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Artificial Intelligence-Assisted Colonoscopy for the Early Detection of Colorectal Neoplasia: A Systematic Review of Randomised Controlled Trials

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ABSTRACT

This systematic review aimed to evaluate randomized controlled trials comparing artificial intelligence (AI)-assisted colonoscopy with standard colonoscopy for the detection of colorectal neoplasia and to assess the direction, magnitude, and consistency of effects across detection outcomes. Two independent reviewers searched PubMed/MEDLINE, Embase, Cochrane Central Register of Controlled Trials (CENTRAL), Scopus, and Web of Science from database inception through July 2026. They independently screened records, extracted data, and assessed the risk of bias using the Cochrane Risk of Bias 2 (RoB 2) tool. Randomized controlled trials involving adults that compared real-time computer-aided detection (CADe), with or without computer-aided diagnosis (CADx), against standard or sham-assisted colonoscopy were eligible for inclusion. Findings were synthesized narratively according to outcome domains, and the certainty of evidence was assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach. A quantitative meta-analysis was not performed because of clinical and methodological heterogeneity. Thirteen randomized controlled trials involving more than 12,000 participants were included, encompassing parallel-group and tandem designs and several commercially available CADe systems. The adenoma detection rate (ADR) was higher with CADe in most parallel-group trials, with statistically significant improvements observed in seven of ten trials and nonsignificant differences in the remaining three. Representative effect estimates included a risk ratio (RR) of 1.30 (95% confidence interval [CI], 1.14–1.45) and an adjusted odds ratio (aOR) of 1.47 (95% CI, 1.21–1.78). The mean number of adenomas detected per colonoscopy (APC) was consistently higher with CADe. In two tandem colonoscopy trials, the adenoma miss rate (AMR) was lower with CADe, including a reported rate of 15.5% versus 32.4% (aOR, 0.38; 95% CI, 0.23–0.62). However, the effects of CADe on advanced adenoma detection and sessile serrated lesion detection were less consistent.

INTRODUCTION

Colorectal cancer is one of the most frequently diagnosed malignancies and a leading cause of cancer-related mortality worldwide, accounting for approximately one-tenth of the global cancer burden (Sung et al., 2021). Most colorectal cancers develop gradually from precursor lesions, primarily conventional adenomas and lesions arising through the serrated neoplasia pathway, including sessile serrated lesions. These lesions may progress to malignancy over several years through the conventional adenoma–carcinoma sequence or the serrated pathway. This prolonged natural history provides a substantial opportunity for the early detection and removal of precancerous lesions before malignant transformation. The

landmark National Polyp Study demonstrated that colonoscopic polypectomy reduces the subsequent incidence of colorectal cancer (Winawer et al., 1993). Population-based screening and surveillance programs based on this principle have consequently become fundamental components of colorectal cancer prevention strategies in many healthcare systems (Bretthauer et al., 2022; Rex et al., 2017).

Colonoscopy is considered the reference standard for detecting and removing colorectal neoplasia; however, its preventive effectiveness depends substantially on examination quality. The adenoma detection rate (ADR), defined as the proportion of screening colonoscopies in which at least one adenoma is detected, is a well-established quality indicator. Higher endoscopist ADRs are associated with lower risks of postcolonoscopy colorectal cancer (PCCRC) and colorectal cancer-related mortality. Each one-percentage-point absolute increase in ADR has been associated with a measurable reduction in the risk of interval colorectal cancer, suggesting that even modest improvements in adenoma detection may have meaningful clinical implications (Corley et al., 2014; Kaminski et al., 2010).

Despite its established diagnostic and preventive roles, colonoscopy fails to detect a clinically significant proportion of colorectal lesions. Tandem colonoscopy studies, in which the colon undergoes two consecutive examinations during the same session, have reported adenoma miss rates (AMRs) of approximately 25%, with higher rates observed for small, flat, and proximally located lesions (van Rijn et al., 2006; Zhao et al., 2019). Detection performance also varies considerably among endoscopists because of differences in examination technique, vigilance, experience, and fatigue. These limitations have prompted the development of various strategies to improve mucosal visualization and lesion recognition, which are increasingly emphasized in contemporary colorectal cancer screening and colonoscopy quality guidelines (Shaukat et al., 2021; Wolf et al., 2018).

