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### Authors

Chavannes, Mallory

Kysh, Lynn

Allocca, Mariangela

et al.

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# Role of artificial intelligence in imaging and endoscopy for the diagnosis, monitoring and prognostication of inflammatory bowel disease: a scoping review protocol

Mallory Chavannes ,<sup>1</sup> Lynn Kysh,<sup>1</sup> Mariangela Allocca,<sup>2,3</sup> Noa Krugliak Cleveland,<sup>4</sup> Michael Todd Dolinger,<sup>5,6</sup> Tom S Robbins,<sup>7</sup> David T Rubin,<sup>4</sup> Shintaro Sagami ,<sup>8</sup> Bram Verstockt ,<sup>9,10</sup> Kerri Novak<sup>11</sup>

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For numbered affiliations see end of article.

## Correspondence to

Dr Mallory Chavannes;  
mchavannes@chla.usc.edu

## ABSTRACT

**Introduction** Inflammatory bowel diseases (IBD) are immune-mediated conditions that are increasing in incidence and prevalence worldwide. Their assessment and monitoring are becoming increasingly important, though complex. The best disease control is achieved through tight monitoring of objective inflammatory parameters (such as serum and stool inflammatory markers), cross-sectional imaging and endoscopic assessment. Considering the complexity of the information obtained throughout a patient's journey, artificial intelligence (AI) provides an ideal adjunct to existing tools to help diagnose, monitor and predict the course of disease of patients with IBD. Therefore, we propose a scoping review assessing AI's role in diagnosis, monitoring and prognostication tools in patients with IBD. We aim to detect gaps in the literature and address them in future research endeavours.

**Methods and analysis** We will search electronic databases, including Medline, Embase, Cochrane CENTRAL, CINAHL Complete, Web of Science and IEEE Xplore. Two reviewers will independently screen the abstracts and titles first and then perform the full-text review. A third reviewer will resolve any conflict. We will include both observational studies and clinical trials. Study characteristics will be extracted using a data extraction form. The extracted data will be summarised in a tabular format, following the imaging modality theme and the study outcome assessed. The results will have an accompanying narrative review.

**Ethics and dissemination** Considering the nature of the project, ethical review by an institutional review board is not required. The data will be presented at academic conferences, and the final product will be published in a peer-reviewed journal.

## INTRODUCTION AND BACKGROUND

Inflammatory bowel disease (IBD) is a complex group of heterogeneous chronic immune-mediated disorders of the digestive tract, which are simplified into two conditions:

### WHAT IS ALREADY KNOWN ON THIS TOPIC?

⇒ Inflammatory bowel disease (IBD) is a heterogeneous entity, with significant differences in disease course between patients, requiring multiple clinical parameters contributing to daily care.  
⇒ Artificial intelligence may offer a way to automate and synthesise information, particularly when applied to the diagnostic evaluation of IBD.

### WHAT THIS STUDY ADDS

⇒ This protocol outlines how we intend to review the existing literature on the use of artificial intelligence in the context of imaging for diagnosing, monitoring and prognosticating IBD.

### HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE, OR POLICY

⇒ The identified gaps in the literature will serve as future directions for research in this area.

Crohn's disease (CD), ulcerative colitis (UC), with a spectrum of presentations in between categorised as IBD-Unclassified. The pathogenesis of IBD is complex and likely stems from interactions between an individual's genetic predisposition, environment and microbiota, leading to immune dysregulation and chronic, often progressive inflammation.<sup>1</sup> Considering this complex pathophysiology, the presentation of IBD varies from one individual to the next. Additionally, the response rate to different therapies is highly variable, reaching a plateau of 50% even with the most effective treatments.<sup>2–6</sup> The diagnosis and response to therapy are evaluated in several ways, including clinical symptom assessment, endoscopy, pathology and cross-sectional imaging.<sup>7</sup> The best disease control is achieved by repeating measurements of these

procedures and evaluations over time.<sup>8</sup> In light of the increasing prevalence of IBD worldwide and the growing information needed to be synthesised to care for a single patient, methods to optimise diagnosis, monitoring and prognostication would optimise the care of patients with IBD. There is increasing interest in leveraging the potential of artificial intelligence (AI) technology through integration into radiological tools, endoscopy, pathology and the electronic medical record to achieve this goal.<sup>9</sup>

