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Review Article

Comparative Analysis of Barium Enema and Computed Tomography Colonography: Diagnostic Performance, Patient Experience, and Healthcare Implications - A Narrative Review

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Background: Large bowel lesions present a diagnostic challenge, with both benign polyps and colorectal cancer requiring accurate identification for effective treatment. Traditional diagnostic methods, notably barium enema (BE), have been hampered by limitations in sensitivity and patient comfort. This necessitates a critical evaluation of more advanced methods, such as computed tomography colonography (CTC), to improve diagnostic outcomes.

Objective: This review narrative aimed to (i) conduct a thorough comparative analysis of BE and CTC, specifically concentrating on their diagnostic efficacy, patient experiences, and versatility in diverse clinical settings and (ii) provide clinicians with in-depth insights and actionable recommendations, aimed at enhancing the strategies for imaging and diagnosing large bowel lesions, as well as aiding in the effective setup and planning of diagnostic services.

Methods: We conducted an exhaustive literature review across multiple databases including PubMed, MEDLINE, EMBASE, and the Cochrane Library. The selection criteria focused on studies that directly compared BE and CTC. We examined aspects such as diagnostic accuracy, patient experiences during the procedures, and their economic impact on healthcare systems.

Results: The findings indicate a marked superiority of CTC over BE in terms of diagnostic sensitivity and specificity, particularly in polyp detection. CTC is shown to be more patient-centric, offering enhanced comfort and suitability, especially for vulnerable groups like the elderly and patients with conditions like renal insufficiency. Furthermore, the integration of CTC with ongoing technological advancements and adherence to contemporary clinical guidelines highlights its pivotal role in current preventive healthcare strategies. The application of CTC presents substantial benefits for long-term patient safety and demonstrates cost-effectiveness, making it a preferential choice for adoption in the radiology departments of new healthcare institutions.

Conclusion: CTC stands out as a superior diagnostic tool for large bowel lesions, surpassing BE in effectiveness, patient comfort, and economic viability. It is in harmony with modern healthcare practices and is particularly advantageous in settings with ample resources. This review strongly supports a shift towards CTC in clinical settings, to enhance the quality of patient care and outcomes in the detection and management of colorectal lesions.

Keywords: *Colorectal Neoplasms, Diagnostic Imaging, Health Care Costs, Patient Satisfaction, Polyps, Preventive Health, Radiation Dosage.*

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INTRODUCTION

Large bowel lesions encompass diverse conditions, ranging from benign growths like polyps to malignant tumors such as colorectal cancer [1]. These lesions, critical to identify early for effective treatment, pose a significant challenge in diagnostic medicine [1]. The ability to accurately diagnose these lesions is pivotal for determining the appropriate course of treatment and ultimately impacts patient outcomes [1]. Given the complexities of the large intestine and the varying nature

of these lesions, the choice of diagnostic method plays a crucial role in healthcare delivery [1]. Diagnostic approaches for large bowel lesions have evolved significantly over the years [1, 2]. Traditionally, methods such as digital rectal exams, stool tests, and imaging techniques have been employed [1-3]. Among these, the barium enema (BE) has been a cornerstone diagnostic tool [4]. This method involves coating the lining of the colon and rectum with a barium-based contrast material, followed by X-ray imaging [4]. While it has provided valuable insights into the structure of the large bowel, its limitations are notable, particularly in terms of sensitivity and specificity [5].

Moreover, the procedure can be uncomfortable and is less suited for certain groups, like the elderly or those with particular health complications. The BE, despite its long-standing use, has several imperfections [6]. Its invasive nature often leads to discomfort and can pose risks, especially for vulnerable patient populations. The technique's sensitivity is also a concern, as it may miss smaller lesions or those with subtle presentations [6]. This limitation is particularly critical in early-stage disease where detection is most beneficial. Additionally, the procedure's interpretative nature can lead to variability in diagnostic outcomes, underscoring the need for more reliable and patient-friendly diagnostic options [6]. Computed tomography colonography (CTC), a newer diagnostic method, addresses many of the limitations of the BE [6, 7]. This non-invasive technique utilizes advanced computed tomography imaging to produce detailed images of the colon and rectum [6, 7]. It offers higher sensitivity, especially for small lesions, and is generally more comfortable for patients [6, 7]. The procedure is quicker, involves less physical preparation, and reduces the discomfort associated with traditional endoscopic methods [6, 7]. Its growing adoption in clinical practice reflects its potential as a superior diagnostic tool for large bowel lesions [7].

