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New advances in artificial intelligence for the diagnosis and treatment of colorectal cancer: a literature review

Novos avanços em inteligência artificial para diagnóstico e tratamento do câncer colorretal: uma revisão de literatura

Nuevos avances en inteligencia artificial para el diagnóstico y tratamiento del cáncer colorrectal: una revisión de la literatura

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The article helps update the debate on new applications of AI in the diagnosis of CRC, synthesizing the gaps and offering an integrative view of the relevant literature.
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This research evaluates recent AI applications in CRC diagnosis and treatment, considering regional healthcare variations, offering insights into the evolving landscape of precision medicine for CRC.

ABSTRACT

Introduction: With 1.93 million new instances of colorectal cancer (CRC) reported in 2020, the disease presents a danger to world health. With its potential to improve CRC management, artificial intelligence (AI) has become increasingly prominent in the medical field. This research attempts to evaluate the current status of AI applications in CRC diagnosis and treatment, considering regional differences in healthcare systems and populations. **Methodology**: On databases like ScienceDirect, Google Scholar, and PubMed, a systematic literature evaluation was carried out using search phrases including "artificial intelligence," "colorectal cancer," "diagnosis," and "treatment." English-language research on AI applications in CRC diagnosis and treatment that were published during the previous five years met the inclusion criteria. **Results**: Endoscopic, non-invasive, histological, and radiographic techniques are among the AI applications used in CRC diagnosis. Prognostic forecasts, diagnostic accuracy, and tumor segmentation are all significantly enhanced by AI. AI helps with targeted therapy and chemoradiotherapy decision-making, improves surgical accuracy, and helps with personalized regimens. **Conclusion**: The use of AI in colorectal cancer management has the potential for timely identification, precise diagnosis, and customized care. Continuous developments in AI algorithms and clinical data support the development of precision medicine, which offers significant gains in CRC treatment and detection.

Keywords: colorectal cancer; diagnosis; Artificial intelligence (AI) ; treatment.

RESUMO

Introdução: Com 1,93 milhão de novos casos de câncer colorretal (CCR) relatados em 2020, a doença representa um perigo para a saúde mundial. Com o seu potencial para melhorar a gestão do CCR, a inteligência artificial (IA) tornou-se cada vez mais proeminente na área médica. Esta pesquisa tenta avaliar o estado atual das aplicações de IA no diagnóstico e tratamento do CCR, considerando as diferenças regionais nos sistemas de saúde e nas populações. **Metodologia**: Em bases de dados como ScienceDirect, Google Scholar e PubMed, foi realizada uma avaliação sistemática da literatura usando frases de busca, incluindo "inteligência artificial", "câncer colorretal", "diagnóstico" e "tratamento". Pesquisas em inglês sobre aplicações de IA no diagnóstico e tratamento do CCR publicadas durante os cinco anos anteriores atenderam aos critérios de inclusão. **Resultados**: As técnicas endoscópicas, não invasivas, histológicas e radiográficas estão entre as aplicações de IA utilizadas no diagnóstico do CCR. As previsões prognósticas, a precisão do diagnóstico e a segmentação do tumor são significativamente melhoradas pela IA. A IA ajuda na tomada de decisões sobre terapia direcionada e quimiorradioterapia, melhora a precisão cirúrgica e ajuda com regimes personalizados. **Conclusão**: O uso da IA no tratamento do câncer colorretal tem potencial para identificação oportuna, diagnóstico preciso e atendimento personalizado. Desenvolvimentos contínuos em algoritmos de IA e dados clínicos apoiam o desenvolvimento da medicina de precisão, que oferece ganhos significativos no tratamento e detecção do CCR.

Palavras-chave: câncer colorretal; diagnóstico; Inteligência artificial (IA); tratamento.