AI is characterised by the ability of machines to resemble human intelligence in their ability to learn, remember and make decisions. It permits assessing large amounts of information, some of which clinicians can overlook. For example, AI can assist in detecting lesions, creating differential diagnoses, and even composing automated medical reports.<sup>10 11</sup> Therefore, it provides, in real-time and postprocessing, tools for the automatic and rapid assessment of disease activity in IBD and may aid in decision-making. AI technology can also assist in developing predictive models for prognostication response to therapy.<sup>12</sup> Although such technology is burgeoning, it is expected to become the reference standard when applied to most technologies today.

Through this project, we aim to review the literature available regarding AI as applied to diagnosis, monitoring and prognostication tools commonly used in IBD, such as endoscopy, magnetic resonance enterography (MRE), CT enterography (CTE), histology and intestinal ultrasound (IUS), the latter when available. The project aims to identify the current knowledge on AI applied to patients with IBD and identify gaps that will guide future research.

## METHODS

### Protocol design

As previously described by Arksey and O'Malley, the protocol was developed to include five stages.<sup>13</sup> The stages will consist of (1) the formulation of a research question, (2) the identification of relevant studies, (3) the selection of eligible studies, (4) data charting and (5) summarising the results. The protocol design will use methodology recommended through the Joanna Briggs Institute<sup>14</sup> and uses recommendations from the Preferred Reporting Items for Systematic Reviews and Meta-Analysis—Scoping Review Extension (PRISMA-ScR).<sup>15</sup> The study is planned to begin in January 2023, and we aim to complete the project by July 2023.

### Identifying research question

Our scoping review aims to identify the work published using AI to diagnose, monitor and prognosticate IBD. The goal is to identify gaps in the literature where further research is needed. We employed an iterative process to define the research questions through consultation with the research team and key stakeholders. The following research questions were developed to reach these objectives:

1. In paediatric and adult patients with IBD, does AI used in conjunction with diagnostic tools such as histology,

colonoscopy, CT/CTE, MR/MRE and/or IUS (when available) improve the diagnostic accuracy, monitoring and prognostication of inflammatory disease detection as compared with these diagnostic techniques interpreted by physicians alone?

2. How does AI, combined with these diagnostic tools, compare to these diagnostic techniques interpreted by physicians alone to identify the extent, characteristics and behaviour of IBD?
3. Are there additional discovered benefits of AI/machine learning with these investigational tools identified in the published literature outside of diagnosis and monitoring and prognostication of IBD?

### Identifying relevant studies/development of the search strategy

A systematic search to identify potentially relevant citations will be performed using the following electronic databases: Medline (Ovid), Embase (Elsevier), Cochrane CENTRAL (Wiley), CINAHL Complete (EBSCO), Web of Science (Clarivate) and IEEE Xplore (Institute of Electrical and Electronics Engineers). A medical librarian (LK) initially created Medline and Embase search strategies using a combination of controlled vocabularies and keywords for the concepts of inflammatory bowel disease and AI and either imaging, endoscopy or histology. Team members reviewed the strategies and results to edit and improve the search strategy. With the team's approval, the librarian will create customised search strategies using controlled vocabularies (when available) and keywords in the remaining preidentified databases. See online supplemental appendix I, in supplemental materials, for the Medline search details.

All resulting citations will be exported into an EndNote V.20 (Clarivate Analytics, Philadelphia, USA) library and deduplicated (<https://www.ncbi.nlm.nih.gov/pc/articles/PMC4915647/>).

### Study selection

The studies identified through the search strategy will be screened in two stages. First, a title and abstract review will be performed by two independent reviewers. The second step will involve a full-text review of the selected manuscripts by two independent reviewers. Any discrepancy between the two reviewers will be assessed and resolved by a third independent reviewer.

The study's eligibility criteria are summarised in [table 1](#). Studies written in English, Italian, French and German will be included. The age limit chosen excludes patients with very early onset IBD who have a higher rate of underlying immune deficiency and genetic causes of IBD and may bias AI algorithms. This patient population should be studied separately, considering their different rate of underlying pathophysiology leading to IBD.

