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From obstruction to ischaemia: a systematic review and meta-analysis on the diagnostic accuracy of CT scans in identifying small and large bowel obstruction, underlying causes and predicting critical complications in adults

Suhaib J S Ahmad ,[1] Iris Drvaric,[2] Ahmed R Ahmed,[3] Dominik Jakob,[2] Ioannis Panagiotis Kyriazidis,[4] Sjaak Pouwels ,[5,6] Shahab Hajibandeh ,[7] Alethea Tang ,[8] Peter Cripps ,[8] Wah Yang ,[9] Chetan Parmar,[10] Mohammad Kermansaravi ,[11] Ahmed Abdelwahed,[12] Edgar Gelber,[13] Anil Lala,[13] Graham Whiteley,[13] Danielle Wilkinson,[13] Anurag Agarwal,[14] Aaron Pritchard,[14] Miriam Khalil,[15] David Rawaf,[16] Ameer Khamise,[17] Ali Waleed khalid,[18] Mohamed Abdulmajed,[19] Amila Cizmic,[20] Vincent Ribordy,[21] Wolf E Hautz,[2] Aristomenis Konstantinos Exadaktylos[22]

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SJSA and ID contributed equally.

SJSA and ID are joint first authors.

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For numbered affiliations see end of article.

Correspondence to
Suhaib J S Ahmad;
suhaibsami94@gmail.com

ABSTRACT

Objectives To evaluate the diagnostic accuracy of CT in identifying small and large bowel obstruction and associated complications, including ischaemia and perforation, in adult patients.

Design Systematic review and meta-analysis reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses of Diagnostic Test Accuracy reporting guidelines.

Data sources Ovid MEDLINE and Embase were searched from 1946 to 20 February 2025.

Eligibility criteria The study included randomised controlled trials, cohort studies and case–control studies evaluating the diagnostic accuracy of CT for bowel obstruction in adults (aged ≥18 years). Only studies published in English were included. Conversely, case reports, editorials, conference abstracts without full data and studies focusing exclusively on paediatric populations or animal models were excluded.

Data extraction and synthesis Three reviewers independently extracted data on study characteristics, CT modality, diagnostic accuracy metrics (sensitivity, specificity and predictive values) and complications. Risk of bias was assessed using the QUADAS-2 tool. A random-effects meta-analysis was conducted. Heterogeneity was assessed using I^2 and Tau^2 statistics.

Results Sixty-five studies with 9418 patients were included. The pooled sensitivity and specificity of CT for bowel obstruction were 90% (95% CI 78 to 96; I^2=56%, Tau^2=0.36) and 88.8% (95% CI 78.0 to 94.8; I^2=65%, Tau^2=0.35), respectively. For bowel ischaemia, CT showed a pooled sensitivity of 47.0% (95% CI 32.4 to 59.9; I^2=0%, Tau^2=0.00) and specificity of 85.3% (95% CI 77.9 to 89.5; I^2=1%, Tau^2=0.45). Multidetector CT (MDCT) outperformed older modalities across all endpoints. Ischaemia was present in 22.05% of all cases, with higher rates in small bowel obstruction. Perforation and mortality rates were 3.98% and 4.40%, respectively. No significant publication bias was detected, and the certainty of evidence was graded as moderate for most diagnostic accuracy outcomes.

Conclusions CT, particularly MDCT, offers high diagnostic accuracy for bowel obstruction and is a critical tool for detecting serious complications such as ischaemia and perforation. However, sensitivity for ischaemia remains modest. Standardised protocols and prospective studies are needed to enhance early identification and optimise care pathways.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Comprehensive search across five major databases from inception to 20 February 2025, supplemented with grey literature to minimise publication bias.
⇒ Three independent reviewers took part in the study selection, data extraction and quality assessment using QUADAS-2.
⇒ Restriction to English-language publications may have introduced language bias.
⇒ Variability in CT protocols and diagnostic criteria across included studies may affect the comparability of the results.

INTRODUCTION

Bowel obstruction (BO) is a common surgical emergency that occurs when the normal passage of intestinal contents is partially or completely blocked. This obstruction can result from mechanical or functional causes affecting the small or large intestines. Typical symptoms include abdominal pain, nausea, vomiting, constipation progressing to obstipation and abdominal distension, often prompting urgent diagnostic and therapeutic interventions.

Understanding the underlying cause of BO is critical for its management. Obstructions may arise from intrinsic luminal factors or extrinsic compressive forces. Functional causes, such as adynamic ileus or colonic pseudo-obstruction, result from impaired enteric propulsion, often associated with medications, trauma, metabolic disturbances or postoperative states[1–3] (table 1).

BO poses a significant global healthcare burden. Between 1990 and 2019, its prevalence and incidence increased by 56.91% and 86.67%, respectively.[4] In the United States alone, small BO (SBO) accounts for approximately 80% of BO cases and 16% of annual surgical admissions, contributing to over $2 billion in healthcare expenditures annually.[5–7] Timely and accurate diagnosis is essential for guiding management, as delayed intervention can lead to significant morbidity, mortality and increased healthcare resource utilisation.[8]

CT has emerged as a cornerstone in the diagnosis and management of BO. Compared with traditional imaging modalities, such as plain abdominal radiography and barium studies, CT offers superior diagnostic accuracy, the ability to identify transition points and the potential to assess complications, such as ischaemia, perforation and closed-loop obstruction.[9–12] Plain radiography, while historically used for initial assessment, has limited sensitivity and specificity, particularly in detecting complete, closed-loop or strangulated obstructions.[13] MRI and ultrasonography (USG) provide additional diagnostic options but have limitations, such as longer imaging times, higher costs, limited availability (MRI) and operator dependence (USG).[14–17]