RESUMEN

Introducción: Con 1,93 millones de nuevos casos de cáncer colorrectal (CCR) notificados en 2020, la enfermedad presenta un peligro para la salud mundial. Con su potencial para mejorar la gestión del CCR, la inteligencia artificial (IA) se ha vuelto cada vez más prominente en el campo médico. Esta investigación intenta evaluar el estado actual de las aplicaciones de la IA en el diagnóstico y tratamiento del CCR, considerando las diferencias regionales en los sistemas de salud y las poblaciones. **Metodología**: En bases de datos como ScienceDirect, Google Scholar y PubMed, se llevó a cabo una evaluación sistemática de la literatura utilizando frases de búsqueda que incluían "inteligencia artificial", "cáncer colorrectal", "diagnóstico" y "tratamiento". La investigación en inglés sobre aplicaciones de IA en el diagnóstico y tratamiento del CCR que se publicó durante los cinco años anteriores cumplió con los criterios de inclusión. **Resultados**: Las técnicas endoscópicas, no invasivas, histológicas y radiográficas se encuentran entre las aplicaciones de IA utilizadas en el diagnóstico del CCR. La IA mejora significativamente los pronósticos de pronóstico, la precisión del diagnóstico y la segmentación de tumores. La IA ayuda con la toma de decisiones sobre terapias dirigidas y quimio-radioterapia, mejora la precisión quirúrgica y ayuda con regímenes personalizados. **Conclusión**: El uso de la IA en el tratamiento del cáncer colorrectal tiene el potencial de lograr una identificación oportuna, un diagnóstico preciso y una atención personalizada. Los continuos avances en algoritmos de IA y datos clínicos respaldan el desarrollo de la medicina de precisión, que ofrece ganancias significativas en el tratamiento y la detección del CCR.

Palabras clave: cáncer colorrectal; diagnóstico; Inteligencia artificial (IA); tumor; tratamiento.

INTRODUCTION

The public's health is at risk from a frequent condition called colorectal cancer (CRC). The International Agency for Research on Cancer estimates that 1.93 million new cases of colorectal cancer (CRC) occurred globally in 2020, placing it in third position on the list of most prevalent cancers. Particularly noteworthy is the prevalence of CRC in nations going through social and economic upheaval. In terms of morbidity, lung cancer accounted for the majority of the approximately 560 thousand newly diagnosed cases of colorectal cancer in China in 2020 (Sung et al., 2021). China is expected to have more new instances of colorectal cancer (CRC) than any other country in the world in 2022, with an estimated 590 thousand cases, according to demographic statistics from the World Health Organization (WHO) and the GLOBOCAN 2020 cancer assessment (Xia et al., 2022). These days, endoscopy, imaging, histopathological examination, laboratory testing, and other procedures are the primary means of diagnosing colorectal cancer. Among the conventional methods of treating colorectal cancer (CRC) are surgery, radiation, and post-metastasis treatment (Ciardiello et al., 2022). The frightening increase in CRC incidence and death occurs despite all these methods.

Artificial intelligence (AI) may be defined as the study of the fundamentals of human intelligence activities, the creation of artificial intelligence-capable systems, and the investigation of ways to allow computers do tasks that previously required human intellect. These days, AI is being used extensively in medicine because to the quick advancement of computer technology and the fervent advocacy of precision medicine (Mitsala et al., 2021). There are presently two categories of AI applications in medicine: virtual and physical. AI's machine learning (ML) subfield is crucial. Additionally, it may be broken down into subsets like convolutional neural networks (CNN), support vector machines (SVM), random forests (RF), supervised learning (SL), semi-supervised learning (SSL), deep learning (DL), and random forests (RF). DL and CNN are two of the most effective algorithms that have been applied to medicine recently (Sultan et al., 2020). They are involved in many different aspects of medicine administration, diagnostic prediction, information control, and data management (Hassan et al., 2021). The primary applications of physics are in the fields of medical equipment and robots, including the widely-used da Vinci robot system (Park et al., 2020).

