Computer-aided detection and diagnosis for chest imaging

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Policy contains: chest radiography; ClearRead; computer-aided detection; computer-aided diagnosis; computed tomography; lung cancer; RapidScreen; solitary pulmonary nodule.

This policy is a Sandhills Center Clinical Coverage Policy adopted from AmeriHealth Caritas of North Carolina. These clinical policies are used to assist with making coverage determinations. Sandhills Center's clinical policies are based on guidelines from established industry sources, such as the Centers for Medicare & Medicaid Services (CMS), state regulatory agencies, the American Medical Association (AMA), medical specialty professional societies, and peer-reviewed professional literature. These clinical policies along with other sources, such as plan benefits and state and federal laws and regulatory requirements, including any state- or plan-specific definition of "medically necessary," and the specific facts of the particular situation are considered by Sandhills Center when making coverage determinations. In the event of conflict between this clinical policy and plan benefits and/or state or federal laws and/or regulatory requirements, the plan benefits and/or state and federal laws and/or regulatory requirements shall control. Sandhills Center clinical policies are for informational purposes only and not intended as medical advice or to direct treatment. Physicians and other health care providers are solely responsible for the treatment decisions for their patients. Sandhills Center's clinical policies are reflective of evidence-based medicine at the time of review. As medical science evolves, Sandhills Center will update its clinical policies as necessary. Sandhills Center clinical policies are not guarantees of payment.

Coverage policy

Computer-aided detection or computer-aided diagnosis for chest imaging is investigational/not clinically proven and, therefore, not medically necessary.

Limitations

No limitations were identified during the writing of this policy.

Alternative covered services

- Unaided chest radiography.
- Unaided chest computed tomography.

Background

A solitary pulmonary nodule represents an early-stage T1 round or oval lesion in the lung parenchyma measuring less than 3 cm in diameter with discrete margins and no associated abnormality (Hansell, 2008). Most often, solitary pulmonary nodules are screen-detected or incidental findings on chest radiography (National Cancer Institute, 2021). They present a diagnostic challenge in the absence of a biopsy, as these lesions are often

benign and asymptomatic, and the differential diagnosis can be extensive. The objective of the workup is to differentiate malignancies requiring intervention from benign lesions that can be observed safely.

Low-dose computed tomography is the recommended screening modality for lung cancer, as it has sufficient sensitivity and specificity to detect early–stage disease in high-risk populations and could prevent a substantial number of lung cancer–related deaths (Krist, 2021). The harms associated with low-dose computed tomography are false-positive results leading to unnecessary tests and invasive procedures, incidental findings, short-term increases in distress due to indeterminate results, overdiagnosis, and radiation exposure (Jonas, 2021). Current nodule evaluation protocols on computed tomography (e.g., Lung CT Screening Reporting & Data System [Lung-RADS]) are designed to reduce false-positive results and associated invasive procedures (American College of Radiology, 2021).

Compared to computed tomography, chest radiography is widely available and less costly, and offers lower radiation exposure (Jonas, 2021). However, false positive findings are common, and it lacks sufficient resolution to detect the earliest, smallest stage lung cancers or provide reliable information on other nodule characteristics visible on computed tomography, which could confound malignancy assessment. Therefore, chest radiography is insufficiently sensitive to serve as an effective screening modality for reducing lung cancer mortality but can provide information on nodule size and location, presence of calcium in the nodule, and growth over time, which can inform the probability of malignancy.

A computer-aided detection system is dedicated computer software that detects potential abnormalities on diagnostic radiology exams (U.S. Food and Drug Administration, 2012). Through pattern recognition and data analysis, the system highlights suspicious areas of irregularity on a previously acquired and interpreted medical image for the radiologist to reassess, with the goal of improving reader performance in the intended use population. It acts as a “second reader” and may overcome the limitations of chest radiography and avoid the risks associated with computed tomography and biopsy by improving sensitivity and reducing the number of false positive findings.

The U.S. Food and Drug Administration (2001) has approved one medical imaging analyzer for detection of solitary pulmonary nodules measuring 9 mm to 30 mm in size — RapidScreen™ RS-2000 (Riverain Medical Group, Miamisburg, Ohio, also marketed under the trade name ClearRead Xray). The device is intended for use as an aid only after a physician has performed an initial interpretation of the radiograph. Regulatory approval for the RapidScreen RS-2000 was based on a pivotal study of male heavy smokers older than 45 years of age. Participants comprised 160 non-cancer cases and 80 T1 cancer cases with lesions measuring 9.5 mm to 27.5 mm in diameter. Fifteen community board-certified radiologists interpreted the chest radiographs with and without RS-2000 assistance. For cancers that had been missed by two screening radiologists, receiver-operating characteristic analysis showed a 10% increase in sensitivity, and computer-aided detection increased by 10% while the fraction of false positives increased slightly. Improvement in computer-aided detection was highest among the smaller lesions (9.5 mm to 15 mm diameter) than larger lesions.