CT scans are invaluable in evaluating the underlying cause and severity of BO. Studies have shown that CT is highly effective in identifying mechanical obstructions, delineating the transition point and determining the presence of ischaemic bowel, adhesions or neoplasms.[11 12] A systematic review and meta-analysis confirmed the high diagnostic utility of CT in BO, with reported sensitivities and specificities significantly outperforming other imaging techniques.[12] Furthermore, CT-guided assessments can influence clinical decision-making by identifying patients who require urgent surgical intervention compared with versus those who may benefit from conservative management.[18]

Timely intervention is critical for favourable outcomes in BO. Current guidelines recommend limiting non-operative management trials to no more than 3 days in uncomplicated SBO cases to avoid delays in necessary surgical intervention.[19 20] Delayed surgical management, particularly when conservative treatments fail, is associated with worse outcomes, including prolonged hospital stays, increased morbidity and higher healthcare costs.[21 22] CT scans, by accurately diagnosing the severity and cause of obstruction, play a pivotal role in optimising the timing of intervention and reducing the risks associated with delayed management.

This meta-analysis aims to evaluate the diagnostic accuracy and clinical applications of CT scans in adult patients presenting with suspected SBO and large BO (LBO). By focusing on the diagnostic performance of CT and its

Table 1 Common causes of small and large bowel obstruction

Category	SBO	LBO
Mechanical obstruction	Adhesions (post-surgical or inflammatory)	Colorectal cancer
	Hernias (inguinal, femoral or umbilical)	Diverticulitis (complicated with abscess or stricture)
	Intussusception (especially in children)	Volvulus (commonly sigmoid or caecal)
	Tumours (benign or malignant)	Faecal impaction
	Strictures (Crohn's disease, ischaemic or induced by radiation)	Inflammatory strictures (eg, inflammatory bowel disease)
	Volvulus (less common than in LBO)	Ischaemic colitis with stricture formation
	Gallstone ileus	–
	Foreign bodies	–
Functional/paralytic	Paralytic ileus (postoperative, metabolic or medication-related)	Pseudobstruction (Ogilvie syndrome)
	Intestinal ischaemia (mesenteric vascular occlusion)	–
Congenital causes	Malrotation with volvulus	Congenital atresia
	Meckel's diverticulum (with associated obstruction)	–

LBO, large bowel obstruction; SBO, small bowel obstruction.

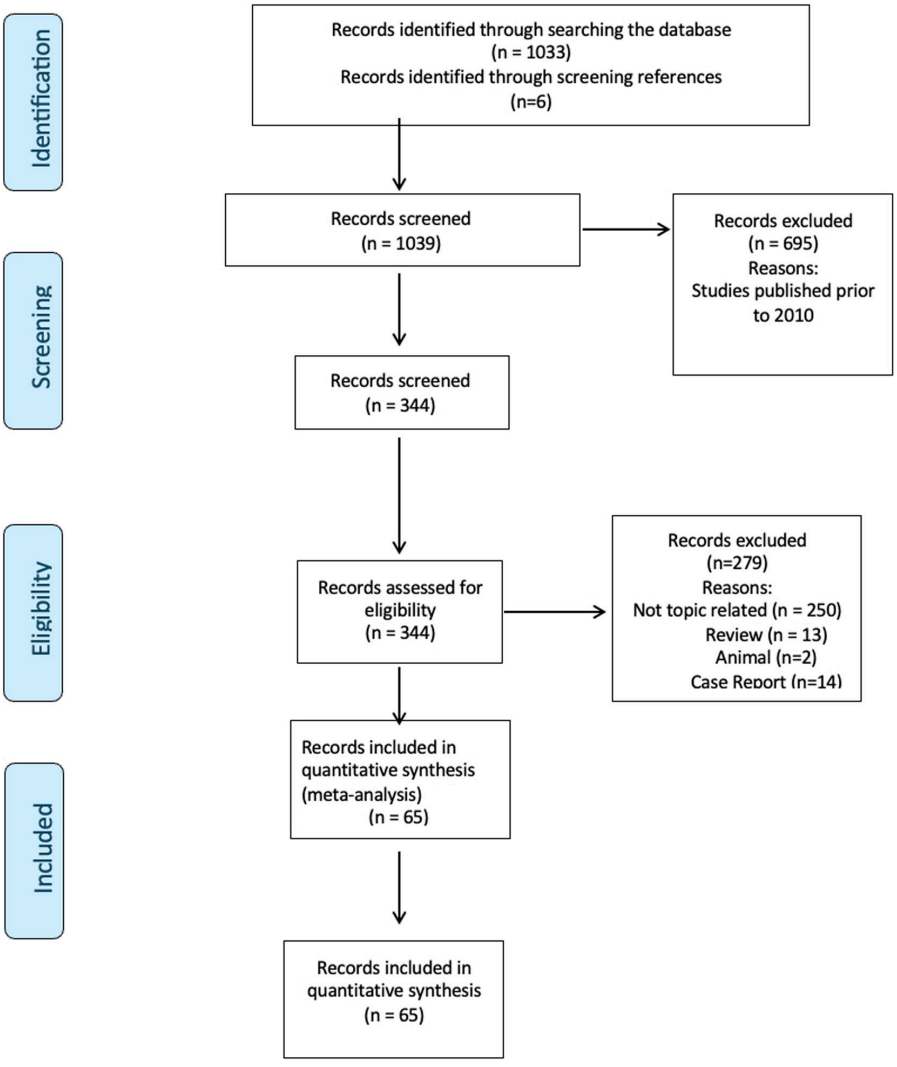


Figure 1 Selection flow diagram for Preferred Reporting Items for Systematic Reviews and Meta-Analyses of Diagnostic Test Accuracy.

effect on clinical outcomes, this study sought to provide a comprehensive understanding of the modality's role in the evaluation and management of BO.

