IMPROVING INTERPRETIVE SKILLS FOR CT COLONOGRAPHY

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Disclosures

- Echopixel Research Grant
- NIH CT Dose Collaboratory Grant
Executive Summary

“All members of the joint panels agreed that, given the risks and benefits identified, CTC should be one option for CRC screening of asymptomatic patients.”
Final Research Plan
Colorectal Cancer: Screening

Recommendations made by the USPSTF are independent of the U.S. government. They should not be construed as an official position of the Agency for Healthcare Research and Quality or the U.S. Department of Health and Human Services.

Preface

The final Research Plan is used to guide a systematic review of the evidence by researchers at an Evidence-based Practice Center. The resulting Evidence Report will form the basis of the USPSTF Recommendation Statement on this topic.

The draft Research Plan was available for comment from January 9 until February 5, 2014 at 5:00 p.m., ET.

Stages of Development

Topics under review and development are listed below.

Step 1: Develop a Research Plan (4 topics)
Step 2: Systematically Review the Evidence (24 topics)
Step 3: Develop a Draft Recommendation Statement (10 topics)
Step 4: Finalize the Recommendation Statement (1 topics)

Step 2: Systematically Reviewing the Evidence

EPC independently gathers and reviews the available published evidence.

Evidence review critiqued by external national subject matter experts
<table>
<thead>
<tr>
<th>Grade</th>
<th>Definition</th>
<th>Suggestions for Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>The USPSTF recommends the service. There is high certainty that the net benefit is substantial.</td>
<td>Offer or provide this service.</td>
</tr>
<tr>
<td>B</td>
<td>The USPSTF recommends the service. There is high certainty that the net benefit is moderate or there is moderate certainty that the net benefit is moderate to substantial.</td>
<td>Offer or provide this service.</td>
</tr>
<tr>
<td>C</td>
<td>The USPSTF recommends selectively offering or providing this service to individual patients based on professional judgment and patient preferences. There is at least moderate certainty that the net benefit is small.</td>
<td>Offer or provide this service for selected patients depending on individual circumstances.</td>
</tr>
<tr>
<td>D</td>
<td>The USPSTF recommends against the service. There is moderate or high certainty that the service has no net benefit or that the harms outweigh the benefits.</td>
<td>Discourage the use of this service.</td>
</tr>
<tr>
<td>I</td>
<td>The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of the service. Evidence is lacking, of poor quality, or conflicting, and the balance of benefits and harms cannot be determined.</td>
<td>Read the clinical considerations section of USPSTF Recommendation Statement. If the service is offered, patients should understand the uncertainty about the balance of benefits and harms.</td>
</tr>
</tbody>
</table>
Colorectal Carcinoma

- Most (> 95%) CRC arise in adenomatous polyps

**Risk of Carcinoma**

<table>
<thead>
<tr>
<th>Size (mm)</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 5</td>
<td>0 %</td>
</tr>
<tr>
<td>6 - 9</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>10 - 20</td>
<td>up to 10%</td>
</tr>
<tr>
<td>&gt; 20</td>
<td>&gt; 25%</td>
</tr>
</tbody>
</table>

- ≤ 10 mm polyp to invasive ca: 10 years
## Advanced Neoplasia in Small (6 – 9 mm) Polyps

<table>
<thead>
<tr>
<th>Study</th>
<th>Total # Small Adenomas</th>
<th>Advanced Histology</th>
<th>Cancer</th>
<th>1 – 5 mm Polyps Lieberman N=3,744</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shinya (1979)</td>
<td>1,661</td>
<td>15.5%</td>
<td>0.5%</td>
<td>Advanced Histology</td>
</tr>
<tr>
<td>NPS (1990)</td>
<td>1,230</td>
<td>7.3%</td>
<td>1.5%</td>
<td>Cancer</td>
</tr>
<tr>
<td>Gschwantler (2002)</td>
<td>2,789</td>
<td>13.5%</td>
<td>0.9%</td>
<td></td>
</tr>
<tr>
<td>Butterly (2006)</td>
<td>921</td>
<td>10.1%</td>
<td>0.9%</td>
<td></td>
</tr>
<tr>
<td>Lieberman (2008)</td>
<td>1,198</td>
<td>6.6%</td>
<td>0.2%</td>
<td>1.7%</td>
</tr>
</tbody>
</table>