Computer-aided diagnosis refers to software that both identifies suspicious regions and characterizes the lesion (e.g., benign versus malignant) (U.S. Food and Drug Administration, 2012). Computer-aided diagnosis systems assess disease in terms of the likelihood of malignancy or by disease type, severity, stage, or recommended intervention. These systems integrate nodule characteristics and most often use the area under the receiver operating characteristic curve measurement to distinguish the nodule.

The U.S. Food and Drug Administration (2021) has approved one computer-aided diagnosis system — the Optellum® Virtual Nodule Clinic (Optellum Ltd., United Kingdom) — for use in tracking, assessment, and characterization of incidentally detected pulmonary nodules on computed tomography. The Optellum system generates a Lung Cancer Prediction Convolutional Neural Network score to be used by a pulmonologist or

radiologist to assess each abnormality independently. It is indicated for patients who meet the following criteria, regardless of smoking history:

- Age 35 or older.
- Has between one and five incidentally detected solid and/or semisolid pulmonary nodules measuring 5 mm to 30 mm in diameter.
- Has no other history of cancer in the past five years.
- Has no thoracic implants that impact the nodule appearance.

Approval was based on the results of a multisite validation study comprising 300 patients with solid and semi-solid indeterminate pulmonary nodules on imaging collected retrospectively (U.S. Food and Drug Administration, 2021). There was a significant improvement in the discriminating ability of the 12 readers using aided interpretation compared to unaided interpretation (mean effect size = 6.85 area under the receiver operating characteristic curve points, 95% confidence interval 4.29 to 9.41, $P < .001$).

Findings

For computer-aided diagnosis for computed tomography, we included one systematic review (Amir, 2016) and appropriateness criteria from the American College of Radiology (2012). For computer-aided detection for chest radiography, we included one systematic review (Haber, 2020) and four observational studies (de Hoop, 2010; Li, 2008; Szucs-Farkas, 2010; White, 2009) examining detection performance.

The published literature consists primarily of technical feasibility studies lacking specific inclusion criteria and contain a high risk of bias, and it fails to establish an impact on care management or health outcomes. Results suggest computer-aided detection or computer-aided diagnosis may improve reader performance and could potentially reduce interpreter error rate, particularly among less experienced readers, but its contribution to the detection of smaller cancers less than one centimeter in diameter often missed on chest imaging or considered indeterminate is unclear.

Key limitations of the research are their retrospective nature and variable inclusion criteria that fail to define the population who would most likely benefit from the added sensitivity, such as an asymptomatic screening population versus a clinical population. The probability of malignancy before imaging varies substantially among these populations and will influence the post-imaging probability of malignancy and subsequent care management decisions.

The American College of Radiology (2012) mentions computer-aided detection [diagnosis] systems as having the potential to serve as a “second opinion” by improving radiologists’ diagnostic confidence in characterizing small benign nodules from malignant ones on high-resolution computed tomography. They do not mention its role in assisting chest radiography interpretation.

Amir (2016) evaluated the accuracy of computer-aided diagnosis of lung cancer from 14 low-to-moderate-quality studies, representing 1,868 computed tomography scans with overlapping study populations. Nine studies compared unaided and aided radiologists’ interpretation to pathology, and five studies compared a stand-alone assisted reading to pathology with no comparison to an unassisted reading. Eight of the nine comparison studies showed a significant accuracy improvement in the area under the receiver operating characteristic curve of 0.8 or higher ($P = .002$ to $.020$).

For computer-aided detection, a systematic review (Haber, 2020) of seven studies published since 2010 found the average sensitivity was 58.67% (range 44.2% to 71%) with a mean false positive rate of 2.22 (range 0.19 to 3.9) per image. For the early detection of pulmonary nodules on chest radiography, they failed to confirm a

correlation between sensitivity and false positive rate using computer-aided detection. Most studies were retrospective using data from different radiology and computer-aided detection systems, and inconclusive results required confirmation in larger, prospective analyses. Four retrospective studies published prior to 2010 presented mixed results with similar limitations (de Hoop, 2010; Li, 2008; Szucs-Farkas; 2010; White, 2009).

The research on computer-aided detection systems preceded annual screening recommendations with modern low-dose, helical computed tomography for populations at high risk of lung cancer (Krist, 2021). The harms associated with low-dose computed tomography are false-positive results leading to unnecessary tests and invasive procedures, incidental findings, short-term increases in distress due to indeterminate results, overdiagnosis, and radiation exposure (Jonas, 2021). The evidence examining computer-aided detection for chest radiography does not address these concerns in the context of current practices.

References

On June 7, 2021, we searched PubMed and the databases of the Cochrane Library, the U.K. National Health Services Centre for Reviews and Dissemination, the Agency for Healthcare Research and Quality, and the Centers for Medicare & Medicaid Services. Search terms were “computer assisted radiographic image interpretation (MeSH),” “image processing, computer assisted (MeSH),” “solitary pulmonary nodule (MeSH),” and "computer-aided detection.” We included the best available evidence according to established evidence hierarchies (typically systematic reviews, meta-analyses, and full economic analyses, where available) and professional guidelines based on such evidence and clinical expertise.

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Policy updates

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