METHODS

Study design and objectives

This systematic review and meta-analysis is reported following the reporting guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses of Diagnostic Test Accuracy (PRISMA-DTA) standards[23] (figure 1). The review protocol was retrospectively registered on Protocols.io (https://www.protocols.io/view/from-obstruction-to-ischemia-a-systematic-review-a-36wgqpy7xvk5/v1).

The primary objective was to assess the diagnostic accuracy of CT in identifying BO and its complications. A secondary objective was to propose an algorithm for the initial assessment of suspected BO.

Databases and search strategy

Three independent reviewers searched Ovid MEDLINE and Embase databases to identify relevant articles from 1946 to 20 February 2025. The search was restricted to articles published in English. Articles were then screened by reading the title, abstract and full text. The detailed search strategy is provided in online supplemental table 2.

Inclusion criteria

Articles were included if they met all of the following criteria:

- They were original articles (randomised controlled trials (RCTs), cohort studies, case–control studies, case series (>5 patients) and cross-sectional studies).
- They reported data on at least one of the following outcomes:
  1. CT scan.
  2. Patients with a suspected diagnosis of BO and its complications.
  3. Adults (aged >18 years).

Both RCTs and observational studies were eligible for inclusion, as most diagnostic accuracy studies in this field are observational. This ensured a comprehensive synthesis of available evidence while allowing for standardised bias assessment using the QUADAS-2 tool.

Exclusion criteria

To maintain a contemporary, clinically relevant evidence base focused on CT diagnostic accuracy in adults, studies that met any of the following criteria were excluded:

- Articles published before 2010 (studies published before 2010 were excluded to ensure the inclusion of research reflecting contemporary imaging technologies, diagnostic protocols and clinical practices)
- Review articles (systematic and narrative reviews).
- Case reports.
- Experimental articles.
- Cadaver studies.
- Animal studies.
- Focused assessment with sonography for trauma (FAST) and extended FAST scans.
- Patients with trauma.
- MRI
- X-rays.
- USG.
- Studies were designed to test the specificity and sensitivity of an artificial intelligence (AI) system in detecting BO using CT scans, not just CT scans themselves.
- Studies with a focus only on CT scenogram.
- Studies reporting diagnostic accuracies for CT scan in diagnosing internal hernias without differentiation from SBO.
- Gastric volvulus and gastric outlet obstructions.
- Studies related to internal hernias with no evidence of obstruction.
- Studies with the main outcome CT prediction for surgery, with no reference to obstruction or ischaemia.
- Studies focused on CT as a predictor for surgery without focus on obstruction or ischaemia in patients with BO.

Outcomes and imaging definitions

Radiological criteria summary

Across the included studies, mechanical BO was diagnosed using standard radiological criteria, most often involving the identification of a transition point with proximal dilatation and distal collapse. Indirect signs, such as bowel wall thickening, air–fluid levels and the 'string of beads' sign were variably reported. Complications assessed included ischaemia, strangulation, perforation, closed-loop obstruction, volvulus, abscess formation and systemic effects. Detailed definitions and radiological criteria for both BO and complications are provided in online supplemental table 1.[1 12 14 17 24]

Reference standards to confirm obstruction

The following reference standards were accepted to confirm obstruction/complications; where multiple were available, operative findings within 24 hours of CT were considered highest priority:

- Surgical findings of BO in patients who underwent surgical intervention (within 24 hours of CT scan).
- Clinical findings
- Enteroclysis
  - CT enteroclysis: combines enteroclysis with CT for comprehensive evaluation.
  - MRI enteroclysis: radiation-free option, ideal for younger patients or when repeated imaging is needed.
- Contrast studies:
  - Barium or water-soluble contrast studies: these can assess the degree and site of obstruction, particularly in partial or chronic cases.
  - Small bowel follow-through: involves oral ingestion of contrast to observe its progression through the small intestine.
- Endoscopic evaluation: (flexible sigmoidoscopy or colonoscopy) useful in LBOs, especially when identifying tumours, strictures or volvulus.
- Manometry or motility studies: assess functional obstructions such as adynamic ileus or pseudo-obstruction.
- Cross-sectional Imaging:
  - CT enterography: combines oral contrast with CT for detailed visualisation of the small bowel and its pathology.
  - MRI enterography: a radiation-free alternative providing excellent soft tissue contrast, especially for recurrent or chronic obstructions.

Data extraction and quality assessment

Three independent reviewers extracted study characteristics, patient demographics, CT modality, diagnostic accuracy metrics and complication data. Any discrepancies or discordances in study selection, data extraction and quality assessment were resolved through discussion and consensus, with a fourth reviewer consulted when agreement could not be reached. Risk of bias was assessed using the QUADAS-2 tool, and the level of evidence was determined using the Oxford Centre for Evidence-Based Medicine framework. Any disagreements in assessment were discussed until consensus was reached. Data were recorded in a standardised extraction form to ensure consistency and completeness across all studies.[25]

The certainty of evidence for diagnostic accuracy outcomes was assessed using the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) approach for tests and strategies. For each prespecified outcome (overall BO, SBO, LBO and ischaemia), certainty was rated across five domains—risk of bias, inconsistency, indirectness, imprecision and publication bias—starting from high certainty and downgrading as appropriate. Pooled sensitivity, specificity and

likelihood ratios were summarised and translated into post-test probabilities at a representative pre-test probability (baseline prevalence) derived from the included studies.