Based on the observed limitations in sensitivity and patient comfort associated with BE, alongside the emerging evidence supporting the efficacy of CTC, our review addressed several key gaps. These include a comprehensive evaluation of diagnostic accuracy between the two methods, an assessment of patient tolerability and safety, and an analysis of the applicability of these techniques across diverse patient populations. Thus, the aims of our narrative review were (i) to engage in a detailed comparative examination of BE and CTC, with a focus on assessing their diagnostic accuracy, patient experience, and adaptability across a range of clinical environments; and (ii) to furnish clinicians with comprehensive insights and practical guidance, designed to improve imaging and diagnostic approaches for large bowel lesions and to support the efficient establishment and planning of diagnostic services.

MATERIALS AND METHODS

The methodology for this narrative review involved a comprehensive and systematic search strategy, designed to capture a wide range of relevant literature on the diagnostic performance, patient experience, and clinical adaptability of BE and CTC in the diagnosis of large bowel lesions.

Search Strategy and Databases

We utilized multiple electronic databases, including PubMed, MEDLINE, EMBASE, and Cochrane Library. The search strategy combined various Boolean operators with key terms related to our research topic. Terms such as "barium enema," "CT colonography," "diagnostic accuracy," "patient experience," "radiation exposure," and "cost-effectiveness" were combined using operators like AND and OR to ensure a comprehensive retrieval of relevant literature.

Inclusion and Exclusion Criteria

Studies included in this review were those that provided direct comparisons between BE and CTC, focusing on aspects such as diagnostic efficacy, patient safety, and economic analysis. We excluded studies that did not make direct comparisons between these two methods or were not in line with our research objectives.

Data Extraction and Analysis

Relevant data were extracted from the identified studies, including study design, population characteristics, diagnostic outcomes, patient experiences, and economic analyses. This data was then synthesized to provide a comprehensive understanding of the current state of BE and CTC in diagnosing large bowel lesions.

Review Structure and Thematic Focus

Based on the collected data and its comprehensive analysis, the following key thematic areas were formulated to structure the narrative review:

i) Diagnostic Performance Comparison: A detailed examination of the diagnostic accuracy of BE and CTC, focusing on sensitivity, specificity, and polyp detection rates.

ii) Patient-Centric Evaluation: An assessment of patient experiences, including comfort, anxiety, and tolerability, with a special focus on the geriatric population.

iii) Technological and Clinical Adaptability: Analysis of the adaptability of both methods to technological advancements and evolving clinical guidelines.

iv) Radiation Exposure and Long-Term Safety: A comparative analysis of radiation doses and the implications for patient safety, especially in repeated screenings.

(v) Healthcare System and Economic Analysis: An exploration of the cost-effectiveness of both diagnostic methods and their economic implications for healthcare systems.

DIAGNOSTIC PERFORMANCE COMPARISON

This section aimed to dissect and evaluate the nuances of these two prevalent diagnostic tools, examining their efficacy in detecting bowel lesions, ranging from benign polyps to malignant tumors. We explored the specificity and sensitivity of each method, drawing upon recent advancements and empirical evidence to discern their respective capabilities.