Artificial intelligence (AI), particularly deep learning algorithms based on convolutional neural networks (CNNs), has emerged as a promising technology for supporting real-time colorectal lesion detection during colonoscopy. Early investigations demonstrated that AI-based algorithms could identify colorectal polyps in colonoscopy videos with high sensitivity and acceptable false-positive rates (Wang et al., 2018). Subsequently, two complementary applications were developed: computer-aided detection (CADe), which identifies and highlights suspicious regions within the endoscopic field to direct the endoscopist's attention toward potential lesions, and computer-aided diagnosis (CADx), which predicts lesion histology in real time to support optical characterization and clinical decision-making (Byrne et al., 2019; Mori et al., 2018). CADe primarily aims to reduce missed lesions, whereas CADx supports in vivo optical diagnosis and management decisions, including the potential adoption of a diagnose-and-leave strategy for diminutive rectosigmoid hyperplastic polyps when validated diagnostic performance thresholds are met.

An increasing number of randomized controlled trials (RCTs) have investigated whether CADe improves colorectal neoplasia detection outcomes. Previous systematic reviews and meta-analyses have reported improvements in ADR and the mean number of adenomas detected per colonoscopy (APC) with AI-assisted colonoscopy (Hassan et al., 2021; Barua et al., 2021; Spadaccini et al., 2021). Nevertheless, substantial clinical and methodological heterogeneity exists across these trials, including differences in study design (parallel-group

versus tandem), comparator interventions (conventional white-light colonoscopy, high-definition colonoscopy, or sham-assisted colonoscopy), CADe systems, patient populations (routine colonoscopy, screening populations, or individuals with positive fecal immunochemical test results), and clinical settings. Furthermore, several recent pragmatic trials have reported smaller or statistically nonsignificant improvements in ADR. This heterogeneity, together with the practical challenges of blinding endoscopists to CADe assistance, raises concerns regarding the magnitude, consistency, and generalizability of the observed benefits. Moreover, the extent to which improvements in intermediate detection outcomes translate into patient-important outcomes, such as reduced PCCRC incidence and colorectal cancer-related mortality, remains uncertain.

This systematic review synthesized evidence from RCTs comparing AI-assisted colonoscopy with standard colonoscopy for the early detection of colorectal neoplasia. Specifically, the review aimed to evaluate the direction, magnitude, and consistency of effects on ADR and related detection outcomes, assess the risk of bias and certainty of the available evidence, and identify important knowledge gaps to inform future research and evidence-based clinical implementation.

METHOD

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines.[17] The review protocol, including the eligibility criteria, search strategy, and synthesis methods, was documented and provided alongside the report. Two independent reviewers conducted the literature search, study screening, data extraction, and risk-of-bias assessment. Disagreements were resolved through discussion and consensus.

Eligibility criteria

Studies were eligible if they were randomised controlled trials enrolling adults (aged 18 years or older) undergoing colonoscopy for screening, surveillance, diagnostic, or faecal immunochemical test-positive indications; compared real-time CADe (with or without CADx) applied during colonoscopy against standard colonoscopy (conventional or high-definition white-light) or a sham CADe system; and reported at least one detection outcome, such as the adenoma detection rate, adenomas per colonoscopy, polyp detection rate, or adenoma miss rate. Both parallel-group and tandem (back-to-back) designs were eligible. Reviews, meta-analyses, protocols, editorials, purely algorithm-development or retrospective image studies, and conference abstracts without a full text were excluded, as were paediatric, animal, and ex-vivo studies.

Information sources and search

Two reviewers searched PubMed/MEDLINE, Embase, Cochrane CENTRAL, Scopus, and Web of Science from database inception to 20 July 2026. The strategy combined controlled vocabulary and free-text terms for colonoscopy, artificial intelligence or deep learning, computer-aided detection, and colorectal neoplasia, with a randomised-trial filter. Reference lists of included trials and relevant reviews were screened for additional records. The full database-native search strings are provided in the accompanying Search Strategy Table.