Statistical analysis

For consistency and transparency, the diagnostic accuracy metrics to be reported were predefined and synthesised as follows:

A bivariate random-effects meta-analysis was conducted to jointly synthesise sensitivity and specificity and account for the within-study correlation between these measures. Summary receiver-operating-characteristic curves were generated following Kester and Buntinx. Between-study variance (τ^2) was estimated with restricted maximum likelihood. Statistical heterogeneity was quantified using Cochran's Q (with $p<0.10$ indicating heterogeneity) and the I^2 statistic, interpreted as low (25%–49%), moderate (50%–74%) or high (≥75%). For each pooled estimate, I^2, τ^2, Q and p were reported. When sufficient studies were available, heterogeneity was explored by a priori subgrouping (eg, multi-detector CT (MDCT) vs helical CT; SBO vs LBO). Small-study effects/publication bias were evaluated using Deeks' funnel-plot asymmetry test for diagnostic accuracy meta-analyses. All analyses were conducted in OpenMeta (OpenMetaAnalyzer) and IBM SPSS version 29 (IBM Corp., Armonk, NY, USA).[26]

Statistical outcomes[27]

- Diagnostic odds ratio
- Negative likelihood ratio
- Positive likelihood ratio
- Sensitivity
- Specificity

Patient and public involvement

None.

RESULTS

A total of 65 studies were included in this meta-analysis. Details of the search strategy can be found in online supplemental table 2: The PRISMA-DTA flowchart is shown in figure 1. The results of the QUADAS-2 assessment are presented in online supplemental table 3.

Grading of Recommendations, Assessment, Development and Evaluation

For CT diagnosing any BO, certainty was moderate due to risk of bias (several retrospective designs with unclear flow/timing) despite consistent accuracy estimates; publication bias was not detected on Deeks' asymmetry testing. For SBO and LBO subgroups, certainty was low to moderate owing to study limitations and between-study variability. For ischaemia, certainty was low, mainly due to imprecision (wide CIs and event-sparse data in several studies) and indirectness (variable reference standards and timing). The findings are summarised in online supplemental table 4 for effect estimates, post-test probabilities and downgrade rationales.

Risk of bias

Out of the 65 studies analysed, patient selection was rated as low risk in 15 studies, high risk in 12 and unclear in 38. For the index test, 49 studies were considered low risk, only 1 was high risk and 15 were unclear. Regarding reference standards, 45 studies were judged as low risk, 2 as high risk and 18 as unclear. In terms of flow and timing, 13 studies showed low risk, 7 showed high risk and the majority—45 studies—were rated as unclear.

Applicability concerns

For patient selection, 26 studies were considered low risk, 5 were high risk and 34 were unclear.

In the index test, 53 studies were rated as low risk, with 11 marked as unclear and 1 as high risk.

Regarding the reference standards, 45 studies exhibited low risk, 19 were unclear and only 1 was rated as high risk.

Study characteristics

A total of 9418 patients were included across the studies, with 8,900 CT examinations performed. The median number of patients per article was 115, which ranged from 9 to 652. Please see online supplemental table 5.

Included articles

Among the 65 classified articles, 55 (86%) employed a retrospective design, while only 9 (14%) were prospective. In terms of evidence level, 44 (68%) studies were categorised as level III, providing moderate-level evidence, and 21 (32%) were level IV, reflecting lower-level evidence.

Regarding study types, cohort studies dominated the dataset with 44 (68%) articles. There were also 16 case series, 4 case–control studies and one cross-sectional study, indicating a strong preference for longitudinal observational designs, particularly cohort and case series formats.

The articles spanned a 15-year period from 2010 to 2025. Early publication activity was modest, with seven articles in 2010 and a consistent output maintained throughout the 2010s. However, research activity surged significantly in recent years: from 2021 to 2024, 30 articles (nearly half the dataset) were published. The peak year was 2024, with nine studies, marking the highest annual output and highlighting a growing academic and clinical interest in the field.

The characteristics of the included studies are summarised in online supplemental material. Online supplemental table 6 lists the journals in which the 65 articles were published, and online supplemental table 7 details their countries of origin. Across these studies, MDCT was the predominant imaging modality (n=61), either used alone or in combination with other techniques. One study combined MDCT with dual-energy CT (DECT) and another with MRI, whereas helical (spiral) CT was reported in four studies.

Table 2 Aetiology of bowel obstruction

	Weighted rate (%), LBO	Weighted rate (%), overall	Weighted rate (%), SBO	Total patients evaluated, LBO	Total patients evaluated, overall	Total patients evaluated, SBO
Abscess	1.27	2.06	3.25	788	1311	523
Adhesions	28.21	55.22	65.86	1762	6240	4478
Carcinoma	11.65	11.46	11.28	1657	3315	1658
Closed loop	10.88	21.99	27.52	854	4773	3789
Foreign body	1.24	3.45	5.48	889	1857	968
Hernia	5.79	8.88	10.8	1657	4323	2666
Inflammatory	4.53	6.34	8.12	1060	2144	1084
Intussusception	NAD	3.53	4.63	NAD	1981	1187
Stricture	7.59	6.5	5.75	764	1878	1114
Tuberculosis	NAD	4.26	2.92	NAD	938	617

LBO, large bowel obstruction; SBO, small bowel obstruction.