A. In-depth analysis of the sensitivity and specificity of BE versus CTC

In assessing the efficacy of diagnostic techniques for large bowel lesions, the comparison of sensitivity and specificity between BE and CTC is vital [6]. These metrics, fundamental in medical diagnostics, provide critical understandings into the reliability of these methods in accurately detecting colorectal pathologies [6]. BE, a traditional radiological technique, has been integral in diagnosing large bowel conditions for decades [4]. However, its reliance on two-dimensional imaging and the physical properties of barium contrast often limits its sensitivity, particularly for smaller or flatter lesions [8]. While effective in identifying larger anomalies, BE's inability to consistently detect early-stage pathologies or subtle mucosal changes is a significant drawback [8]. This limitation is particularly concerning in the context of colorectal cancer screening, where early detection is crucial for successful treatment outcomes [9]. The introduction of CTC represented a significant technological advancement in colorectal diagnostics [6]. Employing sophisticated imaging techniques, CTC offers enhanced resolution and three-dimensional views of the colon, vastly improving lesion detectability [7]. This increased sensitivity is especially beneficial in identifying smaller polyps and early-stage cancers, pivotal in preventive oncology [7].

The detailed imaging of CTC facilitates a more thorough and accurate assessment of the colon, thus addressing one of the major limitations of BE [5]. However, sensitivity is only one side of the diagnostic accuracy equation. Specificity, the ability to correctly identify patients without the disease, is equally important [10]. CTC's superior imaging quality potentially reduces false-positive rates, a critical factor in preventing unnecessary follow-up procedures and the associated patient anxiety [11]. In comparison, BE's specificity, although generally high, can be compromised by its less detailed imaging, occasionally leading to ambiguous interpretations, especially in patients with existing benign colon conditions [12].

Clinical studies and trials provided empirical evidence supporting the superior sensitivity of CTC over BE [13]. Research consistently demonstrated CTC's higher detection rates for smaller polyps and early-stage cancers, underscoring its effectiveness as a diagnostic tool [13, 14]. Such data was invaluable in informing clinical guidelines and screening protocols, advocating for the use of CTC in routine colorectal cancer screening [13]. Comparative overview of studies evaluating diagnostic approaches in BE and CTC for colorectal lesions are provided in Table 1.

Table 1. Comparative Overview of Studies Evaluating Diagnostic Approaches in BE and CTC for Colorectal Lesions.

Study Reference	Year	Study Population	Comparison Focus	Key Findings	Clinical Implications
Saraiva et al. [1]	2022	Colorectal malignant polyps patients	BE vs. CTC	Discusses advanced imaging techniques and therapeutic modalities for T1 colorectal cancer.	Emphasizes importance of diagnostic accuracy in treatment planning.
Kawasaki et al. [4]	2021	Colorectal cancer patients	BE vs. CTC	Compares the effectiveness in colorectal cancer management and lesion detection.	Highlights evolving role of imaging in colorectal cancer diagnosis.
Halligan et al. [5]	2007	Older symptomatic patients	BE vs. CTC	Evaluates CTC against colonoscopy or BE for diagnosing colonic cancer.	Suggests CTC as a less invasive alternative in certain patient groups.
Johnson et al. [14]	2004	Screen-detected colorectal polyps	BE vs. CTC	Focuses on the relative sensitivity in polyp detection.	Underscores CTC's role in early detection of colorectal pathologies.
Sosna et al. [15]	2008	Screening for colorectal polyps	BE vs. CTC	Shows lower sensitivity and specificity of BE compared to CTC for detecting polyps ≥ 6 mm.	Indicates CTC as a more effective screening tool for smaller polyps, crucial in early cancer detection.
Chung et al. [16]	2012	Patients with renal insufficiency	BE vs. CTC	Finds higher diagnostic yield and positive predictive value for CTC in detecting colorectal neoplasia.	Suggests CTC as a preferable option for patients with renal insufficiency due to higher diagnostic accuracy.

BE: Barium Enema, CTC: Computed Tomography Colonography.

The implications of these findings for clinical decision-making are profound. The choice between BE and CTC can significantly impact patient care, particularly in the screening and early detection of colorectal cancer. The enhanced sensitivity and specificity of CTC make it a more reliable and effective option, influencing clinicians' choice of diagnostic method [14]. Indeed, the comparison of BE and CTC in terms of sensitivity and specificity reveals a clear preference for CTC in modern clinical practice [14]. Its advanced imaging capabilities provide more accurate and reliable results, essential in the early detection and effective management of colorectal pathologies.