AVG = 10.6% 0.8%
ACR PRACTICE PARAMETERS

- Personnel Qualifications and Responsibilities

For physicians already with prior CT interpretation/supervision qualifications:

- Training in CTC technique: patient preparation, insufflation and image acquisition

- Interactive review of at least 50 cases (with and without tagging, IV Contrast)

- Maintenance of Competence: 50 cases /2 years
PRIMARY 2D INTERPRETATION

SUPINE

PRONE
Primary 2D Interpretation

1. Scroll through axials
   supine and prone linked
   colon windows
   rectum to cecum
   ✓ use magnified images and scroll slowly

2. For potential polyps or cancers
   bookmark
   interactively correlate with MPR’s or 3D view
Primary 2D Interpretation

4. Scroll through axials – supine only, soft tissue windows
   - flat lesions, lipomas
   - colon cancer vs collapse
   - extra-colonic lesions
OTHER 3D OPTIONS FOR PROBLEM SOLVING

FLY-THROUGH

DISSECTION VIEW
Primary 2D - Advantages

- Lesion density (Stool, Lipomas)
- Can avoid 3D pitfalls - i.e. diverticula
- Can achieve high polyp detection accuracy
- Rapid interpretation times
PRIMARY 3D INTERPRETATION
Primary 3D Interpretation

1. Automatic colonic segmentation and centerline generation

2. Automatic navigation supine and prone
   - anterograde
   - retrograde

3. For potential polyps or cancers
   - bookmark
   - interactively correlate with axials and MPR’s to evaluate density
Primary 3D Interpretation

4. Painting, review skipped areas on 3D
5. Scroll through axials – supine only, soft tissue windows
   - flat lesions, lipomas
   - colon cancer vs collapse
   - extra-colonic lesions
Primary 3D Advantages

- Ease of automatic navigation
- May be easier to learn for some
- Differentiation of folds from polyp
- Can achieve high polyp detection accuracy
POLYP APPEARANCES
Large Sessile Polyp

≤ 5 mm = Diminutive : Do not report
6 - 9 mm = Small
≥ 10 mm = Large
Sessile Polyps

Typical Features

Homogeneous
Round, ovoid
Fixed
Large Pedunculated Polyp
Polyp Flattened by Rectal Balloon
Obscured Polyp Caused By Inflated Rectal Balloon
Irregular Polyps

Need 2D to show ST density of these types of lesions
Irregular Polyp
Irregular Polyp
Annular Cancer
POLYP
MEASUREMENT
Measurement 3D

10.1 +/- 1mm.
Measurement 2D vs. 3D

Same Polyp
Measurement 2D (MPR) vs. 3D

Axial

5.2 +/- 1mm

11.7 +/- 1mm
Measurement 2D (MPR) vs. 3D

Sagittal
Measurement 2D (MPR) vs. 3D
Measurement 2D (MPR) vs. 3D

Oblique
Measurement Errors on CTC

- Not measuring maximum diameter
- Improper cursor placement
- Inaccurate automated measurement

- Use 3D views for obtaining maximum diameter
  - except if polyp has a coating of contrast
- Rotate 3D image after cursor placement
- Visually double-check automated tool
CAD

COMPUTER AIDED DETECTION
CAD FEATURES

- hemispherical shape
- CT density
- regular margins
- limited / no mobility
- increased wall thickness
Strategies for CAD Workflow

- Second reader
- Concurrent reader
- Primary reader
- Standalone CAD

Optimum reading strategy varies depending on reader experience and preference
**CAD Reader Trials**