Symptom profile of patients undergoing computed tomography for suspected bowel obstruction

Among patients undergoing CT for suspected BO, a diverse range of gastrointestinal and systemic symptoms was reported. Abdominal pain was the most prevalent symptom, affecting approximately 88.23% of patients, followed by nausea and vomiting, reported by 70.09%. Abdominal distension was noted in 58.42% of cases, and 42.73% experienced either constipation or diarrhoea. Systemic symptoms such as fevers and chills were less common, present in only 17.92% of the patients.

Aetiology and complications of bowel obstruction

The aetiology of BO in the included studies is detailed in table 2. Ischaemia or necrosis was reported in a total of 6498 patients. The overall weighted rate of ischaemia or necrosis was 22.05%. Among patients with SBO, the rate was 25.86% (based on 4992 patients), compared with 1.77% for LBO (622 patients).

Perforation outcomes were reported for 2135 patients, with an overall weighted perforation rate of 3.98%. The perforation rate for SBO was 2.39% (1,170 patients), whereas the rate for LBO was 7.92% (568 patients).

Mortality data were available for 2069 patients. The overall weighted mortality rate was 4.40%. Stratified by obstruction type, the mortality rate for SBO was 6.21% (1,402 patients), whereas the mortality rate for LBO was 0.34% (591 patients).

Diagnostic accuracy

Pooled estimates are presented in table 3, with corresponding heterogeneity statistics (I^2, τ^2, Q and p). For overall CT accuracy in BO, the pooled sensitivity rate was 90% (95% CI 78 to 96; I^2=56%, τ^2=0.36, Q=15.89, p=0.026) and that of specificity was 88.8% (95% CI 78.0 to 94.8; I^2=65%, τ^2=0.35, Q=11.56, p=0.021). Across modalities, diagnostic performance was generally high, with MDCT outperforming helical CT in both SBO and LBO. In contrast, for bowel ischaemia, sensitivity was more variable and often lower than specificity—particularly in LBO. Subgroup results (MDCT vs helical; SBO vs LBO), predictive values (positive predictive value (PPV)/negative predictive value (NPV)), 95% CIs and full heterogeneity metrics are shown in online supplemental figures 1–28 and table 3. No significant small-study effects were detected.

DISCUSSION

The current meta-analysis represents a comprehensive synthesis to date regarding the diagnostic accuracy and prognostic value of CT in the evaluation of BO and its associated life-threatening complications, including ischaemia, perforation and mortality. By systematically analysing data from 65 studies encompassing a total of 9418 patients, this study provides statistical evidence supporting the clinical utility of CT in the initial assessment of suspected BO in adult populations.

Across all CT modalities, the pooled sensitivity for detecting BO was found to be 90% (95% CI 78% to 96%), with a corresponding specificity of 88.8% (95% CI 78.0% to 94.8%). These metrics underscore CT's reliability as a frontline imaging modality, demonstrating high diagnostic accuracy for the detection of BO. These findings are consistent with and, in many instances, superior to previous meta-analyses, such as that by Li *et al*,[12] which also affirmed the superiority of CT over conventional imaging modalities.[12] In contrast, abdominal radiography and USG have shown limited sensitivity, often ranging from 50% to 70%, depending on operator expertise, patient habitus and the clinical setting.[14–17] The comparative inferiority of these traditional techniques further highlights the critical role of CT, especially MDCT, in contemporary diagnostic pathways for suspected BO.

Diagnostic performance was observed to vary by both anatomical location and CT technology. For SBO, MDCT exhibited excellent sensitivity (83%) and a high NPV