B. Polyp detection rates and implications for early cancer screening.

In colorectal cancer prevention, the detection of polyps is a critical factor, with polyp detection rates being a key measure of a diagnostic tool's efficacy [1, 2]. CTC's advanced imaging technology, particularly its ability to provide high-resolution, three-dimensional views, significantly enhances its capacity to detect polyps, even those that are small in size [7]. This is crucial in colorectal cancer screening, where the early identification and removal of polyps can prevent progression to malignancy [15]. Studies have consistently shown that CTC is more effective than BE in detecting smaller polyps, attributing to its superior imaging capabilities [4-6]. This increased detection rate is a vital component in early intervention strategies, potentially reducing the incidence and mortality of colorectal cancer [15]. CTC's ability to detect extracolonic findings, which might be missed by BE, further underscores its comprehensive nature in cancer screening [16].

One notable study by Halligan et al. [13]focused on symptomatic patients suggestive of colorectal cancer. This multicenter randomized trial revealed that CTC had a higher detection rate for colorectal cancer or large polyps (≥10 mm) compared to BE, with detection rates being 7.3% for CTC vs. 5.6% for BE [13]. The significance of this finding lies in CTC's ability to better identify large polyps, which are crucial for early intervention and cancer prevention. Furthermore, Sosna et al. [15]conducted a comprehensive analysis encompassing multiple studies. This meta-analysis compared the sensitivity of BE and CTC for detecting colorectal polyps of various sizes [15]. For polyps larger than 10 mm, CTC exhibited a per-patient sensitivity of 0.823, significantly higher than BE's sensitivity of 0.702 [15]. The specificity for CTC was also higher, which is indicative of its greater accuracy in correctly identifying patients without the disease.

Conversely, BE, with its reliance on two-dimensional imaging, has limitations in detecting smaller polyps. While it remains effective in identifying larger lesions, its reduced sensitivity in detecting smaller polyps can lead to missed opportunities for early intervention [4].

The implications of these differences in polyp detection rates are profound for clinical practice, especially in preventive oncology. The superior polyp detection rate of CTC supports its role as a more effective tool in colorectal cancer screening programs [17]. It

underscores the need for a strategic approach in choosing the appropriate diagnostic method based on the patient's risk profile and the specific goals of the screening.

PATIENT-CENTRIC EVALUATION

In transitioning to a patient-centric evaluation, it's essential to recognize the significance of patient experience in the diagnostic procedures for large bowel lesions [5, 13, 18].

This section shifts the focus from the technical aspects of BE and CTC to the human element, exploring how these procedures are perceived and tolerated by patients. It's crucial to understand that the success of a diagnostic method is not solely measured by its technical accuracy, but also by its acceptability and comfort from a patient's perspective [18].

A. Detailed assessment of patient comfort, anxiety, and overall tolerability for both procedures.

In the diagnostic methodologies for large bowel lesions, the patient-centric evaluation of BE and CTC is as crucial as their technical efficacies. Indeed, patient comfort during diagnostic procedures is not merely a matter of convenience but a significant determinant of the procedure's success. BE, known for its invasiveness, often requires patients to undergo a more physically demanding process, which includes the insertion of a tube and retention of barium contrast [4, 19]. This can lead to discomfort, particularly in patients with pre-existing conditions or the elderly [19]. In contrast, CTC with its non-invasive nature, typically offers a more patient-friendly experience [20]. The absence of invasive tube insertion and the relatively short duration of the procedure contribute significantly to enhancing patient comfort [18]. The aspect of procedural anxiety cannot be overstated [21]. Medical procedures, especially those perceived as invasive, can induce significant stress and anxiety in patients [21]. BE, with its more hands-on approach, might elevate anxiety levels, impacting the overall patient experience and possibly affecting the diagnostic outcomes. CTC, in this regard, presents an advantage [21]. Its non-invasive nature, coupled with advanced imaging technology, tends to be less intimidating, thereby reducing patient anxiety and making the experience more manageable. The "overall tolerability" of a procedure, therefore, is a measure that combines these aspects of physical comfort and psychological well-being [22]. In the context of diagnostic procedures for large bowel lesions, it is crucial to consider both of these factors. A procedure that is physically less demanding but causes significant anxiety may not be well tolerated, just as a procedure that is physically demanding but causes minimal psychological stress may also have poor tolerability [22].