• **Lawrence et al. Radiology 2010;256:791-798**
  - 3,046 screening pts underwent CTC with cleansing + tagging
  - **Standalone CAD** had excellent performance for small + large polyps

<table>
<thead>
<tr>
<th></th>
<th>≥ 6mm</th>
<th>≥ 10mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per Pt Sensitivity</td>
<td>94%</td>
<td>97%</td>
</tr>
<tr>
<td>Per Polyp Sensitivity</td>
<td>95%</td>
<td>96%</td>
</tr>
</tbody>
</table>

• **Halligan et al. Radiology 2011;258:469-476**
  - 112 pts, 132 polyps in 56 pts, cleansing + tagging
  - **Second read CAD** significantly improved polyp detection (58% vs 65%)
  - Concurrent CAD less effective (58% vs 62%)

• **Dachman et al. Radiology 2010;256:827-835**
  - Use of **Second Reader CAD** significantly improved sensitivity (42% vs 48%)
    with a small decrease in specificity
CAD Reader Trials

- **Mang et al. Eur Radiol 2012;22:2768-2779**
  - 616 pts underwent CTC with cleansing + tagging
  - *First reader CAD* strategy using an image gallery detected all large polyps

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<th>≥ 10 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Per Pt Sensitivity</strong></td>
<td>84%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Per Polyp Sensitivity</strong></td>
<td>83%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Overall Specificity = 96%  
Mean interpretation time = 3.1 min*
CAUTION
Common 2D Pitfalls

- Adherent homogeneous stool
- Bulbous folds
- Confluence of folds
- Mobile pedunculated polyp
- Rotated segment
2D Pitfall: Stool
2D Pitfall: Mobile Pedunculated Polyp
2D Pitfall: Rotated Segment

SUPINE

PRONE
Internal Hemorrhoids
Rectal Venous Plexus
Common 3D Pitfalls

- Stool
- Diverticula
- Lipoma
- Appendiceal Orifice
- Ileocecval Valve
- Residual Pill Fragments
- External Compression
Typical Stool Appearance
3D Pitfall: Diverticula
3D Pitfall: Impacted Diverticula
3D Pitfall: Lipoma
Appendiceal Orifice (similar to Diverticula) will show a darker rim than a polyp.
3D Pitfall: Ileocelecal Valve
3D Pitfall: Polyp on Ileocecal Valve
Carcinoma Adjacent to ICV
3D Pitfall: Extrinsic Compression
BEWARE
Pitfalls on 2D and 3D

- Adherent, homogenous stool
- Rotated segment
- Flat lesions
- Anal papillae, condyloma
- Inverted appendiceal stump
2D/3D Pitfall: Rotated Colonic Seg

Supine

Prone
2D / 3D Pitfall: Flat Lesion

Use soft tissue windows
2D/ 3D Pitfall: Flat Lesion
Tagging can help find flat lesions

SUPINE

PRONE

3D view

Colonoscopy
Tagging can help find other lesions
Hypertrophied Anal Papillae
Inverted Appendiceal Stump
ACR CTC Resources Website

http://www.acr.org/Quality-Safety/Resources/CTC-Resources

- Policies, Statements
- Approp Criteria
- Research
  - ACRIN
  - JACR
- Education
- Practice Guidelines
- Registry
- Pt Information
  - radiologyinfo.org
- Private payer coverage
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Rating</th>
</tr>
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<tbody>
<tr>
<td>CT Colonography</td>
<td>9</td>
</tr>
<tr>
<td>DC Barium Enema</td>
<td>6</td>
</tr>
<tr>
<td>SC Barium Enema</td>
<td>4</td>
</tr>
<tr>
<td>MR Colonography</td>
<td>4</td>
</tr>
</tbody>
</table>

If CTC or DCBE cannot be performed

Scale: 1 (not appropriate) to 9 (more appropriate)
Virtual Colonoscopy (CT Colonography)

What Are the Risks and Benefits Compared to Traditional Colonoscopy?