AI in CRC screening has the potential to greatly lower the incidence and death rates of CRC patients by increasing the early screening rate. AI's built-in bioinformatics capabilities may assist in finding and screening additional CRC biomarkers. AI-assisted pathology identification technology may decrease the percentage of missing and incorrect diagnoses, increase pathologists' productivity, and lessen their burden (K. S. Wang et al., 2021). AI image recognition uses machine learning (ML), which may significantly increase the readability of medical pictures, decrease empirical mistakes, objectively give thorough and trustworthy reference viewpoints, and assist clinicians in making more correct clinical judgements.

Research on AI applications for CRC is now at a broad stage, including a variety of approaches and technology. Important studies in the field have examined the use of AI in several areas, such as biomarker discovery, therapy response prediction, and image interpretation of radiographic and histological data(Echle et al., 2020). Even with the encouraging outcomes, there are disagreements and conflicting theories, especially when it comes to the approval and use of AI models in healthcare settings. Solving these problems is essential to guarantee the consistency and dependability of AI-assisted methods in the intricate field of colorectal cancer (Mitsala et al., 2021).

It is clear that context-specific solutions are required in a global setting. Contextualizing the use of AI in CRC diagnosis and therapy based on local literature of particular nations is crucial, given the variability of healthcare systems, patient demographics, and available resources. Furthermore, it is critical to conduct a comprehensive analysis of the literature from across the globe during the last five years in order to grasp the most current developments and patterns in AI-driven techniques for CRC.

This work's primary goal is to objectively assess the state of AI applications in colorectal cancer detection and therapy, addressing issues and conflicting theories. By doing this, we want to provide a thorough grasp of the possible advantages, difficulties, and future directions of incorporating AI into CRC management. The goal of this project is to direct the development of strong, evidence-based AI solutions that will improve the accuracy and effectiveness of care for colorectal cancer while also adding to the current conversation in the field.

METHODS

The integrative approach of methodology is adopted in this review and it involves a methodical examination and evaluation of pertinent material sourced from scholarly sources such as ScienceDirect, Google Scholar, and PubMed. The approach presented supports the methodology, and some of its components have been modified from established methods in related review studies.

Search terms such as "artificial intelligence," "colorectal cancer," "diagnosis," and "treatment" were used to search the relative literature and articles. Refinement of search queries for a more focused retrieval of literature was done via the use of Boolean operators (AND, OR).

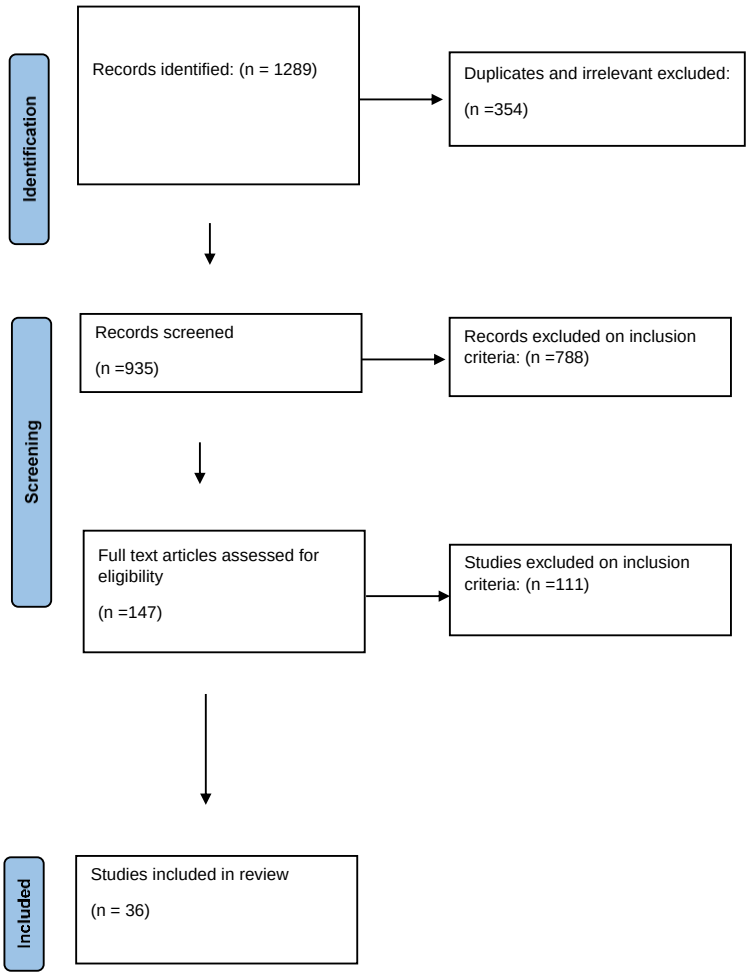
Inclusion and Exclusion Criteria:

- Studies with an emphasis on AI applications in colorectal cancer diagnosis and therapy that have been published in English within the last seven years (2017-2023) are eligible for inclusion.
- Research involving non-human participants, irrelevant results, or poor technique was excluded.

A preliminary screening of publications was conducted using abstracts and titles as the primary criteria which resulted in 1289 articles. The application of inclusion and exclusion criteria shorted down the articles to 147. It was followed by a full-text examination of the publications and leaving 36 articles to be included in review. Their results and contribution to the literature is reviewed in this article for providing valuable evidence.

A systematic approach was used to classify literature review results on recent breakthroughs in artificial intelligence (AI) for colorectal cancer (CRC) detection and therapy into coherent analytical categories. To guarantee clarity and consistency, the categorization used precise criteria and a logical framework. Endoscopic diagnosis, non-invasive examination, diagnostic histology, and diagnostic radiography fall within AI diagnosis approaches. Each category was based on AI applications and methods used to overcome CRC diagnostic difficulties. Endoscopic diagnostics focused on AI-enhanced adenoma identification, whereas non-invasive examination examined how ML improves tumor marker accuracy. DP uses of deep learning in diagnostic histopathology might increase diagnostic efficiency. Diagnostic radiology focused on AI-enhanced radiomics and CRC imaging accuracy. After using AI to CRC treatment, the outcomes were divided into surgical method, chemoradiotherapy, and AI in tailored medication. In minimally invasive surgery, chemotherapeutic decision support systems, and prediction models for customized targeted therapy, AI is developing in CRC treatment. This thorough categorization organizes AI's numerous uses in CRC diagnosis and therapy, making current advances easier to grasp.

Figure 1. Flowchart with the stages of the literature review



Source: own elaboration (2023)

RESULTS AND DISCUSSION

AI techniques in diagnoses:

Endoscopic diagnoses:

Despite being the gold standard for early colorectal screening, colonoscopy has limitations due to operator variability and inadequate preparation, which affects the polyp and adenoma detection rate (Viscaino et al., 2021). Researchers are using computer-aided detection (CADe) and artificial intelligence (AI), mostly based on deep learning (DL) methods, to solve these problems (Su et al., 2022). In colorectal cancer (CRC) screening, the adenoma detection rate (ADR) is a critical criterion. Artificial intelligence (AI)-assisted colonoscopy, specifically with YOLOV3 AI, has demonstrated the ability to significantly improve ADR in real-time, making it an affordable option for widespread adoption, particularly in developing regions (J. W. Li et al., 2021). Furthermore, real-time CADe technology helps to spot tiny, low-risk polyps and adenomas that might go unnoticed during a traditional colonoscopy, which could lower the incidence of colorectal cancer (CRC) (P. Wang et al., 2019). Research, such as that conducted by Kamba et al., shows how artificial intelligence (AI), particularly when it comes to CNN algorithms, has significantly reduced the adenoma miss rate (AMR), which is a crucial metric that quantifies differences in lesions discovered during a follow-up endoscopy (Kamba et al., 2021). In comparison to a conventional colonoscopy, the CADe-assisted group had a lower AMR (22.9%), demonstrating the sensitivity of AI in lesion diagnosis.