The title, abstract and full-text screening will be done using Covidence (Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia. Available at [www.covidence.org](http://www.covidence.org).) Studies included in the

**Table 1** Inclusion and exclusion criteria

Inclusion	Exclusion
Studies including adult patients and children 6 years and older.	Young children and infants (< 6 years old)
Known or suspected to have inflammatory bowel disease (Crohn's disease, ulcerative colitis of IBD-unclassified)	No mention of listed inflammatory bowel diseases
Intervention using AI, machine learning, or deep learning	No mention of artificial intelligence
The studies will assess the context of cross-sectional imaging (MR enterography, CT enterography, or intestinal ultrasound), endoscopy or histology.	No mention of listed diagnostic techniques

AI, artificial intelligence; IBD, inflammatory bowel disease; MR, magnetic resonance.

review will focus on using AI in the context of radiological and endoscopic examinations. Studies only focusing on AI for natural language processing or review of electronic medical records will be excluded. We will accept all primary study types, including experimental, observational (prospective or retrospective) and qualitative studies. The inclusion and exclusion criteria were tested in a sample search and demonstrated consensus among the study team. Exclusion reasons at the full-text review stage will be described for each study rejected. The selection process of studies will be summarised using a flow diagram, as recommended by the PRISMA guidelines (figure 1).<sup>16</sup>

### Data collection

The study team will develop a data collection instrument to confirm the study's relevance and extract its characteristics. The publication year, country, study design, patient population (adult vs paediatric), disease studied (CD, UC of IBD-unclassified), and modality investigated using AI (endoscopy or imaging tool) will be collected. We will also collect the objective of the studies (diagnosis, monitoring or prognosis of IBD).

The data abstraction will be collected independently by two reviewers. A third reviewer will resolve any conflicts elicited. The data will be compiled using Microsoft Excel software for validation and coding. Considering that this scoping review aims to assess the breadth of literature available on AI used for diagnosing and managing IBD, critical appraisal of each manuscript was judged not to be required for the study.

### Data summary

Following the data extraction of the studies, the results will be organised first by imaging modality using AI and second by the studied outcome (diagnosis, monitoring, or prognostic of IBD). The results will be presented within the paper both in a tabular form and with an accompanying narrative. We will provide an overview of the target population studied, the diagnostic modality investigated, the AI methodology used for that end, and the outcome of interest that was investigated. The final manuscript and report will closely follow the guidelines suggested by the PRISMA-ScR. Identifying gaps in the literature will detect areas where further research is needed and will direct the next steps in our research.

### ETHICS AND DISSEMINATION

Approval by an Institutional Review Board is not needed to proceed with this project. We aim to complete the project within 6 months. The preliminary results of the scoping review will be presented at gastroenterology conferences. Once the project is complete, we aim to publish our conclusions in a peer-reviewed journal.