B. Focus on the geriatric population, including a discussion on procedural risks and compliance issues.

The traditional use of BE has long been standard in diagnosing colorectal conditions. However, its invasiveness and physical demands, such as requiring various positional changes and being time-consuming, pose significant challenges, particularly for elderly patients [19]. This demographic, often fragile or with limited mobility, may experience discomfort and stress during the procedure, raising concerns about its suitability and safety [19]. Additionally, the risk of complications like bowel perforation, though rare, is a critical consideration in this vulnerable group [23]. In contrast, CTC offers a less invasive alternative, with significant advantages in patient comfort and reduced physical burden. Its non-invasive nature is particularly beneficial for elderly patients, for whom the preparation and procedure of BE can be taxing [24]. This comfort is crucial in ensuring patient compliance, a key factor in the successful implementation of any diagnostic tool. The reduced physical requirements and quicker procedure time of CTC make it a more suitable and tolerable option for the elderly [24].

The accuracy of these diagnostic methods in geriatric patients is also a crucial factor. Age-related changes in the colon, such as the increased presence of diverticulosis, can impact the effectiveness of these techniques [25]. CTC, with its advanced imaging capabilities, offers a more comprehensive view of the colon, allowing for a more accurate diagnosis [25].

Moreover, the impact of these diagnostic choices on healthcare systems cannot be overlooked. With an aging population, healthcare systems must adapt to meet the needs of older adults. Considering the specific needs and limitations of the geriatric population, it is important to select diagnostic methods that are not only effective but also align with evolving paradigms in geriatric

healthcare and are mindful of the patient's overall well-being

C. Consideration of patient experiences in diverse populations, including those with specific medical conditions like renal insufficiency.

The inclusion of diverse patient populations, particularly those with specific medical conditions like renal insufficiency, is crucial for a holistic evaluation of diagnostic methods.

Patients with renal insufficiency present a unique challenge in the administration of diagnostic procedures. BE, which traditionally involves the use of barium sulfate as a contrast agent, can be particularly problematic for these patients [26]. The risk of exacerbating renal conditions or triggering adverse reactions necessitates a cautious approach [26]. The physical demands of the BE procedure, coupled with the potential renal complications, often render it less suitable for patients with renal insufficiency [26]. On the other hand, CTC offers several advantages in this context. Its non-invasive nature and the absence of nephrotoxic contrast agents significantly reduce the risk to renal function. Additionally, the procedure is less physically demanding, making it more suitable for patients who may be managing multiple health issues [20, 22]. This compatibility is especially relevant as it ensures the diagnostic process does not further compromise the patient's health.

The choice of diagnostic method extends beyond individual procedure risks. It involves a comprehensive understanding of each patient's medical history and current health status.

For patients with renal insufficiency, this might mean considering factors like the stage of renal failure, the presence of other comorbidities, and the overall impact of the procedure on their health. The evolution of diagnostic technology also plays a crucial role in catering to diverse patient needs. Advances in CTC, such as lower radiation exposure and enhanced imaging techniques, are significant in making this method more accessible and adaptable to a wider range of patient conditions, including those with renal concerns.

TECHNOLOGICAL AND CLINICAL ADAPTABILITY

The technological progression in diagnostic imaging has had a differential impact on BE and CTC. BE, once a cornerstone in colorectal diagnostics, has seen limited technological evolution [4]. Its principle, grounded in two-dimensional imaging and contrast material, has undergone refinements but not transformative changes [4]. This static nature in a rapidly advancing field poses challenges in its adaptability to new clinical practices and guidelines, which increasingly favor less invasive and more accurate diagnostic methods.

