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Integrative analysis of the impact of artificial intelligence in the early diagnosis of gastrointestinal diseases

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ABSTRACT

Artificial intelligence (AI) has played a significant role in the early diagnosis of gastrointestinal diseases, showing constant evolution in contemporary medical practice. This study aims to analyze the impact of AI in this context, exploring its historical, epidemiological, and organizational implications in gastroenterology through integrative review. Studies investigating the use of AI in the diagnosis of gastrointestinal diseases were examined, using databases such as Medline and the Latin American and Caribbean Literature in Health Sciences (LILACS). The results highlight the effectiveness of AI in the early detection of gastrointestinal lesions, its contribution to improving diagnostic accuracy, and the need for continuous improvement in this field. It is concluded that the integration of AI in gastroenterological practice can offer significant benefits, including more efficient patient management and a more accurate and holistic approach to the diagnosis and treatment of gastrointestinal tract diseases.

Keywords: Artificial Intelligence, Early Diagnosis, Gastroenteropathies.

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INTRODUCTION

Artificial intelligence (AI) has significantly advanced the analysis of medical images, thus contributing to the field of gastroenterology. This has allowed an improvement in the evolution of gastrointestinal endoscopy, resulting in more accurate screening and diagnosis of gastric lesions. This way, it is possible to detect gastric changes early, especially neoplastic ones. Regarding gastric cancer, it is the fifth most common neoplasm and the third leading cause of cancer-related deaths globally. Esophageal cancer is the sixth leading cause of cancer death in the world. Thus, early diagnosis contributes greatly to the patient's survival and prognosis[1,2].

Artificial intelligence systems have been very successful in the early diagnosis of diseases of the gastrointestinal tract, ensuring a better prognosis regarding the cure of patients affected by cancers in this region, since these are aggressive diseases that lead to a large number of individuals in the world to death. The use of technological resources could increase the 5-year survival rate in patients diagnosed with gastric adenocarcinoma from just 31% to 95%. The expectation regarding the increased survival of these patients encourages hope both in patients and in the medical community[3].

It is observed that artificial intelligence has demonstrated increasing sensitivity and less time spent diagnosing cancers of the digestive system. A study carried out in Tokyo with 13,584 endoscopic images suggestive of gastric cancer demonstrated that artificial intelligence achieved a sensitivity of 58.4% when compared to endoscopists who achieved 31.9%[4].

Furthermore, regarding the accuracy of endoscopic diagnosis of *Helicobacter infection pylori* is approximately 70%, indicating that there is room for improvement in this method. Thus, the use of artificial intelligence (AI) to early detect the presence of *Helicobacter pylori* in the stomach lining, plays a key role in preventing gastric disorders and their complications. This bacterium is associated with the development of functional dyspepsia, peptic ulcers, mucosal atrophy, neoplasms and gastric cancer, in addition to causing atrophic gastritis and intestinal metaplasia[2,5].

It is important to mention that the use of AI in medical practice is not intended to replace healthcare professionals, but rather as a complement that will help identify injuries that could otherwise go unnoticed, especially with regard to oncological diagnosis. Furthermore, although many AI systems have an accuracy greater than 80%, it is necessary to carry out clinical trials to prove their feasibility, effectiveness and safety in clinical practice. Although there are current challenges, AI is likely to experience continued progress that will enable its increasingly frequent adoption in daily clinical practice in the imminent future[1, 6].

Therefore, the present study aims to analyze the impact of artificial intelligence on the early diagnosis of gastrointestinal diseases, evaluating its effectiveness, accuracy and ability to improve clinical outcomes and reduce morbidity and mortality through an integrative review. Furthermore, to

highlight better prognoses achieved with the use of artificial intelligence systems in the survival rate of individuals affected by diseases of the gastrointestinal tract.

MATERIALS AND METHODS

This is an integrative review that investigates the impact of artificial intelligence on the early diagnosis of gastrointestinal diseases, using the Medline and Latin American and Caribbean Literature in Health Sciences (LILACS) databases through the Virtual Health Library (VHL). The search resulted in the identification of 215 articles in Medline and (1) one in LILACS, which were selected based on the relevance of their objectives, using the descriptors "Artificial Intelligence", "Early Diagnosis" and " Gastroenteropathies ", combined with the boolean operator "AND". The studies included cover the period from 2019 to 2024 and present described methodology and methods, being available in English, Portuguese or Spanish, free of charge, and focusing on the application of artificial intelligence in the diagnosis of gastrointestinal diseases. On the other hand, publications such as thesis and monographs were excluded, as they do not suit the purpose of this study. Among the 23 eligible articles, 12 were selected for analysis in this review.