Identifying benign and malignant polyps is also crucial once the colorectal polyps have been filtered out. The integration of AI with colorectal endoscope has injected additional momentum for future diagnosis as endoscopic techniques, including magnifying endoscopy, chromoendoscopy, confocal laser endomicroscopy, and autofluorescence endoscopy, continue to progress (Mitsala et al., 2021). Narrow-band imaging (NBI) was formerly used by Japanese specialists to categorize magnifying endoscopes. They were the first to use magnifying endoscopes with NBI imaging technologies in a clinical setting (Byrne et al., 2019). Gonai et al. determined the difference in microvessel density in colorectal lesions using a combination of NBI and magnification endoscopy. This difference served as the differential point for the diagnosis of colorectal cancer (CRC) against adenoma (Gonai et al., 2019). Using probe confocal laser endoscopy, a few US specialists created CADe algorithms that year to differentiate between tumor and non-tumor polyps. More than 90% can be said of the sensitivity, specificity, and sensitivity (Yin et al., 2023). It is anticipated that the use of AI would significantly increase endoscopic diagnostic accuracy while lowering the risk of misdiagnosis and overtreatment.

Non-invasive examination:

Finding different, relatively specific tumor markers in ascites, faeces, blood, and other samples is the primary non-invasive screening method. Non-invasive screening has a lower risk and requires less preparation time than colonoscopy screening (A. Ferrari et al., 2021). Nevertheless, few useful tumor markers exist for the early diagnosis of colorectal cancer. Low sensitivity and specificity are characteristics of common non-invasive screening techniques like carcinoembryonic antigen (CEA) and faecal occult blood test (FOBT) . Medical data analysis has made extensive use of machine learning (ML) in recent years, which may help us filter out new possible marker genes and increase the accuracy of already available biomarkers (Su et al., 2022).

One of the most researched indicators for colorectal tumors is CEA; however, in individuals without symptoms, the sensitivity of blood CEA screening is low. Li et al. employed five machine learning models to separate CRC patients from healthy individuals after extracting some of the most prevalent indicators from laboratory blood testing (H. Li et al., 2021). By providing a non-invasive and economical method, the logistic regression model considerably improves the sensitivity and specificity of CEA for the diagnosis of colorectal cancer (CRC). BRAF V600E mutations in CRC tissues are successfully differentiated by Zhang et al. using NIR spectroscopy and CP-ANN, exhibiting high sensitivity (100%) and specificity (87.5%) (X. Zhang et al., 2019). Six DNA methylation indicators are identified using the "Walking away" approach in conjunction with machine learning, which may improve the identification of colorectal cancer (CRC) (A. Ferrari et al., 2021). The evaluation of CRC prognosis is aided by bioinformatics analysis and machine learning, which also uncovers early biomarkers.

A recent study by Hammad et al. used bioinformatics analysis of gene expression microarray data in the Gene Expression Omnibus (GEO) collection to identify 105 differentially expressed genes (DEGs) and 10 hub genes. The diagnostic utility of hub genes as CRC biomarkers was predicted by the researchers using a variety of techniques, such as SVM, survival analysis, and Receiver Operating Characteristic Curve (ROC). According to the findings, every gene's area under the ROC curve (AUC) value was more than 0.92, indicating that these genes are likely to be biomarkers for colorectal cancer (CRC) (Hammad et al., 2021). The field of sequencing technology has led to the discovery of several non-coding RNAs, or ncRNAs. Long non-coding RNAs (lncRNAs), messenger RNAs (mRNAs), microRNAs (miRNAs), and so forth are examples of non-coding RNAs (ncRNAs). Because of their persistent extracellular characteristics and ease of extraction and preservation, they may be examined in a variety of bodily fluids (Tanos et al., 2020). A family of endogenous ncRNAs with a length of around 22