Table 3 Diagnostic accuracy of CT for bowel obstruction and ischaemia

Condition	CT modality	Sensitivity % (95% CI), Fig	Specificity % (95% CI), Fig	PPV % (95% CI), Fig	NPV % (95% CI), Fig
Bowel obstruction (all types of CT)	All contrast-enhanced (<5 mm)	90.0 (78 to 96), Tau²=0.36, I²=56%, Q=15.89, p=0.026 online supplemental figure 1	88.8 (78.0 to 94.8), Tau²=0.35, I²=65%, Q=11.56, p=0.021 online supplemental figure 2	87.5 (74.8 to 94.1), Tau²=0.36, I²=65%, Q=11.59, p=0.021 online supplemental figure 3	88.4 (76.4 to 94.6), Tau²=0.79, I²=81%, Q=15.73, p=0.001 online supplemental figure 4
Small bowel obstruction (MDCT)	Multi-detector CT	83.0 (76 to 89), Tau²=0.168, I²=85.4%, Q=116.77, p=<0.001 online supplemental figure 5	74.0 (65 to 82) Tau²=NA, I²=0%, Q=NA, p=NA online supplemental figure 6	77.0 (70 to 83), Tau²=NAD, I²=0%, Q=NA, p=NAD online supplemental figure 7	91.0 (83 to 95), Tau²=NA, I²=0%, Q=NA, p=NA online supplemental figure 8
Small bowel obstruction (helical)	Helical/spiral CT	79.0 (63 to 85), Tau²=0, I²=0%, Q=0.16, p=0.69 online supplemental figure 9	67.0 (55 to 77), Tau²=2.72, I²=93.2%, Q=14.68, p=<0.001 online supplemental figure 10	48.0 (26 to 87), Tau²=0.43, I²=59.9%, Q=2.49, p=0.11 online supplemental figure 11	89.0 (79 to 99), Tau²=0.86, I²=60.3%, Q=2.52, p=0.11 online supplemental figure 12
Large bowel obstruction (MDCT)	Multi-detector CT	85.0 (65.4 to 94.4), Tau²=0.21, I²=61%, Q=10.32, p=0.035 online supplemental figure 13	83.1 (63.4 to 93.3), Tau²=1.69, I²=83%, Q=23.01, p=<0.001 online supplemental figure 14	83.4 (63.9 to 93.5), Tau²=0.35, I²=50%, Q=8.01, p=0.091 online supplemental figure 15	84.7 (64.9 to 94.3), Tau²=0.38, I²=79%, Q=14.55, p=0.002 online supplemental figure 16
Bowel ischaemia (general)	Mixed CT	47.0 (32.4 to 59.9), Tau²=0.0, I²=0%, Q=0.84, p=0.658 online supplemental figure 17	85.3 (77.9 to 89.5), Tau²=0.45, I²=1%, Q=14.72, p=0.001 online supplemental figure 18	54.3 (40.1 to 65.1), Tau²=1.31, I²=1%, Q=21.02, p=<0.001 online supplemental figure 19	80.9 (73.4 to 86.8), Tau²=0.5, I²=1%, Q=19.87, p=<0.001 online supplemental figure 20
Small bowel ischaemia (helical)	Helical/spiral CT	65.63 (NAD), NAD	92.11 (NAD), NAD	72.35 (NAD), NAD	89.5 (NAD), NAD
Small bowel ischaemia (DECT)	Dual-energy CT	95.45 (NAD), NAD	94.17 (NAD), NAD	75.0 (NAD), NAD	99.12 (NAD), NAD
Small bowel ischaemia (MDCT)	Multi-detector CT	72.7 (51.1 to 87.2), Tau²=0.91, I²=86%, Q=203.46, p=<0.001 online supplemental figure 21	87.5 (80.3 to 92.3), Tau²=1.07, I²=93%, Q=413.83, p=<0.001 online supplemental figure 22	51.6 (34.5–68.3), Tau²=1.27, I²=91%, Q=318.54, p=<0.001 online supplemental figure 23	94.6 (88.5 to 97.6), Tau²=1.06, I²=90%, Q=293.86, p=<0.001 online supplemental figure 24
Large bowel ischaemia (MDCT)	Multi-detector CT	47.8 (24.3 to 84.5), Tau²=1.72, I²=81%, Q=5.38, p=0.02 online supplemental figure 25	86.1 (70.7 to 94.6), Tau²=0.29, I²=64%, Q=2.79, p=0.095 online supplemental figure 26	68.0 (41.0 to 87.5), Tau²=0.32, I²=0%, Q=1.8, p=0.179 online supplemental figure 27	79.0 (61.2 to 87.4), Tau²=0.22, I²=0%, Q=0.67, p=0.412 online supplemental figure 28

DECT, dual-energy CT; MDCT, multi-detector CT.

of 91%, supporting its clinical utility in safely excluding obstruction in equivocal presentations. However, its specificity (74%) was modestly lower, suggesting potential false positives, particularly in patients with postoperative ileus or other non-mechanical causes of bowel dilation.[28 29] In contrast, older technologies such as helical CT demonstrated inferior diagnostic metrics, with pooled sensitivity and specificity of 79% and 67%, respectively, and a particularly low PPV of 48%, reinforcing the technological and clinical advantages of MDCT in this setting.[12]

For LBO, MDCT maintained a high level of diagnostic reliability, with pooled sensitivity and specificity of 85% and 83.1%, respectively. Furthermore, the balanced PPV (83.4%) and NPV (84.7%) suggest that MDCT is equally effective in confirming and excluding LBO, contributing to timely and accurate clinical decision-making. These findings align with previous work by Muldoon and Balthazar, who emphasised the role of CT in delineating the site, cause and potential complications of colonic obstruction.[30 31] Taken together, this evidence reinforces

the value of MDCT as the preferred modality in the diagnostic evaluation of mechanical BO, offering a combination of precision, speed and comprehensive anatomical detail that is unmatched by alternative imaging strategies.

The aetiological analysis reveals distinct pathophysiological patterns between SBO and LBO, which have important implications for both diagnostic strategies and clinical management. SBO was predominantly caused by adhesions (65.86%), closed-loop obstruction (27.52%) and hernias (10.8%), findings that align with prior research identifying postoperative adhesions as the leading cause of SBO.[29] In contrast, LBO was more commonly attributed to colorectal carcinoma (11.65%) and volvulus, which is consistent with the results of studies emphasising the role of distal neoplastic lesions and anatomical torsion in colonic obstruction.[31]

These aetiological differences are reflected in the distinct clinical profiles and complication rates associated with each condition. SBO was associated with significantly higher rates of ischaemia (25.86%), perforation (2.39%) and mortality (6.21%), likely due to the acute onset and vascular compromise that characterise small bowel entrapment, particularly in closed-loop obstructions.[28] In contrast, LBO exhibited a lower ischaemia rate (1.77%) but a substantially higher rate of perforation (7.92%), often resulting from progressive intraluminal pressure secondary to obstructing tumours or volvulus.[32] These findings underscore the necessity for anatomically and aetiologically informed diagnostic algorithms and treatment pathways.