Virtual colonoscopy uses low radiation dose equal to about a year of radiation we all get from environmental sources. Long-term risk of low-dose radiation is unclear. However, the American Association of Physicists in Medicine considers risk from dose levels, such as those used in the virtual exam, to be very small.

In traditional colonoscopy a long tube (colonoscope) is maneuvered from the rectum to the beginning of the colon. There is a small risk of colon perforation from this — approximately 1 patient per 1,000 standard colonoscopies.

In virtual colonoscopy, only a very small flexible tip is placed into the rectum to gently inflate the colon. The risk of perforation from the virtual colonoscopy is far lower.

Traditional colonoscopy is most often performed with sedation, which carries risk of allergic reaction and other side effects. Virtual colonoscopy does not require sedation. Most patients can go back to their daily activities. President Obama had his first colorectal cancer screening using virtual colonoscopy.

Unlike standard colonoscopy, the virtual exam can detect unexpected medical problems outside the colon. While only 1 in 200 patients who get screening virtual colonoscopy will have colon cancer, up to 1 in 200 patients have been shown to have an unexpected kidney, lung, or lymph node cancer. Some of these incidental findings will require additional imaging tests, which may be associated with additional costs.

What is a Virtual Colonoscopy?

Virtual colonoscopy is a computed tomography (CT) scan that can produce three-dimensional (3D) and moving images of the colon. Doctors examine these images for colorectal cancer and precancerous polyps. The exam generally takes about 10 minutes. It does not require sedation. Afterward, you can go back to daily activities.

Colorectal Cancer

Colorectal cancer is the second leading cause of cancer death in the United States. Each year, about 140,000 people are diagnosed and 50,000 people die from colorectal cancer.

Most colorectal cancers begin as small polyps on the colon surface. Virtual colonoscopy can find these polyps while they are small and harmless and also identify cancers early when they are most treatable.

How Accurate Is Virtual Colonoscopy?

Virtual colonoscopy is comparable accurate to a standard colonoscopy for people at average risk for colorectal cancer. That is most people. Those at high risk for the disease due to a family history or other factors should consider the standard colonoscopy.

Who Should Have a Virtual Colonoscopy?

The American Cancer Society (ACS) and other medical organizations recommend that these at average risk for colorectal cancer begin screening at age 50. Virtual colonoscopy is an ACS recommended screening exam to be done every five years for those at average risk. The virtual exam may also be an option for those at increased risk who can’t physically tolerate a colonoscopy.

Where Should I Have My Virtual Colonoscopy?

As more insurers cover virtual colonoscopy, the exam is becoming more widely available. Look for a facility accredited in CT by the American College of Radiology (ACR). Contact those facilities and ask if they offer virtual colonoscopy. Most large hospitals will offer this test. Your primary care physician or specialist may be able to assist you as well.

What Can I Expect Before, During and After My Virtual Colonoscopy?

Bowel cleaning is required to remove stool prior to the exam. A small, flexible tube is placed in the rectum to gently inflate the colon with air or carbon dioxide. This gas is safely absorbed by the body or breathed out. Two scans are performed, one lying on your back — a second on your stomach or side. Each takes about 10 seconds. You can then get dressed and go about your day.

Will Insurance Cover My Virtual Colonoscopy?

Many private insurers — including CIGNA, UnitedHealthcare, Anthem Blue Cross Blue Shield and others cover screening virtual colonoscopy. Medicare is currently considering coverage of the virtual exam.

Further information on local coverage for virtual colonoscopy exams can be found on the ACR website at acr.org/VirtualCT.

For more information on virtual colonoscopy, visit RadiologyInfo.org/VirtualCT.
CT Colonography

What is CT Colonography?

CT scanning—sometimes called CAT scanning—is a noninvasive medical test that helps physicians diagnose and treat medical conditions.