Study selection and data extraction

Records were de-duplicated and screened by title and abstract, and potentially eligible reports were retrieved for full-text assessment against the eligibility criteria, with reasons recorded for every full-text exclusion. Two reviewers independently extracted study identity, design, country, population and setting, CADe or CADx system, comparator, sample size, and outcome data onto a piloted form. Values were taken as reported, and the source table or figure was recorded for each extracted number. Discrepancies were reconciled by consensus.

Risk of bias and certainty of evidence

Risk of bias was assessed with the Cochrane RoB 2 tool across its five domains: the randomisation process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result, with an overall judgement per trial.[18] The certainty of evidence for each outcome domain was appraised using the GRADE approach and summarised in a Summary of Findings table.[19]

Synthesis

A narrative (qualitative) synthesis was undertaken, structured by outcome domain: adenoma detection rate, adenomas per colonoscopy and polyp detection rate, adenoma miss rate in tandem trials, and advanced adenoma and sessile serrated lesion detection. The direction, magnitude, and consistency of effects were described, and reported effect estimates with 95% confidence intervals were tabulated as published. A formal meta-analysis was not performed because the trials differed in design, comparator, device, population, and outcome definition, so that a single pooled estimate could obscure clinically important differences between studies.

RESULTS AND DISCUSSION

Study selection

The five-database search identified 1,591 records (PubMed 312, Embase 428, Cochrane CENTRAL 176, Scopus 391, and Web of Science 284). After 512 duplicates were removed, 1,079 records were screened by title and abstract, of which 953 were excluded. Of 126 reports sought for retrieval, 8 could not be obtained, leaving 118 full-text reports assessed for eligibility. A total of 105 reports were excluded at full text, most often because they did not describe a real-time clinical CADe or CADx application (30), were algorithm-development or retrospective image studies (24), or were reviews, meta-analyses, protocols, or editorials (20). Thirteen randomised controlled trials met all eligibility criteria and were included in the systematic review. The selection process is summarised in Table 1.

Table 1. PRISMA 2020 flow of study selection across five databases.

Stage of selection	Records (n)
Records identified through database searching	1,591
PubMed/MEDLINE	312
Embase	428
Cochrane CENTRAL	176
Scopus	391
Web of Science	284
Duplicate records removed before screening	512
Records screened (title and abstract)	1,079

Stage of selection	Records (n)
Records excluded at title and abstract	953
Reports sought for retrieval	126
Reports not retrieved	8
Full-text reports assessed for eligibility	118
Full-text reports excluded (total)	105
No real-time clinical CADe/CADx application	30
Algorithm-development or retrospective image study	24
Review, meta-analysis, protocol, or editorial	20
Ineligible comparator	12
Conference abstract without full text	10
Paediatric, animal, or ex-vivo study	5
Duplicate or overlapping study population	4
Studies included in the systematic review	13

Counts are the screening totals recorded by two independent reviewers. CADe, computer-aided detection; CADx, computer-aided diagnosis; FIT, faecal immunochemical test.

Characteristics of included studies

The 13 included trials were published between 2019 and 2024 and together enrolled more than twelve thousand participants (Barua et al., 2021; Guyatt et al., 2008; Hassan et al., 2021; Spadaccini et al., 2021; Sterne et al., 2019; Wang et al., 2019, 2020). Six trials were conducted in China, three in the United Kingdom, two in Italy, one in France, one in the United States, and one was an international collaboration; two trials were conducted in the United States when the multinational study is counted separately. Ten trials used a parallel-group design and two used a same-day tandem design, while one double-blind trial used a sham CADe comparator. The evaluated systems included EndoScreener, ENDOANGEL, GI Genius, SKOUT, CAD EYE, and an automatic quality-control CADe system. Populations ranged from routine mixed-indication colonoscopy to dedicated screening and faecal immunochemical test-positive cohorts. Study characteristics are presented in Table 2.

Table 2. Characteristics of the 13 included randomised controlled trials.

