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From obstruction to ischemia: 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

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Abstract

This protocol presents the methodological framework for conducting a systematic review and meta-analysis to evaluate the diagnostic accuracy of computed tomography (CT) in identifying small and large bowel obstruction and associated complications such as ischemia and perforation in adult patients. The review aims to assess CT's sensitivity, specificity, and diagnostic odds ratio compared to reference standards such as surgical, radiological, or endoscopic findings. Searches will be conducted in Ovid MEDLINE and Embase databases from inception to February 2025. Eligible studies will include adult populations (≥18 years) assessed with CT for suspected bowel obstruction. Data extraction will include study characteristics, CT modality, diagnostic metrics, and quality assessments using QUADAS-2. A bivariate random-effects meta-analysis will be performed to pool sensitivity and specificity estimates. The expected outcome is a comprehensive synthesis of CT's diagnostic performance and identification of methodological heterogeneity across studies to inform future diagnostic guidelines.

Troubleshooting

1 **DescriptionObjective**

The objective of this systematic review and meta-analysis is to rigorously evaluate the **diagnostic accuracy of computed tomography (CT)** in identifying **small and large bowel obstruction (SBO/LBO)** and associated **critical complications**, including **ischemia**, **perforation**, and **closed-loop obstruction**, in adult patients.

The review aims to:

- Quantify CT's pooled **sensitivity**, **specificity**, and **diagnostic odds ratio (DOR)** for the diagnosis of bowel obstruction and its complications.
- Compare diagnostic performance across CT technologies, including **multidetector CT (MDCT)**, **helical CT**, and **dual-energy CT (DECT)**.
- Assess sources of heterogeneity, such as **study design**, **imaging protocol**, **reference standards**, and **population characteristics**.
- Identify **methodological gaps**, **variability in diagnostic thresholds**, and **reporting limitations** that hinder clinical guideline standardization.
- Propose a framework for improving diagnostic algorithms and reporting consistency in future radiological research.

This study is conducted in accordance with the **PRISMA-Diagnostic Test Accuracy (PRISMA-DTA)** statement to ensure transparency, reproducibility, and methodological rigor.

Main Research Question

What is the **diagnostic accuracy** of computed tomography (CT) in detecting **small and large bowel obstruction** and their major complications—specifically **ischemia** and **perforation**—when compared with established **reference standards** such as operative findings, endoscopic evaluation, or contrast-based imaging, in **adult patients** presenting with suspected bowel obstruction?

Sub-questions include:

1. How does CT performance differ between **small bowel** and **large bowel obstruction**?
2. What CT signs or parameters most reliably predict **ischemia** or **perforation**?
3. How do diagnostic metrics vary according to **CT modality** (e.g., MDCT vs. helical)?
4. What are the key methodological sources of **bias or heterogeneity** among published studies?

Keywords and Synonyms

Bowel obstruction; intestinal obstruction; small bowel obstruction; large bowel obstruction; mechanical bowel obstruction; functional obstruction; paralytic ileus; computed tomography; CT scan; multidetector CT (MDCT); helical CT; dual-energy CT; diagnostic imaging; cross-sectional imaging; radiology; diagnostic accuracy; sensitivity; specificity; predictive value; diagnostic odds ratio; receiver operating characteristic (ROC); bowel ischemia; intestinal ischemia; bowel perforation; closed-loop obstruction; emergency radiology; PRISMA-DTA; QUADAS-2; meta-analysis; systematic review.

Source Selection Criteria (Databases)

The literature search will be designed to ensure **comprehensive and reproducible coverage** of the evidence base.

- **Primary Databases**
- **Ovid MEDLINE** (1946 – February 2025)
- **Embase** (1946 – February 2025)
- **Supplementary Searches**
- Manual screening of reference lists from previous systematic reviews and meta-analyses on CT for bowel obstruction.
- Search of **grey literature** (theses, clinical reports, or institutional publications) when full-text data are available and meet eligibility standards.
- Screening of abstracts from relevant radiology and surgery conferences (e.g., RSNA, ECR, EAES).
- **Search Strategy Design**
- The search will combine **MeSH terms** and **free-text keywords**, including: “intestinal obstruction,” “small bowel obstruction,” “large bowel obstruction,” “computed tomography,” “CT scan,” “diagnostic imaging,” “sensitivity,” “specificity,” and “ischemia.”
- Boolean operators (AND/OR), truncations, and proximity searches will be used to optimize retrieval.
- The search strategy will be peer-reviewed by an experienced medical librarian prior to execution.

Study Selection Criteria

Inclusion Criteria

- Original, **peer-reviewed** research articles.
- Study designs: randomized controlled trials (RCTs), cohort studies, case-control studies, or cross-sectional diagnostic accuracy studies.