nucleotides is known as microRNAs (miRNAs). They are linked to the initiation and spread of cancer and perform a number of crucial regulatory tasks in the cell. MiRNAs may be useful indicators of colorectal cancer (CRC), according to mounting data (W. W. Zhang et al., 2019). Through bioinformatics analysis techniques, such as Kyoto Encyclopedia of Genes and Genomes (KEGG) enrichment analysis, correlation analysis, survival analysis, validation of expression levels, protein–protein interactive (PPI) network construction, and gene ontology (GO), Zhang et al. (2019) determined whether miR–31 could be used as a biomarker for the diagnosis of CRC lymph node metastasis (LNM). These scientists discovered that the plasma and tissue of CRC patients with LNM had considerably higher levels of miR-31. They hypothesized that miR-31, which has a significant predictive impact on patients, would target TNS1 as a protein (W. W. Zhang et al., 2019).

Diagnostic histopathology:

Planning a treatment strategy and diagnosing tumors depend heavily on pathology. Deep learning and pattern recognition applications in digital pathology (DP) enable automated AI-assisted diagnoses, suggesting a bright future for pathology. Numerous studies have shown how pathologists may increase diagnosis rates and decrease misdiagnosis rates by using AI technology to improve diagnostic efficiency, reduce burden, and enhance working conditions (Acs et al., 2020). AI was utilized by Kasahara et al. to gather 146 T1 CRC patients. They examined the nuclear morphological features in slide pictures stained with hematoxylin and eosin (HE). The model may improve preoperative lymph node metastatic prediction accuracy, according to the findings; nevertheless, further clinical practice validation is required (Kasahara et al., 2022).

Medical image processing in the setting of colorectal cancer (CRC) has been greatly influenced by deep learning, notably as shown by Convolutional Neural Networks (CNN). Researchers trained CNN through transfer learning using more than 100,000 Hematoxylin and Eosin (HE) picture patches from CRC tissue slides. This resulted in an impressive nine-class accuracy of over 94% in differentiating histological images and forecasting the survival rate of CRC patients receiving therapy (Kather et al., 2019). A CNN-based method for classifying histopathological images was introduced by Wang et al.; in separating CRC from benign tissues, the method showed an outstanding area under the curve (AUC) of 0.988 (K. S. Wang et al., 2021). A number of research works suggested the use of CNN for therapeutic equivalency; they included the categorization and staging of colon histopathology photos stained with hematoxylenol (HE) with over 90% accuracy in four different datasets (Wei et al., 2021).

Moreover, the leading method in AI-assisted pathology detection solutions is now self-supervised learning (SSL). The problem of huge data markers in supervised learning (SL) is addressed by an SSL approach based on average instructor structure, which shows promise in improving AI core dependability and lowering the need for impracticable labelled data .(Yu et al., 2021) Significant progress has been made in AI-supported pathological reading, as shown by the precise prediction of surgical outcomes for CRC patients with lung metastases by a comprehensive model that incorporates ML-pathomics, immunoscore, radiomics, and clinical factors.

Diagnostic radiology:

The process of "radiomics," which converts medical pictures into high-dimensional data, is now essential for prognosticating and diagnosing cancer. While MRI, CT, and ultrasonography are examples of traditional CRC imaging modalities with limitations, AI systems, namely those that use T2-weighted imaging (T2WI), improve prediction accuracy. Tumor segmentation and quantitative evaluation are made possible by the extraction of information from many picture sources using a combination of AI and radiomics. Using a generative adversarial network (Lagan) with label assignment, Liu et al. presented an accurate CRC ROI segmentation approach that reduced labor costs and time (Liu et al., 2019). Using a U-Net deep neural network as the foundation, Hamabe et al. created a rectal cancer segmentation program that produced high DICE similarity coefficients in MRI image segmentation (Hamabe et al., 2022). Song et al. used endorectal ultrasonography to develop a deep multi-view fusion network system for early CRC detection, which significantly decreased the number of false positives and the amount of labor ultrasonographers had to complete (Song et al., 2022). These developments demonstrate the value of AI-enhanced radiomics for accurate CRC treatment and diagnosis.