RESULTS

It was prepared in a descriptive and expository way: the type of study, objective and conclusion of the ten articles on the impact of artificial intelligence on the early diagnosis of gastrointestinal diseases in Table 1.

Table 1: Detailed analysis of the reviewed and selected articles regarding the type of study.

Title	Author/Year	Kind of study	goal	Conclusion
Artificial intelligence and upper gastrointestinal endoscopy: Current status and future perspective	MORI *et al.* , 2019 [2]	Quantitative study.	Identify the automation of dysplasia in Barrett's esophagus and detect early gastric cancer.	The conclusion about the study allows us to certify that with larger learning samples and well-designed prospective trials, the technology for upper gastrointestinal endoscopy can be implemented in clinical practice in the near future.
Detecting early gastric cancer: Comparison between the diagnostic ability of convolutional neural networks and endoscopists	IKENOYAMA *et al.* , 2020 [9]	Quantitative study .	Evaluate whether the performance of a convolutional neural network (CNN) in early detection of gastric cancer is better than that of endoscopists.	CNN detected gastric cancer earlier than endoscopists. Therefore, it is concluded that the CNN needs additional training to achieve greater diagnostic accuracy. However, a diagnostic support tool for gastric cancer using a CNN will be realized in the near future.
Development and validation of a	TANG *et al* ., 2020 [3]	Retrospective study.	real-time deep convolutional neural networks (DCNNs)	In conclusion, we have developed an efficient AI system based on DCNN

real-time artificial intelligence-assisted system for detecting early gastric cancer: A multicentre retrospective diagnostic study			system to detect early gastric cancer (EGC).	for real-time EGC detection. The DCNN system demonstrated excellent performance for EGC detection in independent validation datasets and improved the diagnostic ability of endoscopists-in-training to a level comparable to that of experts.
Application of artificial intelligence using a convolutional neural network for diagnosis of early gastric cancer based on magnifying endoscopy with narrow-band imaging	UEYAMA *et al* ., 2021 [8]	Quantitative study .	Build an AI-assisted CNN computer-aided diagnosis (CAD) system, based on ME-NBI images, to diagnose EGC and evaluate the diagnostic accuracy of the AI-assisted CNN-CAD system.	The system used in the study demonstrates great potential for future application in real clinical settings, which would facilitate the diagnosis of EGC using ME-NBI in practice. The CNN-CAD system uses AI to diagnose EGC using ME-NBI, with the possibility of processing many ME-NBI images that are stored in a short period of time and has a high diagnostic capacity.
Application of artificial intelligence-driven endoscopic screening and diagnosis of gastric cancer	HSIAO *et al* ., 2021 [1]	Qualitative study.	To summarize the current status of various AI applications in gastric cancer and point out directions for future research and implementation into clinical practice from a clinical perspective.	Overall, the use of AI in gastroenterology is still in its infancy. Currently, there are several retrospective models applied to both images and videos and using WLI and NBI endoscopies that have proven to have superior performance for carrying out the same tasks performed by experienced endoscopists. However, there were no attempts at clinical trials. In contrast, there are still clinical trials being carried out in order to detect colorectal polyps, it is also observed that the applications of AI in GC and its corresponding diagnostic methods are still preliminary. There are limitations to the efforts pointing to the need for continued research in the area, which can greatly contribute to making faster, more accurate and accurate assessments of GC risk. Even though we have witnessed its rapid and marked growth in the last decade, future studies are needed to speed up the machine learning process and define its role in computer-aided diagnosis of *H. pylori* and GC infections in clinical settings of life. real.
Development and evaluation of a double-check support system using artificial intelligence in endoscopic screening for gastric cancer	OURA *et al.* , 2021 [7]	Quantitative study .	Prevent missing gastric cancer and target low-quality images by developing a double-check support system (DCSS) for static esophagogastroduodenoscopy (EGD) images using artificial intelligence.	The DCSS demonstrated excellent ability to detect lesions and identify low-quality images.