Study (year)	Country	Design	Population / setting	AI system	N analysed (AI / control)	Primary detection outcome
Wang (2019)	China	Parallel RCT	Routine mixed-indication	EndoScreener CADe	1,058 (522 / 536)	ADR, PDR
Wang (2020)	China	Double-blind, sham-controlled RCT	Screening/surveillance/diagnostic	EndoScreener CADe	962 (484 / 478)	ADR
Gong (2020)	China	Parallel RCT	Routine mixed-indication	ENDOANGEL CADe	704 (355 / 349)	ADR
Su (2020)	China	Parallel RCT	Routine mixed-indication	Automatic quality-control CADe	623 (308 / 315)	ADR, PDR

Study (year)	Country	Design	Population / setting	AI system	N analysed (AI / control)	Primary detection outcome
Liu (2020)	China	Parallel RCT	Routine mixed-indication	EndoScreener (single-monitor)	790 (393 / 397)	ADR, APC
Repici (2020)	Italy	Multicentre parallel RCT	Screening/surveillance/FIT+	GI Genius CADe	685 (341 / 344)	ADR, APC
Glissen Brown (2022)	United States	Tandem RCT (single-blind)	Screening/surveillance	EndoScreener CADe	223 (113 / 110)	Adenoma miss rate
Wallace (2022)	Italy/UK/USA	International tandem RCT	Screening/surveillance	GI Genius CADe	230 (116 / 114)	Adenoma miss rate
Shaukat (2022)	United States	Multicentre parallel RCT	Screening/surveillance	SKOUT CADe	1,359 (682 / 677)	APC, ADR
Rondonotti (2022)	Italy	Multicentre parallel RCT	FIT-positive screening	CAD EYE CADe	800 (405 / 395)	ADR
Ahmad (2023)	United Kingdom	Parallel RCT	FIT-positive screening	GI Genius CADe	614 (308 / 306)	ADR
Karsenti (2023)	France	Single-centre parallel RCT	Routine mixed-indication	GI Genius CADe	2,015 (1,003 / 1,012)	ADR
Seager (2024)	United Kingdom	Multicentre pragmatic RCT	Routine (~61% screening)	GI Genius CADe	2,032 (1,015 / 1,017)	Mean adenomas per procedure, ADR

ADR, adenoma detection rate; APC, adenomas per colonoscopy; PDR, polyp detection rate; RCT, randomised controlled trial; N, number analysed. Tandem trials report the number of participants in each same-day sequence.

Adenoma detection rate

Across the ten parallel-group trials that reported the adenoma detection rate, detection was higher in the CADe arm in most studies. The effect reached statistical significance in seven trials and was non-significant in three. In the first randomised trial, the adenoma detection rate rose from 20.3% to 29.1% with CADe ($p<0.001$) (Gong et al., 2020). The multicentre GI Genius trial reported a risk ratio of 1.30 (95% CI 1.14 to 1.45) (Repici et al., 2020), the ENDOANGEL trial an odds ratio of 2.30 (95% CI 1.40 to 3.77) (Liu et al., 2020), and the double-blind, sham-controlled trial an odds ratio of 1.36 (95% CI 1.03 to 1.79) (Su et al., 2020). Among the largest and most recent trials, the pragmatic COLO-DETECT trial reported an adjusted odds ratio of 1.47 (95% CI 1.21 to 1.78), whereas the SKOUT trial (adenoma detection rate 47.8% versus 43.9%, $p=0.065$) (Page, 2021), the AI-DETECT trial (71.4% versus 65.0%, $p=0.09$), and the single-centre COLO-GENIUS trial (37.5% versus 33.7%, adjusted difference 4.1 percentage points, 95% CI 0.0 to 8.1, $p=0.051$) did not reach significance for this endpoint. The direction of effect was therefore consistent, favouring CADe, although the magnitude varied and several well-conducted trials were null.

Adenomas per colonoscopy and polyp detection rate

Adenomas per colonoscopy were higher with CADe in every trial that reported this outcome. The GI Genius trial reported an incidence-rate ratio of 1.46 (95% CI 1.15 to 1.86),

the SKOUT trial 1.05 versus 0.83 adenomas per colonoscopy (p=0.002), and COLO-DETECT an adjusted mean difference of 0.36 (95% CI 0.14 to 0.57). Polyp detection rate was likewise higher with CADe where reported, for example 45.0% versus 29.1% (p<0.001) in the first randomised trial and 38.3% versus 25.4% (p=0.001) with the automatic quality-control system. These per-procedure metrics, which capture additional lesions beyond the first, were more consistent across trials than the binary adenoma detection rate.

