

C. Quality Control

The following quality controls should be applied to all CTC examinations:

1. Colon cleansing and distention should be adequate for detecting polyps 1 cm or larger.
2. Efforts should be made to ensure a diagnostic quality examination before the patient leaves the facility. Focused additional imaging of the patient should be performed as necessary.
3. The following is suggested for a quality control program:
 - a. Radiologic, endoscopic, and pathologic findings should be correlated whenever available.
 - b. Detection rates for colorectal cancer and polyps of 1 cm or greater should be determined and periodically monitored. There should be an assessment of false positive rates for all reported polyps.
 - c. Participation in the ACR CTC Registry is recommended, with regular comparison of facility data to national data to determine how local detection and complication rates compare with national rates, and whether performance is adequate or if further internal review is indicated (<https://nrdr.acr.org>).

D. Data Interpretation

The purpose of CTC is to accurately evaluate the colon for the presence or absence of clinically significant neoplastic lesions. Abnormalities may range from discrete mucosal elevations (which may be malignant or at risk to become malignant) to infiltrating tumors. Lesion morphology (sessile, pedunculated, flat) and segmental location should be reported. There are different definitions of what constitutes “flat,” and the use of the term should make specific reference to the definition being used.

1. Detection and characterization of colorectal findings

CT data should be interpreted on a computer workstation that allows an integrated approach of 2D and 3D image display techniques (axial imaging, multiplanar reformatted imaging, and 3D endoluminal viewing). Workstations should be able to display both axial supine and prone

data together, and should allow the interpreting physician to change the window width and level settings interactively and in real time. The primary search for colorectal polyps and cancers can be performed using either a primary 2D or a primary 3D endoluminal search technique. Whether 2D or 3D is used to primarily detect a lesion, the corresponding views are important for further characterization.

If an abnormality is suspected during either primary 2D or 3D search:

- a. The abnormality should be interrogated with multiplanar reconstruction (MPR) and multiple endoluminal views to evaluate the morphology of the suspected lesion.
- b. Supine and prone data should be evaluated to determine if the lesion is mobile. Causes of mobility include residual fecal material, pedunculated polyp, or a rotating colon segment.
- c. The window setting should be adjusted to determine if the lesion shows homogeneous soft tissue attenuation or is heterogeneous.

2. Measurement of colorectal findings

Polyps should be measured using either optimized multiplanar reconstruction (i.e., axial, sagittal or coronal view which best elongates lesion) and/or 3D images. Measurement of the size of the lesion should be based on the largest diameter of the polyp head (excluding stalk if present) or at the base of a sessile lesion [37, 38].

3. Extracolonic findings

Extracolonic structures should be evaluated at the time of the review of the colon. Significant abnormalities should be included in the report. A study optimized for evaluating colon abnormalities may not be optimal for detecting and characterizing extracolonic abnormalities. Specifically, detecting incidental findings with low subject contrast may be limited with aggressive dose reduction. This limitation may be reduced by propagating a sliding thick slab through the image volume to improve noise characteristics and reader efficiency by decreasing the number of images that need to be reviewed for incidental lesion detection. Abnormalities or questionable abnormalities in structures unrelated to the colon may be identified during the process of reviewing the 2D axial images of the colon. These are most common in, but not limited to, the kidneys, liver, adrenal glands, visualized portions of the lungs, and the major vessels.

V. DOCUMENTATION AND COMMUNICATION OF RESULTS

Reporting should be in accordance with the [ACR Practice Guideline for Communication of Diagnostic Imaging Findings](#).

Any colonic segment that cannot be adequately evaluated for technical reasons should be documented as such. Polyps ≥ 6 mm should be identified and reported. Consistent with the 2008 American Cancer Society recommendations [39], these patients should be offered polypectomy at colonoscopy, understanding that clinical management may vary depending on the patient's age, risk to undergo colonoscopy, other significant comorbidities, or the preference of the patient or the referring physician. Recommendations for clinical management options may be incorporated into the report.

In patients with only diminutive polyps ≤ 5 mm, the risk of high grade dysplasia or cancer is extremely low [6,10, 40]. The benefits of polypectomy versus 5 year surveillance need to be balanced with the broader risks, including the costs and complications of polypectomy. Namely, given the low risk of advanced neoplasia along with the low specificity of diminutive lesions at CTC, a large number of patients could be referred to endoscopy inappropriately.

At colonoscopy, concern over decreased productivity for false positive CTC examinations has been raised [41], in addition to the low rate of detecting small lesions at colonoscopy [42,43]. Current CTC acquisition techniques targeted at the index lesion size of greater than or equal to 6 mm with low dose techniques do not always optimize detection of diminutive lesions. The ACR currently does not believe that reporting of these diminutive lesions is necessary [44]. Multidisciplinary consensus is being sought for the future.

Extracolonic abnormalities of potential medical significance should also be reported. Good patient care mandates that CTC interpretation include full evaluation of the numerous extracolonic structures and that findings of potential clinical significance be reported and communicated in a clear and timely fashion. However, most extracolonic findings are not clinically significant in screening/asymptomatic cohorts. In screening cohorts, the prevalence of clinically significant extracolonic findings is low [45-50]. Caution should be used in the interpretation and reporting of findings likely to be of low clinical significance in order to avoid unnecessary subsequent/serial diagnostic examinations and associated patient anxiety [44].

Clarity and consistency of reporting the colonic and extracolonic findings are critical for effective implementation. One option is the use of CT

Colonography Reporting and Data System (C-RADS) which is a consensus statement of a standardized reporting structure for CTC findings published in 2005, modeled after the Breast Imaging Reporting and Data System (BI-RADS[®]) reporting of mammography [44]. This reporting structure of C-RADS describes how to report lesion size, morphology, and location with a summary category score per patient. Polyp size measurement, another important factor for patient care management, is also defined. Namely, a polypoid lesion should be measured along the long axis of its head, excluding the stalk if present. A flat or sessile lesion should be measured as the long axis of its base along the wall. Patient management criteria have not yet been standardized.

VI. EQUIPMENT SPECIFICATIONS

Examinations should be performed with MDCT equipment meeting all applicable federal and state radiation standards as well as the requirements described in section IV.B.

Equipment should provide diagnostic image quality and networking capability. Equipment should be capable of producing kilovoltage of 120 kVp or greater and ≤ 100 mAs.

VII. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, radiologic technologists, and all supervising physicians have a responsibility to minimize radiation dose to individual patients, to staff, and to society as a whole, while maintaining the necessary diagnostic image quality. This concept is known as "as low as reasonably achievable (ALARA)."

Facilities, in consultation with the medical physicist, should have in place and should adhere to policies and procedures, in accordance with ALARA, to vary examination protocols to take into account patient body habitus, such as height and/or weight, body mass index or lateral width. The dose reduction devices that are available on imaging equipment should be active; if not, manual techniques should be used to moderate the exposure while maintaining the necessary diagnostic image quality. Periodically, radiation exposures should be measured and patient radiation doses estimated by a medical physicist in accordance with the appropriate ACR Technical Standard. (ACR Resolution 17, adopted in 2006 – revised in 2009; Resolution 11)

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education appearing under the heading *Position Statement on QC & Improvement, Safety, Infection Control, and Patient Education* on the ACR web page (<http://www.acr.org/guidelines>).

For specific issues regarding CT quality control, see the [ACR Practice Guideline for Performing and Interpreting Computed Tomography \(CT\)](#).

Equipment performance monitoring should be in accordance with the [ACR Technical Standard for Medical Physics Performance Monitoring of Computed Tomography \(CT\) Equipment](#).

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