Hybrid and Deep Learning Approach for Early Diagnosis of Lower Gastrointestinal Diseases	FATI; SENAN; AZAR, 2022 [11]	Quantitative study .	Develop several multi-methodologies , where the work was divided into four proposed systems; each system has more than one diagnostic method.	Future work will apply the principal component analysis (PCA) algorithm to reduce the dimensions of deep feature maps extracted by CNN models, in addition to including maps from more than one CNN model and reducing their dimensions by the PCA algorithm.
Cooperation between artificial intelligence and endoscopists for diagnosing invasion depth of early gastric cancer	GOTO *et al.* , 2023 [12]	Quantitative study	artificial intelligence (AI) classifier to differentiate intramucosal gastric and submucosal cancers and examine them to establish a diagnostic method based on cooperation between AI and endoscopists.	Cooperation between AI and endoscopists has demonstrated improved diagnostic ability to reveal the depth of invasion of early gastric cancer.
Evaluation of deep learning methods for early gastric cancer detection using gastroscopic images	SU *et al* ., 2023 [10]	Qualitative study.	Compare the performance of different models from the RCNN series for EGC.	Methods based on deep learning have contributed to the early diagnosis of cancer through endoscopic images. However, the performance of these methods did not meet the demands of clinical practice. Therefore, more advanced AI methods must be proposed for the early detection of cancer, it is necessary to develop a combination of more advanced imaging technology and AI methods.

DISCUSSION

The use of artificial intelligence (AI) to identify gastric pathologies early, such as *Helicobacter pylori* in the gastric epithelium, is crucial to prevent complications. This bacterium is responsible for functional dyspepsia, peptic ulcers, mucosal atrophy, gastric neoplasia, gastric cancer, atrophic gastritis and intestinal metaplasia. Studies indicate that the majority of gastric neoplasms are closely related to *H. pylori infection* , which leads to the need to perform a C13 urea breath test, and for subclinical cases, invasive biopsies that require more time to be performed. realization. Furthermore, there is a protocol requirement by the Kyoto Classification, the gold standard in gastroenterology for identifying the level of severity of the infection, that examiners observe the lesions with the naked eye, which corroborates the development of a new protocol that uses intelligence artificial so that the standard exam is less subjective. Gastric cancer is the fifth most common neoplasm on a global scale, affecting more than one million people, and leading to death in 78% of cases, which makes endoscopic practice a crucial exam to diagnose, treat the disease and alleviate symptoms. . Endoscopic techniques are advancing, with the use of chromoendoscopy and optical techniques with light source modulation, such as fluorescence endoscopy and elastic scattering spectroscopy. In this sense, the use of AI has proven to be of great relevance in oncological diagnosis, both in the analysis of exams and in the classification, in a precise way in the identification

and characterization of imaging exams, even subtle changes. In gastroenterology, the application of endoscopic capsules has been effective in detecting the location of mucosal changes, such as colonic polyps , especially in the 2010s with a significant increase in the search for this segment, being improved over the years regarding its specificity, sensitivity, positive predictive value and precision in the elaboration of statistics[1].

It is worth analyzing that the use of AI is still a field that needs improvement, such as the identification of *H. pylori*. Analysis systems need to have more rigorous control with a greater variety of image and endoscopy databases, with the concomitant application of convolutional neural network (CNN) algorithms that take over image processing after training with images selected by researchers, which are limited to existing models. Overcoming these challenges corresponds to better accuracy when identifying cured and infected patients, or the precise anatomical location of the site of infection, important aspects for the clinical area. To identify changes in the gastric mucosa, specific markers are used that identify surface and color, which are subsequently interpreted by endoscopists, whose assessment could be replaced by real-time AI, applying antiperistaltic agents to polyethersulfone and indigo carmine chromoscopy to identify lesions surfaces with irregular pattern[1].