CTC, conversely, stands as a beneficiary of technological advancement in medical imaging. The advent of high-resolution CT scanners and sophisticated software algorithms has substantially elevated its diagnostic accuracy [27, 28]. The adaptability of these diagnostic methods is also reflected in their practicality across various healthcare settings.

BE, with its requirement for specialized radiological equipment and expertise in radiographic interpretation, can be resource intensive [29]. It demands significant time allocation per procedure and can strain workflow efficiency, particularly in high-volume healthcare settings.

CTC, in contrast, demonstrates greater versatility and integration into diverse medical environments. Its procedure is relatively quicker, and the digital nature of its imaging allows for easier storage and transfer of medical data, fitting seamlessly into the digital infrastructure of modern healthcare systems. The efficiency of CTC, both in terms of procedural time and workflow integration, represents a significant advantage in resource allocation and operational workflow in healthcare facilities [27, 28]. Moreover, the high sensitivity of CTC helps to detect and manage diseases at their earliest stages, ultimately reducing the burden of illness and healthcare costs [30].

Additionally, the streamlined nature of CTC translates into a more patient-friendly experience. Unlike BE, which often requires extensive preparation and can cause discomfort, CTC is less invasive and generally more tolerable for patients. This aspect is crucial in improving patient compliance and satisfaction, as discussed in studies like those of Halligan et al. [13]. The reduced invasiveness of CTC not only enhances patient comfort

but also lowers the risk of procedure-related complications, further safeguarding patient safety.

The adaptability of CTC extends to its application in various patient demographics, including those with specific health concerns like renal insufficiency, as highlighted by Chung et al. [16]. Unlike BE, which can pose risks in certain patient groups, CTC's versatility makes it a suitable option across a broader patient base. This inclusive diagnostic capability is essential in delivering equitable healthcare services.

Furthermore, the digital abilities of CTC allow for the application of advanced analytical tools, such as artificial intelligence (AI) and machine learning algorithms, for enhanced image analysis and interpretation. As per Liang et al. [28], the integration of AI in CTC could lead to more accurate diagnosis, reduced human error, and the potential for automated polyp detection. This technological synergy not only streamlines diagnostic processes but also opens avenues for research and development in diagnostic radiology.

RADIATION EXPOSURE AND LONG-TERM SAFETY

In a comprehensive exploration of radiation exposure and long-term safety in BE and CTC, we investigated the comparative radiation doses associated with each technique and their implications for patient safety, particularly in the context of repeated screenings.

Radiation exposure in diagnostic imaging is a critical concern, especially in procedures frequently used in colorectal cancer screening [31]. BE, historically, has been associated with lower radiation exposure compared to CTC [31, 32]. However, advancements in imaging technology have been focused on minimizing this exposure [33]. For BE, the exposure is a result of X-ray imaging, which has seen improvements but remains fundamentally unchanged in its basic technique [4]. CTC, as a CT-based procedure, inherently involves higher radiation levels due to the nature of computed tomography [34]. However, the actual exposure depends on various factors, including the equipment, scanning protocol, and dose-reduction strategies. Recent technological advancements in CT, like iterative reconstruction techniques and low-dose CT protocols, have significantly reduced radiation exposure, maintaining image quality [35].

A critical aspect of these diagnostic methods is the cumulative radiation dose in repeated screenings [31]. Regular diagnostic tests over several years, as in colorectal cancer screening programs, make cumulative radiation a key factor in choosing the diagnostic modality. Individual CTC procedures involve higher radiation doses than a single BE procedure, but the overall risk-benefit ratio needs evaluation in the context of diagnostic efficacy and early cancer detection.

The long-term safety implications of radiation exposure also need careful consideration. The risk of radiation-induced malignancies must be weighed against the benefits of early and accurate disease detection, particularly in populations at increased risk of colorectal cancer where screening frequency is higher.

In summary, the assessment of radiation exposure and long-term safety in BE and CTC demands a nuanced understanding of radiological physics, patient safety, and clinical needs. Balancing immediate diagnostic benefits with potential long-term risks associated with radiation exposure ensures optimal patient care and safety in colorectal cancer screening and diagnostics. This careful balancing act highlights the need for continued advancements in diagnostic imaging that prioritize patient safety without compromising diagnostic accuracy.