Although CT remains the cornerstone for diagnosing mechanical BO, its utility in predicting ischaemic complications is more nuanced. This meta-analysis found the pooled sensitivity of CT for ischaemia to be modest at 47%, suggesting that nearly half of ischaemic events may be missed on imaging. Nevertheless, the specificity (85.3%) and NPV (80.9%) were relatively high, allowing clinicians to reasonably exclude ischaemia when CT findings are negative.[28] Diagnostic performance significantly improved when stratified by imaging technology. MDCT demonstrated a sensitivity of 72.7% and an NPV of 94.6% for small bowel ischaemia, underscoring its superiority in early risk stratification.[33] DECT, although assessed in only one high-quality study, achieved a sensitivity of 89% and specificity of 93%, suggesting a promising role in detecting perfusion deficits before irreversible bowel injury.[34] However, the PPV across modalities remained limited (51.6%–68%), implying that classic CT findings, such as bowel wall hypoenhancement, pneumatosis intestinalis and mesenteric stranding, may lack specificity and should be interpreted within the broader clinical context.[33]

Perforation was present in 3.98% of all BO cases, with rates notably higher in LBO. Although this study did not directly assess CT's accuracy for detecting perforation, radiologic indicators such as free intraperitoneal air, focal discontinuity of the bowel wall and extensive mesenteric fat stranding are well-established and should prompt immediate surgical evaluation, particularly in the presence of systemic compromise.[30] Regarding prognosis, the overall weighted mortality was 4.4%, increasing to 6.21% SBO and falling to 0.34% in LBO. These disparities align with the observed distribution of ischaemic complications and reinforce the prognostic role of CT, not only in diagnosing obstruction but also in identifying those at the highest risk of deterioration.[29] Radiologic signs such as the 'whirl sign', 'beak sign' and features of closed-loop obstruction have indirectly shown strong associations with strangulation and high-risk pathology and should prompt early surgical consultation.[10 17]

From a clinical management perspective, the data reinforce CT, particularly MDCT, as the first-line imaging modality for all adults with suspected BO. Its rapid diagnostic capacity and ability to localise transition points and evaluate for ischaemia and perforation make it indispensable in emergency care.[28] When available, DECT may further enhance sensitivity, particularly for early vascular compromise.[34] Importantly, the high NPV of CT for both SBO and ischaemia supports its role in guiding conservative treatment for select patients without high-risk features. However, given the moderate sensitivity for ischaemia, imaging findings must be contextualised with clinical signs, laboratory data (eg, lactate) and serial examinations to avoid delays in intervention.[33] CT also serves as a critical triaging tool. When integrated into clinical algorithms, it can effectively differentiate between operative and non-operative pathways. Previous studies have demonstrated that delays exceeding 3 days in non-operative SBO management are associated with increased complications and prolonged hospital stays.[20–22 35] As such, timely and accurate CT interpretation is essential for optimising outcomes and resource allocation in the management of BO.

Based on the findings of this meta-analysis, we developed a proposed evidence-based diagnostic and management framework—referred to as the *Metaflow* (figure 2)—which summarises the key decision-making steps for clinicians managing patients with suspected BO.

However, the analysis is not without limitations. A majority (86%) of the included studies were retrospective, with lower levels of evidence (level III/IV), which may introduce bias and limit causal inference. Additionally, substantial heterogeneity in imaging protocols, diagnostic thresholds and definitions of complications, such as ischaemia and perforation, may have influenced the pooled estimates. Data on advanced modalities like DECT remain limited.

Future research should focus on standardising CT interpretation criteria for ischaemia, validating predictive models that integrate imaging and clinical data and expanding the evidence base for DECT, AI and radiomics through multicentre, prospective studies.

CONCLUSION

This meta-analysis confirms that CT remains a highly accurate modality for diagnosing BO and