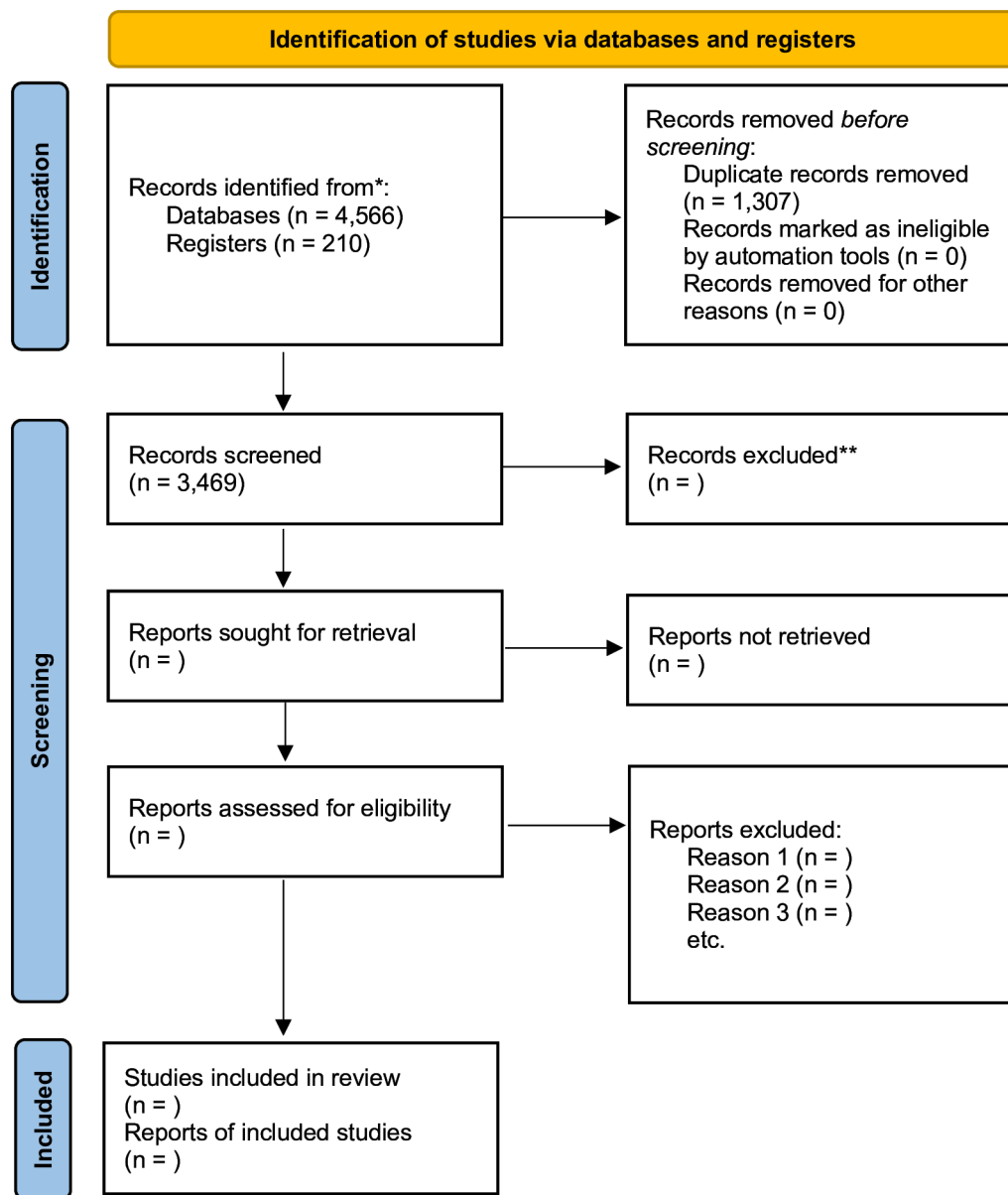
### LIMITATIONS

From our expertise, we expect a limited number of publications addressing specific imaging modalities, particularly IUS. In addition, this scoping review is focused on radiological tests, endoscopic examination and histology. Therefore, we will not address additional areas of interest in using AI, such as natural language processing of notes within electronic medical records. This study will not assess the use of AI for polyp detection. In addition, this scoping review will not address the use of AI to extract clinical disease activity from electronic medical records. In terms of technical limitations, considering AI is a novel area of interest, the review is at risk of publication bias. And finally, although we believe that the languages selected for the articles should capture most of the literature in this area, we may miss a few reports of interest that may be published in languages outside our scope.

### DISCUSSION AND CONCLUSION

Our scoping review will provide insight into the breadth of evidence available on using AI in the context of imaging modalities and endoscopy for the diagnosis, follow-up and prognosis of IBD. Doing so will identify the areas of interest that have not yet been developed. We hypothesise that there is very little information regarding using AI alongside IUS, a modality that can be performed at the bedside as point of care. Adapting some of the work done to bedside IUS can readily bring innovation to the patient for multiple aspects of their care. Such gaps in the literature will therefore be addressed in future research endeavours.