Another important use is the prediction of radiation-induced localized advanced rectal cancer (LARC) after therapy. The ERUS has poor diagnostic utility for metastasis of advanced CRC, although it may be utilized to diagnose early CRC. For the purpose of pathologic complete response (PCR) diagnosis, the MRI evaluation after neoadjuvant therapy may not be dependable. It's interesting to note that by creating a nomogram, we can forecast and categorize the risk of patients after neoadjuvant chemoradiotherapy (NCRT). By combining clinicopathological variables with multi-parametric MRI data, this nomogram removes the impact of PCR intervention and aids in the selection of more precise therapy alternatives (Liu et al., 2021). In a similar vein, Farri et al. developed an AI model to assess the PCR of 55 LARC patients after NCRT, based on the textural properties of MRI images. The findings demonstrated an AUC of 0.86, indicating its value in predicting PCR patients after NCRT (R. Ferrari et al., 2019). A lot of research is still done on distant metastasis using radiomics. In order to track the liver metastases of colorectal cancer, Rocca et al. suggested using CT in conjunction with formal techniques (FMS) last year. The accuracy percentage as a whole was 93.3%. It seems that the FMS is reliable and beneficial (Rocca et al., 2022).

The application of AI in CRC treatment:

Chemotherapy, targeted therapy, surgery, and various combination therapies are used to treat colorectal cancer. AI may be used to create personalized and accurate treatment regimens for patients with colorectal cancer (CRC), improving their prognosis and offering more personalized care.

The surgical procedure:

With the advancement of minimally invasive surgery in recent years, the use of AI in surgery has also increasingly gained relevance. AI was used in lung cancer and breast cancer surgeries sooner than in more complex colorectal cancer surgery. Notably, people are starting to research the use of AI in colorectal surgery and are rapidly realizing that this might lead to significant advancements in the field. A plethora of scientific data on CRC is emerging. Video data analysis and evaluation are possible using computer vision (CV), a branch of artificial intelligence (138). In an effort to improve CNN performance in CV, a group of Japanese researchers have gathered and examined 300 recordings of laparoscopic colorectal surgery. In the same year, South Korean researchers also studied the perfusion of the indocyanine green (ICG) angiography system during laparoscopic colorectal surgery using artificial intelligence. They obtained 10,000 ICG curves, or 200 ROIs for each of the 50 patients. After that, they categorized these data sets into 25 curve types, demonstrating that the use of AI has improved the accuracy of the virtual microcirculation analysis system (Park et al., 2020).

These days, robotic surgery also makes more impressive progress in the field of colorectal surgery, particularly in the area of rectal surgery. Robotic surgery has also been shown to be viable, even in the rather sophisticated and challenging transanal total mesorectal excision (taTME), which calls for extensive laparoscopic expertise. Robotic surgery offers many benefits over open and laparoscopic surgery, including less perioperative bleeding, fewer problems, and enhanced quality of life after surgery. Simultaneously, it may alleviate weariness and lessen the difficulty of the surgeon's procedure (Sheng et al., 2018). Regarding the long-term consequences, the mortality and recurrence rates after robotic surgery are similar to those following laparoscopic surgery. Surgeons may find it easier to identify anatomical tissue during TME with the aid of a flat image navigation system that Igaki et al. recently successfully created. For a more accurate identification in the future, this system requires additional picture data (Igaki et al., 2022).

The da Vinci robot system, which has advanced to the fourth generation, is now the most popular robot available. In the cantilever system, the fourth-generation robot has significantly improved. It now has more sensitive eyesight, precision operation, and a greater concern for individual requirements. Nonetheless, several issues persist, including prolonged operation duration, restricted range of motion, and inadequate sensory system (Ngu et al., 2017). Da Vinci SP is a robot with a single hole in it. It includes three surgical instrument arms and one robotic arm that may be attached to three machines via a single connector. The da Vinci SP system is a great model for taTME and natural orifice specimen extraction, according to experiments.