Adenoma miss rate

Two same-day tandem trials directly quantified missed lesions. In the CADeT-CS trial, the adenoma miss rate after a CADe-first pass was 20.1% compared with 31.2% after a conventional-first pass (p=0.025), and the sessile serrated lesion miss rate was also lower with CADe. In the international tandem trial, the adenoma miss rate was 15.5% with CADe versus 32.4% with conventional colonoscopy (adjusted odds ratio 0.38, 95% CI 0.23 to 0.62, p<0.001), with a parallel reduction in false-negative examinations. Both trials pointed in the same direction, indicating that CADe reduces the number of adenomas overlooked during a single examination.

Advanced adenoma and sessile serrated lesion detection

Effects on advanced and serrated lesions were less consistent. COLO-DETECT reported higher sessile serrated lesion detection with CADe (adjusted odds ratio 1.49, 95% CI 1.09 to 2.03), and AI-DETECT reported a higher combined adenoma-or-sessile-serrated-lesion detection rate (79.2% versus 71.6%, p=0.03) despite a non-significant adenoma detection rate. Several trials did not demonstrate a clear increase in advanced adenoma detection, and confidence intervals for these less frequent lesions were wide. The synthesis of findings across outcome domains is summarised in Table 4, and the certainty of the evidence is summarised in Table 5.

Risk of bias

All included trials shared the structural limitation that endoscopists could not be blinded to CADe use, which introduces potential performance bias in an operator-dependent procedure. On overall RoB 2 judgement, one double-blind, sham-controlled trial was rated as low risk of bias, and the remaining twelve trials were rated as having some concerns, most often arising from deviations from intended interventions related to the lack of blinding and, in some trials, incomplete reporting of allocation concealment or the randomisation sequence. Measurement of the outcome was generally at low risk because adenomas were confirmed by histopathology. Risk-of-bias judgements are presented in Table 3.

Table 3. Risk-of-bias assessment of included trials (Cochrane RoB 2).

Study (year)	D1	D2	D3	D4	D5	Overall
Wang (2019)	SC	SC	L	L	SC	Some concerns
Wang (2020)	L	L	L	L	L	Low
Gong (2020)	SC	SC	L	L	SC	Some concerns
Su (2020)	L	SC	L	L	L	Some concerns
Liu (2020)	L	SC	SC	L	L	Some concerns
Repici (2020)	L	SC	L	L	L	Some concerns
Glissen Brown (2022)	SC	SC	L	L	SC	Some concerns
Wallace (2022)	L	SC	L	L	L	Some concerns
Shaukat (2022)	L	SC	L	L	L	Some concerns

Study (year)	D1	D2	D3	D4	D5	Overall
Rondonotti (2022)	SC	SC	L	L	SC	Some concerns
Ahmad (2023)	SC	SC	L	L	SC	Some concerns
Karsenti (2023)	L	SC	L	L	L	Some concerns
Seager (2024)	L	SC	L	L	L	Some concerns

D1, randomisation process; D2, deviations from intended interventions; D3, missing outcome data; D4, measurement of the outcome; D5, selection of the reported result. L, low; SC, some concerns.

Table 4. Narrative synthesis of findings by outcome domain.

Outcome domain	Trials (n)	Direction and consistency	Representative reported estimates
Adenoma detection rate (ADR)	10 parallel RCTs	Higher with CADe in most trials; statistically significant in 7 and non-significant in 3	Wang 2019 29.1% vs 20.3% (p<0.001); Repici RR 1.30 (95% CI 1.14 to 1.45); Seager adjusted OR 1.47 (95% CI 1.21 to 1.78)
Adenomas per colonoscopy (APC)	7 RCTs	Consistently higher with CADe	Repici IRR 1.46 (95% CI 1.15 to 1.86); Shaukat 1.05 vs 0.83 (p=0.002); Seager adjusted MD 0.36 (95% CI 0.14 to 0.57)
Adenoma miss rate (tandem)	2 tandem RCTs	Consistently lower with CADe	Glissen Brown 20.1% vs 31.2% (p=0.025); Wallace 15.5% vs 32.4%, adjusted OR 0.38 (95% CI 0.23 to 0.62)
Advanced adenoma and sessile serrated lesion detection	5 RCTs	Inconsistent; serrated-lesion detection higher in some	Seager SSL adjusted OR 1.49 (95% CI 1.09 to 2.03); Ahmad adenoma-or-SSL 79.2% vs 71.6% (p=0.03)
Polyp detection rate (PDR)	6 RCTs	Higher with CADe	Wang 2019 45.0% vs 29.1% (p<0.001); Su 38.3% vs 25.4% (p=0.001)

Estimates are reproduced as reported in the primary trials. CI, confidence interval; OR, odds ratio; RR, risk ratio; IRR, incidence-rate ratio; MD, mean difference; SSL, sessile serrated lesion.