Studies indicate that the use of AI is essential in the detection of gastric diseases, with a focus on dysplasia in esophageal cancer, esophageal squamous cell carcinoma, gastric cancers and *H. pylori* infection. Artificial intelligence based on machine learning is divided into deep learning (DL) algorithm and artesana (conventional) algorithm. In the latter, researchers work manually to identify characteristics with pathogenic potential based on clinical medicine, while in DL, autonomously, they extract and learn the discriminative characteristics of the image. People with Barrett's esophagus have an increased risk for developing esophageal adenocarcinoma, and its detection using AI is a promising area in an attempt to perform high-precision biopsies, endorsed by the American Society for Gastrointestinal Endoscopy, with a sensitivity of 90% and a negative predictive value of 98% in the detection of high-grade dysplasia, being one of the most promising areas in the area of endoscopy for computer-based diagnosis (CAD). Regarding esophageal cancer, the sixth leading cause of cancer death in the world, the replacement of the gold standard method of identifying lesions using Lugol's chromoendoscopy, which requires a trained professional eye to identify lesions, resulting in low specificity (70%), by a model governed by AI using CNN as a base, a machine learning with a larger amount of data, resulting in a sensitivity of 98%. Gastric cancer is linked to a high mortality rate worldwide. In the initial stages, it is difficult to identify due to its superficiality and mild erythema, and when advanced, it makes detecting the depth of the mucosal lesion a challenge, as it can reach the submucosa and it is necessary to know how to distinguish the classifications into mucosal, submucosal 1 and 2, as this will define the appropriate treatment in order to reduce the risk of metastases, using CAD in the diagnosis[2].

In a study carried out in Japan, non-magnified white light images were used in the double-check support system (DCSS) instead of retrospective analysis in the database, using artificial intelligence, with the aim of identifying low-quality images, inadequate for the diagnosis of gastric, esophageal, duodenal and stomach lesions. By using deep learning models to improve the quality of images available in DCSS, detecting lesions using the Cascade R-CNN algorithm, a highly efficient method for detecting objects in the medical environment, as convolutional neural networks (CNNs) intersect in cascade under Union-related thresholds (IoU). In addition to these mechanisms, DenseNet was used, which forms a convolutional network of layers to construct a more accurate study. Using these AI tools, a Positive Predictive Value (PPV) of 92.5%, accuracy of 80.4% and sensitivity of 86.1% in detecting lesions were obtained, this system being superior to endoscopic detection of gastric cancer. DCSS also has good accuracy when using low-quality images, helping doctors when analyzing Upper Digestive Endoscopy images. Comparatively, in a study carried out in China using the DCNN system, comparing intraepithelial, intramucosal and submucosal lesions, with an accuracy of 95.3%, contrary to the assessment carried out by endoscopists (87.3%), with high sensitivity, specificity and PPV, as the gold standard in the diagnosis of gastroesophageal cancer is upper digestive endoscopy with biopsy, however it depends on the skill and experience of the performing endoscopist, which is non-existent when it comes to algorithms and artificial intelligence tools[3,7].

Early detection of gastric cancer is of paramount importance to improve survival rates and clinical outcomes for patients. However, white light endoscopy, widely used for this purpose, faces challenges in accurately identifying cancerous lesions especially when they are small. A recently developed technique, known as endoscopic magnification with narrowband imaging (ME-NBI), has been noted for its effectiveness in distinguishing early gastric cancer from noncancerous lesions. This method uses the Vessel and Surface Classification System (VSCS) and the Simple Diagnostic Algorithm for Early Gastric Cancer (MESDA-G) which are valuable tools in this diagnostic process. Studies reveal that the rate of negative misdiagnosis when using esophagogaduodenoscopy (EGD) varies between 4.6% and 25.8%. Recently, artificial intelligence (AI), especially based on convolutional neural networks (CNNs), has made remarkable progress in several areas, including medicine. Previous research has demonstrated that AI, when trained on endoscopic images, can accurately identify gastric cancer. However, there is a lack of studies comparing the diagnostic capacity of CNNs with that of endoscopists[8,9].