HEALTHCARE SYSTEM AND ECONOMIC ANALYSIS

In terms of healthcare economics, the analysis of BE and CTC extends beyond their medical efficacy to encompass their cost-effectiveness, insurance coverage, and overall economic impact on healthcare systems.

The cost analysis of these diagnostic methods is complex. BE, while initially seeming more economical due to its lower technology requirements [36], may lead to increased costs in the long term due to its lower diagnostic accuracy.

CTC, despite its higher initial costs, can offer better value over time due to its higher accuracy, which may decrease the need for subsequent treatments or diagnostic tests [30].

The cost-effectiveness of these methods is further influenced by their diagnostic accuracy. CTC's ability to detect colorectal conditions early and accurately can lead to significant cost savings by reducing the need for more

extensive treatments typically required for advanced stages of diseases [30, 37].

In considering long-term healthcare costs, early and accurate diagnoses through CTC can significantly reduce expenditures associated with the treatment of advanced colorectal diseases, which are often more costly and complex [30].

Insurance coverage plays a crucial role in determining the accessibility and widespread adoption of these diagnostic methods [30, 37]. The extent to which CTC is covered by insurance policies, especially in colorectal cancer screening programs, directly influences its utilization. In diverse healthcare settings, the choice between BE and CTC might vary.

In resource-limited settings, the lower initial cost of BE might make it a more feasible option. However, in settings with more resources, the long-term economic and health benefits of CTC are likely to outweigh its higher initial cost. The broader economic impact on healthcare systems includes factors like patient throughput, workflow efficiency, and human resource allocation. The efficiency of CTC and its integration into digital health systems can offer significant advantages in these areas.

In financially affluent regions, where cost constraints are less restrictive, the adoption of CTC can be particularly advantageous. The preference for CTC in these regions is aligned with a healthcare approach that prioritizes the most advanced and effective diagnostic options available, reflecting a commitment to providing high-quality healthcare.

CONCLUSION

Our narrative review provides clear insights into the relative merits of BE and CTC, underlining the importance of diagnostic accuracy, patient experience, and adaptability in clinical settings.

Clinicians are encouraged to consider CTC as a superior diagnostic tool for large bowel lesions, especially in terms of sensitivity, specificity, and patient comfort.

Its adoption is particularly advantageous in settings where early detection of colorectal cancer is paramount and in patient populations that require a less invasive approach, such as the elderly or those with specific medical conditions like renal insufficiency.

For healthcare systems or new institutions, particularly in financially affluent regions, investing in CTC aligns with a trend towards more advanced, patient-centric healthcare delivery. This investment is justified by CTC's cost-effectiveness in the long term, despite higher initial costs, due to its higher diagnostic accuracy and potential for reducing long-term healthcare expenditures. Ultimately, this review advocates for a shift towards CTC in clinical practice, aligning with evolving medical standards and patient expectations. It calls for continued research and technological advancement in diagnostic imaging to enhance patient care and outcomes in colorectal health.

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

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COMPETING INTERESTS

The authors declare that there are no conflicts of interest regarding the publication of this narrative review. The objective of this study was to present a balanced, nuanced analysis of the available evidence comparing BE and CTC. Efforts were made to critically evaluate and present facts objectively, without bias towards any diagnostic method. The intention of this review is solely to inform and guide clinical practice based on current research and is not intended to promote CTC as a product or service.

AUTHORS' CONTRIBUTIONS

Both authors of this manuscript collectively contributed to all aspects of its development. Their joint efforts included conducting a thorough literature review, analyzing the collected data, and composing all sections of the document. Furthermore, both authors shared the responsibility for granting final approval of the manuscript version destined for publication.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available upon request from the corresponding author.

DECLARATION

The authors wish to clarify that AI chatbots were not utilized at any stage of the manuscript's preparation [38, 39]. This includes, but is not limited to, the generation of content, editing, or enhancing the scientific quality and writing of the paper [38, 39].

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