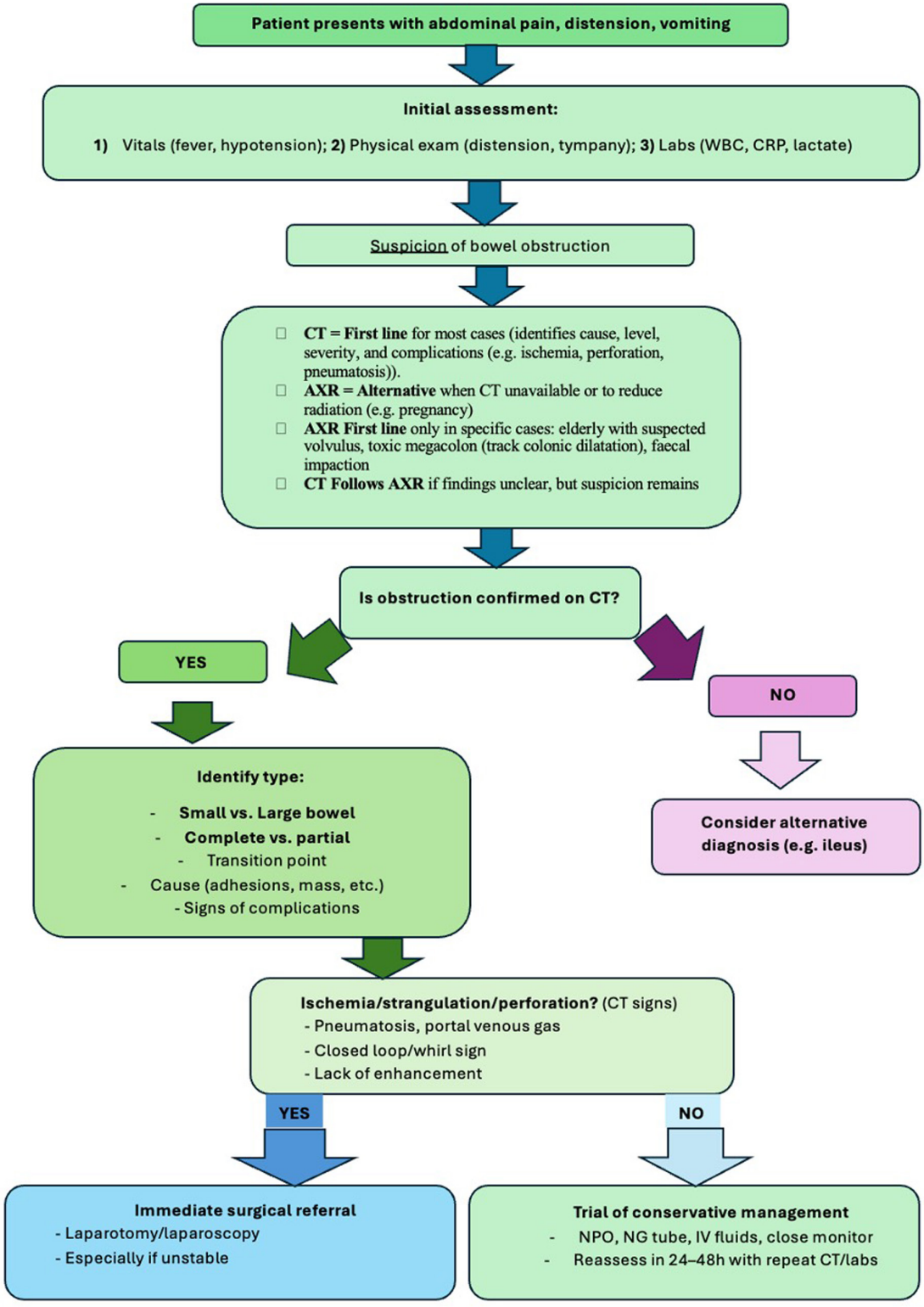


Figure 2 Proposed diagnostic and management workflow for suspected bowel obstruction ('Metaflow'). AXR, abdominal X-ray; CRP, C-reactive protein; NG, nasogastric; NPO, nil per os; WBC, white blood cells

its serious complications, including ischaemia, perforation and mortality risk. As CT technology continues to advance, future research should focus on leveraging innovations such as AI, quantitative imaging biomarkers and dynamic contrast protocols to improve early detection and risk stratification. Standardisation of diagnostic criteria and prospective validation of predictive models will be essential for optimising clinical decision-making. Moving forward, CT is poised to play an even more central role in personalised and precision-based approaches to acute abdominal care.

Author affiliations
[1]NHS Wales Health Education and Improvement Wales, Nantgarw, UK
[2]Inselspital Universitatsspital Bern, Bern, Switzerland
[3]Department of Bariatric and Metabolic Surgery, Imperial College London, London, UK
[4]Department of Diagnostic, interventional and Paediatric Radiology, Inselspital University Hospital of Bern, Bern, UK
[5]Intensive Care, Elisabeth-TweeSteden Ziekenhuis, Tilburg, The Netherlands
[6]Elisabeth-Tweesteden Hospital, Klinikum Lippe Detmold, Detmold, Germany
[7]Morriston Hospital, Swansea, UK
[8]Swansea Bay University Health Board, Port Talbot, UK
[9]Metabolic and Bariatric Surgery, Jinan University First Affiliated Hospital, Guangzhou, Guangdong, China
[10]Department of Surgery, Whittington Hospital, London, UK; University College London, London, UK
[11]Iran University of Medical Sciences, Tehran, Iran (the Islamic Republic of)
[12]Raigmore Hospital, Inverness, UK
[13]Department of General Surgery, Betsi Cadwaladr University Health Board, Bangor, UK
[14]Betsi Cadwaladr University Health Board, Bangor, UK
[15]St James's University Hospital, Leeds, UK
[16]Imperial College London, London, UK
[17]Faculty of Medicine and Healthcare Sciences, School of Medicine, University of Buckingham, Buckingham, UK
[18]School of Medicine, University of Buckingham, Buckingham, UK
[19]Department of Urology, Mersey and West Lancashire Teaching Hospitals NHS Trust, Prescot, UK
[20]University Medical Center Hamburg-Eppendorf, Hamburg, Germany
[21]University and Teaching Hospital Fribourg, Fribourg, Switzerland
[22]Inselspital, Universitätsspital Bern, Bern, Switzerland

Contributors SJSA and ID conceived and designed the study, developed the search strategy, conducted the literature search, performed study screening, extracted data and drafted the initial manuscript. ARA, DJ, IPK, SP, SH, AT, PC, WY, CP, MK, AA, EG, AL, GW, DW, AA, AP, MK, DR, AK, AWK, MA, AC, VR, WEH and AKE contributed to data interpretation, critical revision of the manuscript for important intellectual content, and approved the final version for submission. WEH and AKE provided senior supervision. SJSA is the guarantor of the work and accepts full responsibility for the integrity of the study. Artificial intelligence (AI) tools, specifically language models, were used to assist with grammar correction and restructuring of sentences during the preparation of this manuscript. All content was reviewed and verified by the authors to ensure accuracy and integrity.

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ORCID iDs
Suhaib J S Ahmad https://orcid.org/0000-0001-9803-0651
Sjaak Pouwels https://orcid.org/0000-0002-6390-7692
Shahab Hajibandeh https://orcid.org/0000-0002-3294-4335
Alethea Tang https://orcid.org/0000-0001-9681-9755
Peter Cripps https://orcid.org/0000-0002-4767-3101
Wah Yang https://orcid.org/0000-0003-2341-3310
Mohammad Kermansaravi https://orcid.org/0000-0001-8978-9359

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