While the use of AI is growing in many areas in and outside of medicine, there are potential issues with its use that are difficult to assess in the literature while still being the infancy of this technology. It is particularly difficult to know how this technology can affect physicians who are not familiar with the recent advances in the management of IBD. First, some concerns emerge regarding misdiagnosis, which can occur



**Figure 1** Proposed flow diagram of the studies selection process, as recommended by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.<sup>16</sup>

in the context of AI relying on the inputted algorithm, an algorithm that may not be inclusive and be representative of variations of presentations in a diverse population. Second, inadequate severity of disease assessment can occur, as it requires a nuanced understanding of various factors, including clinical symptoms, laboratory results, endoscopic findings and patient history. Physicians lacking in-depth knowledge of IBD may not fully grasp the complexity of these factors, potentially resulting in inaccurate severity assessments and suboptimal treatment decisions. Third, while current AI algorithms may provide recommendations based on generalised data or guidelines, IBD treatment often requires personalised approaches. Furthermore, as more treatments are available for IBD, verification is required to ensure that these options are represented in the algorithms feeding AI output. Physicians who are not familiar with these updates and the latest products may overly rely on AI,

overlooking patient characteristics that may be important in treatment choices or not noticing missing novel treatments. Fourthly, AI algorithms or dashboards may not consider the complex interplay between patients' lifestyles, preferences and values that is necessary for offering a holistic patient-centred approach to management decisions. Finally, there is an ethical dilemma in building AI, as we now know that some biases and stereotypes have been unintentionally immersed into AI algorithms based on the data available for the machine learning phases. Physicians who lack in-depth IBD knowledge and training may unintentionally perpetuate bias or disparities in care if the AI algorithms they use are not appropriately validated and tested across diverse populations. Additionally, the potential for overreliance on AI systems without critical thinking and oversight raises concerns about responsibility and accountability for patient outcomes.



Therefore, AI can be a valuable tool in IBD care. However, its thoughtful integration requires consideration of the potential threats to patient care. Collaboration between AI developers, IBD specialists and physicians with AI expertise is essential to ensure the development of robust, accurate and context-aware AI systems that enhance rather than replace the expertise and experience of trained healthcare professionals.

#### Author affiliations

- <sup>1</sup>Division of Gastroenterology, Hepatology and Nutrition, Children's Hospital of Los Angeles, Los Angeles, California, USA  
<sup>2</sup>Gastroenterology and Endoscopy, IRCCS San Raffaele Hospital, Milano, Lombardia, Italy  
<sup>3</sup>Università Vita Salute San Raffaele, Milano, Lombardia, Italy  
<sup>4</sup>Inflammatory Bowel Disease Center, The University of Chicago Medicine, Chicago, Illinois, USA  
<sup>5</sup>Division of Pediatric Gastroenterology, Susan and Leonard Feinstein Inflammatory Bowel Disease Clinical Center at Mount Sinai, New York, New York, USA  
<sup>6</sup>Icahn School of Medicine at Mount Sinai, New York, New York, USA  
<sup>7</sup>Motilient Ltd, London, UK  
<sup>8</sup>Center for Advanced IBD Research and Treatment, Kitasato University Kitasato Institute Medical Center Hospital, Kitamoto, Saitama, Japan  
<sup>9</sup>Department of Gastroenterology and Hepatology, University Hospitals Leuven, KU Leuven, Leuven, Belgium  
<sup>10</sup>Department of Chronic Diseases and Metabolism, TARGID-IBD, KU Leuven, Leuven, Belgium  
<sup>11</sup>Division of Gastroenterology and Hepatology, University of Calgary, Calgary, Alberta, Canada

**Twitter** Mallory Chavannes @mallocc\_doc, Shintaro Sagami @DrSagami and Kerri Novak @novakkerri

**Contributors** MC: first author and primary writer, member of Pediatric Committee for International Bowel Ultrasound Group (IBUS) group. LK: second author and primary writer, expertise in conducting systematic and scoping reviews. Consulted on the content of the manuscript. MA, NKC, MTD, DTR, SS and BV: expert in the field of Inflammatory Bowel Disease and gastrointestinal ultrasound, primary editor, and IBUS Scientific Committee member. TSR: expert in the field of Artificial Intelligence, medical imaging, and gastrointestinal ultrasound. KN: primary investigator and primary editor, expert in the field of IBD and gastrointestinal ultrasound, IBUS governing board member and certified IUS trainer.

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#### ORCID iDs

Mallory Chavannes <http://orcid.org/0000-0001-8787-4891>  
 Shintaro Sagami <http://orcid.org/0000-0002-1202-8161>  
 Bram Verstockt <http://orcid.org/0000-0003-3898-7093>

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