Table 5. GRADE Summary of Findings.

Outcome	Trials (participants)	Certainty (GRADE)	Plain-language summary
Adenoma detection rate	10 RCTs (approx. 10,600)	Moderate	CADe probably increases the adenoma detection rate. Downgraded once for risk of bias (endoscopists not blinded).
Adenomas per colonoscopy	7 RCTs (approx. 8,900)	Moderate	CADe probably increases adenomas per colonoscopy. Downgraded once for risk of bias.
Adenoma miss rate	2 tandem RCTs (453)	Moderate	CADe probably reduces the adenoma miss rate. Downgraded once for imprecision (few participants).
Advanced adenoma detection	5 RCTs	Low	The effect of CADe on advanced adenoma detection is uncertain. Downgraded for risk of bias and imprecision.
Sessile serrated lesion detection	5 RCTs	Low	CADe may increase sessile serrated lesion detection, but the evidence is uncertain.

Outcome	Trials (participants)	Certainty (GRADE)	Plain-language summary
			Downgraded for inconsistency and imprecision.

GRADE certainty: high, moderate, low, very low. Participant totals are approximate sums across contributing trials.

This systematic review of 13 randomised controlled trials found that artificial intelligence-assisted colonoscopy was associated with higher adenoma detection and, in tandem trials, lower adenoma miss rates, compared with standard colonoscopy. The direction of effect on the adenoma detection rate favoured CADe in most trials, and adenomas per colonoscopy were consistently higher, which suggests that the benefit extends beyond simply crossing the threshold of finding a first adenoma to detecting additional lesions during the same examination. These findings are coherent with the mechanism by which CADe is expected to act, namely by reducing the number of lesions that escape the operator's attention during withdrawal.

The results are consistent with earlier meta-analyses that reported increases in adenoma detection and adenomas per colonoscopy with artificial intelligence assistance.14,15,16 At the same time, the present synthesis highlights an important nuance that pooled estimates can obscure: several of the largest and most recent pragmatic trials, including SKOUT, AI-DETECT, and COLO-GENIUS, did not reach statistical significance for the adenoma detection rate, even though their point estimates favoured CADe.28,30,31 Possible explanations include high baseline detection by experienced endoscopists, which leaves less room for improvement, the routine use of adjunctive mucosal-exposure devices, and differences in how CADe alerts are acted upon in everyday practice. This pattern indicates that the benefit of CADe is likely to be real but modest and context-dependent, rather than uniform across all settings and operators.

The tandem trials provide the most direct evidence that CADe reduces missed lesions, since each participant serves as their own control for lesions present but overlooked.26,27 A reduction in the adenoma miss rate from roughly one in three to one in six in the international tandem trial is substantial, and it aligns with the known magnitude of miss rates from earlier tandem studies conducted without artificial intelligence.7,8 Whether a lower miss rate translates into fewer post-colonoscopy interval cancers, the outcome that matters most to patients, cannot be answered by these trials, because interval cancer is rare and requires long follow-up and large samples. The link between the adenoma detection rate and interval cancer is well established from observational data,5,6 which provides an indirect basis for expecting benefit, but it remains an inference rather than a demonstrated effect for CADe specifically.

The clinical implications of increased detection are not uniformly positive. Much of the incremental yield from CADe consists of small and diminutive adenomas, whose removal carries a lower absolute cancer-prevention value than that of advanced lesions, while additional polypectomies add procedural time, cost, histopathology workload, and potential risk. The effect of CADe on advanced adenoma detection was inconsistent in this review, which tempers claims of a direct cancer-prevention benefit. Increased detection may also shorten recommended surveillance intervals for some patients, with downstream resource implications. Modelling studies suggest that artificial intelligence-assisted colonoscopy can be cost-effective

when the additional detection is set against averted cancers,33 but such analyses depend on assumptions about the value of the extra lesions found and should be interpreted with caution.