CT imaging combines special x-ray equipment with sophisticated computers to produce multiple images or pictures of the inside of the body. These cross-sectional images of the area being studied can then be examined on a computer monitor or printed.

CT scans of internal organs, bones, soft tissue and blood vessels provide greater clarity and reveal more details than regular x-rays.

CT colonography uses CT scanning to obtain an inner view of the colon (the large intestine) that is otherwise only seen with a more invasive procedure where an endoscope is inserted into the rectum.

What are some common uses of the procedure?

The main reason for performing CT colonography is to screen for polyps and other lesions in the large intestine. Polyps are growths that arise from the inner lining of the intestine. Some polyps may grow and turn into cancers.

The goal of screening with colonography is to find these growths in their early stages, so that they can be removed before cancer has a chance to develop. Many physicians agree that everyone older than 50 years should be screened for polyps every seven to 10 years, individuals at increased risk should be screened every five years and may need to start screening at age 40 or younger. Risk factors for this disease include a history of polyps, a family history of colon cancer, or the presence of blood in the stool.

How should I prepare?

You should wear comfortable, loose-fitting clothing to your exam. You may be given a gown to wear during the procedure.

Women should inform their physicians and the CT technologist if there is any possibility that they are pregnant.

It is very important to clean out your bowels the night before your CT colonography examination so that the radiologist can clearly see any polyps that might be present. You will be asked to take either a set of pills or a cathartic agent. Some common preparations are the Fleet Prep Kit (phospho-soda and bisacodyl) and NuLytel® or Go-Lytely® (Polyethylene glycol electrolyte solution).

Be sure to inform your physician if you have heart, liver or kidney disease or are allergic to any drugs. The bowel prep will be safe. On the day before your exam, you should limit your food intake to clear liquids such as broth, tea or juice. You will be able to resume your normal diet immediately after the exam.

What does the equipment look like?

The CT scanner is typically a large, box-like machine with a hole, or short tunnel, in the center. You will lie on a narrow examination table that slides into and out of this tunnel. Raising around you, the x-ray tube and electronic x-ray detectors are located opposite each other in a ring, called a gantry. The computer workstations that process the imaging information is located in a separate room, where the technologist operates the scanner and monitors your examination.

During CT colonography, you will be asked to lie on your back and then on your stomach or side.
3 Process Measures:
• bowel cleansing and distention
• technical adequacy screening CTC
• technical adequacy diagnostic CTC

3 Outcomes Measures:
• perforation rate
• true positives $\geq 10$ mm
• significant ECF
Purpose:
1) Ensure CTC quality, maintenance of low-dose technique
2) Supports credentialing and reimbursement

https://nrdr.acr.org/portal/CTC/Main/page.aspx
CT Colonography
July 2011 - December 2011
Summary Chart - Sample facility

- Adequate Bowel Cleansing and Distention
- Adequacy of Screening CTC Exam
- Adequacy of Diagnostic CTC Exam
- Colonic Perforations
- True Positives
- Clinically Significant Extracolonic Findings

Percent
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

Sample facility
Registry
ACR   CTC Registry Update

- 9,384 exams registered
- 16 active facilities

- Fee depends on # physicians, # sites, ≥ $500
- Fee waiver for all VA/DOD facilities

- New for 2016: electronic upload ability
Summary Points

- Use meticulous reading technique
- Be proficient in both 2D and 3D interpretations
- Maintenance of competency essential
Thank you

judy.yee@ucsf.edu
What is the finding?
What is the finding?

1. Stool
2. Bulbous fold
3. Ileocecal valve
4. Sessile polyp
5. Pedunculated polyp
6. Carcinoma
Sessile Polyp
What are the findings?

1. Stool
2. Stool and polyp
3. Stool, polyp and lipoma
4. Stool and 2 polyps
5. 2 polyps and lipoma
6. 3 polyps