Gastric cancer, in particular, is one of the most common forms of cancer in China, with early detection playing a crucial role in improving treatment outcomes. Although endoscopy is a common tool for diagnosing gastric cancer, detecting early stages can be challenging due to the lack of clear symptoms and the potential for misdiagnosis. Artificial intelligence (AI) has emerged as a promising

diagnostic tool for gastric cancer. Several AI models have been developed and tested to classify and detect gastric lesions, with encouraging results that surpass the accuracy of experienced endoscopists. These models include Inception-v3, U-Net, VGG16, ResNet50, Tango, YOLOv3, and Mask RCNN. They are able to identify abnormalities in gastroscopic images and mark their location precisely. Among AI methods, models based on convolutional neural networks (CNNs) have stood out in detecting early gastric cancer. RCNN models, including Faster RCNN, Mask RCNN, and Cascade RCNN, have been particularly effective in locating and identifying cancerous lesions in gastric endoscopy images. A recent study compared the performance of these different RCNN models in detecting early gastric cancer, demonstrating that the AI consistently outperformed the accuracy of human experts. These findings highlight the transformative potential of AI in the early detection and effective treatment of gastric cancer, offering hope for improving outcomes for patients[10].

Gastrointestinal cancer can affect both the upper tract, which includes the esophagus and stomach, and the lower tract, encompassing the colon and rectum. Detecting these cancers early is essential for effective treatment, as many cases are diagnosed at advanced stages, leading to high mortality rates. Although several diagnostic techniques such as biomarkers and endoscopy have been developed, early detection of conditions such as polyps and tumors is still challenging due to the complexity of gastrointestinal structures. The introduction of wireless capsule endoscopy in 2000 has allowed comprehensive visualization of the gastrointestinal tract, but manual analysis of images captured by this method is time-consuming and error-prone. Artificial intelligence (AI), especially algorithms such as convolutional neural networks (CNNs), has proven effective in identifying anomalies and classifying gastrointestinal diseases, assisting doctors in quickly and accurately analyzing images. Recent studies highlight the benefits of AI techniques in detecting polyps and differentiating between malignant and benign tissues. Furthermore, hybrid methods between AI and machine learning have proven to be superior even to the accuracy of human experts, promising to revolutionize endoscopic diagnosis and enabling more effective treatments for patients with gastrointestinal cancer. Gastric cancer is one of the leading causes of cancer-related death worldwide. When diagnosed early, it can be treated with endoscopic or surgical resection. However, differentiating between intramucosal and submucosal cancer is crucial in determining the best course of treatment. The accuracy of traditional diagnostic methods such as endoscopy and ultrasound is limited. Recently, artificial intelligence (AI) has been successfully applied to diagnose the invasion depth of gastric cancer, showing high sensitivity and specificity. A study focused on differentiating between intramucosal and submucosal gastric cancer developed an AI classifier and proposed a diagnostic method that combines AI analysis with the opinion of expert endoscopists. This approach promises to improve diagnostic accuracy and optimize the treatment of early gastric cancer[11,12].

FINAL CONSIDERATIONS

This article demonstrated a database that reveals the importance of artificial intelligence in the early diagnosis of gastrointestinal diseases, such as *Helicobacter pylori*. Furthermore, the elucidation regarding the Kyoto classification and endoscopy corroborates the relevance of using artificial intelligence in gastrointestinal oncological diagnoses, interpretation of exams, and identification of subtle changes that are generally not identified.

Furthermore, colorectal cancer is one of the most lethal forms of cancer in the world population, highlighting the urgency of early detection to improve patient survival. In this way, the use of artificial intelligence significantly reduces the number of undetected lesions and improves the effectiveness of colorectal cancer diagnosis. This avoids challenges like blind areas and human errors that require improved strategies.

Similarly, technological advances allow storage and processing of health data, with systems such as EnDia 2.0 helping to manage information from upper digestive endoscopy exams, applying computational processes to acquire useful knowledge for specific decisions.

However, although there has been notable progress in endoscopy, it is necessary to clarify that there are still challenges to be overcome, as AI needs to improve its database for recognizing and analyzing exams and images, which are still limited. Therefore, control systems need to expand their convolutional neural network (CNN), deep learning (DL) and conventional algorithms to obtain better image processing and exam interpretation in order to obtain a more accurate diagnosis of the pathologies investigated.

In short, Artificial Intelligence has relevant clinical aspects for the diagnosis of gastrointestinal diseases, especially with regard to neoplasms and identification of discrete changes in the digestive tract. Furthermore, studies demonstrate increasing advances in this area that lead to the early diagnosis of pathologies that affect the gastrointestinal system.

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