- Adult participants (≥18 years old) with **clinically or radiologically suspected bowel obstruction**.
- Studies evaluating **CT** (contrast-enhanced or non-contrast) as the **index test** for diagnosis.
- Studies reporting at least one **quantitative diagnostic metric**: sensitivity, specificity, positive/negative predictive values, likelihood ratios, or ROC analysis.
- Full text available in English.

Exclusion Criteria

- Studies published before 2010 (to reflect **modern CT technology** and diagnostic standards).
- Case reports, editorials, review articles, conference abstracts, and letters without full datasets.
- Paediatric populations (<18 years) or animal models.
- Studies focused exclusively on **trauma**, **FAST/eFAST**, **MRI**, or **ultrasound** imaging.
- Studies assessing **AI algorithms or radiomics models** rather than conventional CT accuracy.
- Studies limited to internal hernias without obstruction, gastric volvulus, or gastric outlet obstruction.
- Articles reporting CT findings as predictors of surgery rather than diagnostic indicators of obstruction or ischemia.

Screening will be conducted independently by **three reviewers** in two stages (title/abstract and full-text), with disagreements resolved through discussion or by a fourth reviewer.

Quality Assessment Form

Quality appraisal will be performed using the **QUADAS-2** tool, the gold standard for diagnostic test accuracy studies.

It assesses **risk of bias** and **applicability concerns** in four key domains:

1. **Patient Selection** – Was the sampling method representative and free of inappropriate exclusions?
2. **Index Test** – Were CT diagnostic thresholds defined and interpreted independently of the reference standard?
3. **Reference Standard** – Was the comparator (e.g., surgery, contrast imaging) likely to correctly classify the target condition?
4. **Flow and Timing** – Was the time interval between CT and reference test appropriate, and were all patients included in the analysis?

Each domain will be rated as **Low**, **High**, or **Unclear** risk of bias, and the overall applicability of each study will be summarised narratively and graphically.

Risk of Bias Assessment Form

Purpose

To identify and quantify methodological biases that may distort pooled diagnostic performance estimates, particularly in retrospective designs or heterogeneous CT protocols.

Risk Classification

Each study will receive a qualitative classification for each bias type:

- **Low Risk** – minimal concern for bias or confounding.
- **Moderate Risk** – potential bias that could influence diagnostic estimates but not invalidate results.
- **High Risk** – major methodological flaws that threaten the validity or reliability of conclusions.

Eligibility and Data Extraction Form

Purpose

To standardize data collection and ensure comprehensive capture of study characteristics, diagnostic parameters, and methodological details.

All extracted data will be independently verified by a second reviewer to ensure accuracy.

Planned Data Synthesis

The meta-analysis will follow **PRISMA-DTA** guidelines.
Quantitative synthesis will be conducted using **bivariate random-effects models** to account for both within- and between-study variability.

- **Primary Analyses:**
- Pooled sensitivity and specificity for CT in diagnosing SBO, LBO, and associated complications.
- Summary receiver operating characteristic (SROC) curve construction.
- **Heterogeneity Analysis:**
- **I^2 and τ^2 statistics** to quantify heterogeneity.
- **Subgroup analyses** by CT modality (MDCT vs helical vs DECT), bowel region (small vs large), and study design (prospective vs retrospective).
- **Publication Bias:**
- Evaluated using **Deeks' funnel-plot asymmetry test** and visual inspection.
- **Software:**
- Statistical analyses will be conducted using **OpenMetaAnalyzer** and **IBM SPSS Statistics v29**.

Expected Outcomes

This review is expected to:

- Provide the **most comprehensive synthesis** of diagnostic accuracy metrics for CT in bowel obstruction to date.
- Quantitatively confirm CT's superiority over traditional modalities and delineate its **diagnostic limitations** in ischemia detection.
- Identify heterogeneity in study design, reference standards, and CT techniques.
- Establish evidence-based recommendations for **standardized CT interpretation criteria** and **reporting practices**in diagnostic research.
- Highlight **future research directions**, including the role of AI, radiomics, and dual-energy imaging in improving diagnostic precision.

Ethics and Dissemination

As this review analyses previously published data, **no ethical approval** is required.
The results will be disseminated through:

- **Peer-reviewed journal publication** in a radiology or surgery outlet.
- **International conference presentations** (e.g., RSNA, EAES, ECR).
- **Open-access sharing** of extracted datasets (upon request) for reproducibility and secondary analysis.

Funding and Competing Interests

This work is supported by institutional resources from the **University of Bern**.
The authors declare **no financial conflicts of interest** or competing relationships.

Summary of Expected Results

It is anticipated that this review will demonstrate that **CT—particularly MDCT—achieves high diagnostic accuracy** in identifying bowel obstruction, outperforming older modalities.
Sensitivity for ischemia may remain variable, reflecting the complexity of perfusion-related imaging findings.
Through a structured comparative synthesis, the review will delineate methodological gaps and promote a framework for **standardizing CT diagnostic criteria** in both research and clinical practice.