# Improving the Accuracy of CTC Interpretation: Computer-Aided Detection

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• CT colonography • Computer-aided detection
• Observer performance • Colonic polyps

Computer-aided detection (CAD) for computed tomographic colonography (CTC) was introduced in the late 1990s. CAD has developed rapidly and early clinical trials of CAD are beginning to appear in the literature. This article presents a brief overview of the current clinical status of CTC CAD. The article concludes with a description of some advanced computerized display technologies that assist CTC readings and may play an important role in improving the diagnostic efficacy of CTC.

## RATIONALE FOR CAD

It has been shown that perceptual error reduces the sensitivity of CTC by 14% for polyps 1 cm in size or larger.[1] Given the multitude of images in a CTC study, the causes of perceptual error are not mysterious. Depending on the reconstruction interval, there can be 1200 images or more to interpret. For example, images in the prone and supine positions must be interpreted. Some investigators examine the colon antegrade and retrograde, and in lung and soft tissue windows. Three-dimensional virtual endoscopic views may also be needed for problem solving. Average interpretation times ranging from 15 to 25 minutes per study have been reported in the literature.[2,3]

Interpretive errors can lead to substantial reductions in the sensitivity of polyp detection.[4] Polyps can be missed if they are located between or behind haustral folds,

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in areas of poor bowel preparation or inadequate distention or because of inconspicuousness caused by flat shape. Factors affecting the ability to perceive abnormalities on large two-dimensional CT data sets and three-dimensional endoluminal fly-through images require further study.[5]

## EFFECT OF READER FATIGUE

There is as yet little or no information about the effect of reader fatigue on the diagnostic efficacy of CTC interpretation. Anecdotally, radiologists report an upper limit on the number of CTC cases they can interpret per day, typically less than 10. Because interpretation of the CTC data is complex and requires manipulation of different types of images and sustained concentration, it is likely that fatigue is an issue. In addition, without addressing the lengthy interpretive process, it is unlikely that costs for CTC can be substantially reduced. It is therefore likely that CAD implementations that reduce fatigue will be beneficial for improving accuracy and reducing costs. Although some benefits of CAD in improving radiologist performance have been proved, it has not yet been shown that these benefits accrue because of a reduction in fatigue. However, fatigue and perceptual errors are closely intertwined. More research is needed in this area.

### *Performance of 1 Reader Versus 2 Readers (Single vs Double Reading) Without CAD*

Double reading of medical images has been shown to increase sensitivity in certain settings, for example in interpretation of mammograms.[6] There has been relatively little work on double reading of CTC. In a study using 3 readers, Johnson and colleagues[7] found that the per patient and per polyp sensitivities tended to be higher and the specificity lower with double reading than for some single readings. However, there was considerable variability in the sensitivities of the 3 readers for polyp detection. In part, a hope is that CAD will provide a similar benefit to that of double reading but without the additional cost of the second human interpreter.

## PRINCIPLES OF CAD

The purpose of CAD is to locate possible polyps automatically and annotate the images or present a list of image locations. The radiologist reviews the output of the CAD and makes the final diagnosis.

The main function of the CAD software is to identify sites with features characteristic of polyps.[8–12] Examples of useful features for CAD include surface shape and CT attenuation. Once these features are identified, the CAD software classifies sites of detection as potential polyps or false-positive diagnoses. A suitable CAD system has high sensitivity for detection of clinically significant polyps (those more than a size threshold, eg, 0.5 or 1.0 cm) and a low number of false-positive detections. All current CTC CAD systems produce on average at least 1 false-positive detection per CTC examination. Hence, review of the CAD marks by a trained reader is still required to prevent unnecessary referrals for colonoscopic polypectomy.

Once potential polyps are detected by CAD, they must be shown to the radiologist who makes the final diagnosis. There are several ways to do this. One way is to label sites directly on CTC images to show the radiologist where the potential polyps may be found.[13] These labels can be turned on or off so that they do not obscure the original images. To save time, the radiologist can jump directly to the labeled images. Labels can be applied to the two-dimensional cross-sectional and three-dimensional endoluminal images.