Computer-aided diagnosis, which characterises lesions in real time, is a complementary application that could offset some of these costs by supporting resect-and-discard or leave-in-situ strategies for diminutive lesions,12,13 although few of the included trials evaluated CADx endpoints, and optical-diagnosis performance in routine practice remains a separate question from detection. The interplay between improved detection and efficient characterisation is likely to shape the practical value of artificial intelligence in colonoscopy.

Several limitations of the evidence base warrant emphasis. The dominant limitation is the impossibility of blinding endoscopists to CADe use, which places all but one trial at some concerns for risk of bias and raises the possibility that heightened attentiveness, rather than the algorithm itself, contributes to the observed effect. The trials were clinically and methodologically diverse in design, comparator, device, and population, which was the reason a quantitative meta-analysis was not undertaken in this review; a single pooled figure would risk implying a precision and uniformity that the underlying trials do not support. Many trials were single-centre and conducted in high-volume academic settings, which may limit generalisability, and outcome definitions for advanced and serrated lesions varied. Finally, this review focused on randomised trials of detection outcomes and did not incorporate non-randomised implementation data or long-term cancer outcomes.

This review also has limitations of its own. The synthesis was narrative, so effects are described rather than pooled, and the certainty ratings reflect structured judgement rather than a quantitative model. Although two reviewers conducted searching, screening, and appraisal, and the search spanned five databases, relevant trials in languages other than English or in the grey literature could have been missed. The strengths of the review include a comprehensive multi-database search, duplicate independent screening and appraisal, transparent risk-of-bias and GRADE assessment, and a focus on the randomised evidence that is most relevant to causal inference.

For practice, the current evidence supports considering CADe as an adjunct that probably increases adenoma detection and reduces missed adenomas, particularly where baseline detection is suboptimal, while recognising that the benefit is modest, that much of the extra yield is diminutive, and that patient-important outcomes have not yet been demonstrated. For research, priorities include trials or long-term cohorts linking CADe to post-colonoscopy interval cancer, standardised reporting of advanced and serrated lesion outcomes, evaluation of CADe combined with CADx and with mucosal-exposure devices, and pragmatic studies across community settings and less experienced operators.

CONCLUSION

Across 13 randomized controlled trials, artificial intelligence (AI)-assisted colonoscopy was associated with higher adenoma detection rates (ADRs), a greater number of adenomas detected per colonoscopy (APC), and lower adenoma miss rates (AMRs) compared with standard colonoscopy, with moderate certainty of evidence for these detection outcomes. However, the effects on advanced adenoma and sessile serrated lesion detection were less consistent, and the impact on postcolonoscopy colorectal cancer (PCCRC) incidence remains

unproven. These findings suggest that computer-aided detection (CADe) is a promising adjunct to conventional colonoscopy, offering modest but clinically relevant benefits that may vary across clinical settings and patient populations. Cautious clinical implementation is warranted, accompanied by further randomized controlled trials evaluating patient-important outcomes and pragmatic assessments of effectiveness across diverse healthcare settings.

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CONFLICT OF INTEREST
The authors declare that they have no competing interests. No author holds a financial or personal interest in any device, manufacturer, or intervention examined in this review.

AUTHOR CONTRIBUTIONS
Both authors, acting as independent reviewers, contributed to the search, study selection, data extraction, and critical appraisal. Both authors drafted and critically revised the manuscript and approved the final version.

GENERATIVE AI STATEMENT

The author(s) declared that generative AI was used in the creation of this manuscript. The author(s) wish to acknowledge the use of Generative AI for refining the language clarity and grammatical structure of this manuscript. This application was conducted in adherence to established ethical guidelines regarding the use and disclosure of generative AI in scholarly research. Each author has provided substantial intellectual contributions to the work, which has been rigorously vetted for accuracy, and the author(s) assume full responsibility for the integrity and final contentofthemanuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensureaccuracy, including review by thea uthors wherever possible. If you identify any issues, please contact us.

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