Chemoradiotherapy:

NCRT is crucial for the treatment of colorectal cancer (CRC), particularly in individuals with rectal cancer. Patients categorized as moderate risk are the main ones who get adjuvant chemotherapy. Nonetheless, the majority of patients do not need further treatment, making precise clinical decision-making very crucial. AI is beneficial for NCRT patients' treatment decisions and efficacy assessments. Clinical Decision Support Systems (CDSs) powered by Artificial Intelligence (AI) have garnered a lot of attention recently as one of the instruments that may substantially reduce medical negligence. South Korean specialists processed a CRC chemotherapy recommender. This is the nation's first CDSS to use actual data. The data source is somewhat particular and singular (149), which is a downside, but the accuracy is good (AUC > 0.95). Kleppe et al. recently developed the CDSSs based on DL to create a new risk division for patients after colectomy, and they created a DoMore-v1-CRC marker. Patients may be excused from NCRT if they were deemed to be low risk. Consequently, these individuals saw a considerable improvement in their survival rate (Kleppe et al., 2022).

When selecting suitable treatment regimens, clinical professionals consider the prognosis assessment of patients with colorectal cancer. A popular area of current study is the prediction of metastases in LARC patients getting NCRT by DL-based aided MRI (Liu et al., 2021). Interestingly, Farrando et al. created a classifier to forecast the reaction of LARC patients undergoing NCRT. By assessing lncRNA expression, the researchers were able to get good results (AUC = 0.93) (Ferrando et al., 2020). To effectively predict medication resistance, the researchers combined vast computational power with biomarkers with substantial stability, including lncRNAs.

AI in Customized Medicine:

One of the most successful treatments for CRC is targeted therapy. One of the key pharmacological targets is the epithelial growth factor receptor (EGFR). The KRAS gene has strong EGFR sensitivity (152). Nonetheless, it is thought to be a major problem to forecast the KRAS mutation status in CRC non-invasively. To do this, several researchers have recently used the residual neural network-based DL approach, which has shown excellent prediction performance (AUC = 0.90) on the axis.

This is beneficial for more focused CRC therapy (He et al., 2020). In colorectal cancer (CRC), the BRAF gene mutation rate might reach 10%.

Drug resistance may also result from abnormal changes in genes and chromosomes, which presents several challenges for the treatment of colorectal cancer. In such a setting, drug delivery platforms for tailored treatment will advance precision medicine in the future (Sharifi-Azad et al., 2022). Russo et al. analyzed patients who could develop medication resistance both before and after therapy using an AI-based prediction algorithm. In the focused precision treatment and classification, they were able to obtain a sound effect (average AUC = 0.90) (Russo et al., 2022). Theoretical support for the diagnosis and management of colorectal cancer (CRC) may be obtained from genetic research on the disease as it can help us comprehend the pathophysiology of tumors at the molecular level.

Synthesis of theoretical and practical research gaps:

The analysis of the literature shows both convergence and divergence tendencies in the use of AI in the detection and management of colorectal cancer. Convergently, AI shows significant progress in increasing the accuracy of diagnosis, especially in endoscopic, radiographic, and pathological methods. Divergence is shown, nonetheless, in the difficulties posed by non-invasive screening, where the sensitivity and specificity of the available markers continue to be barriers.

Critically, it becomes clear that ethical and epistemological issues are important to take into account when using AI in colorectal cancer research and therapy. Although AI has a great deal of promise for accuracy and speed, ethical issues with data privacy, algorithm bias, and the need for thorough clinical validation are brought up. These critical viewpoints emphasize the significance of methodological and ethical issues in the use of AI in colorectal cancer research and therapy, which helps readers get a more nuanced knowledge of the material. The review emphasizes the need of ongoing multidisciplinary cooperation, careful ethical consideration, and stringent validation procedures to guarantee the ethical and successful incorporation of AI in the treatment of colorectal cancer.

Discussion:

AI has recently been used in CRC surgery in several different contexts, with encouraging outcomes. It is true that we have certain obstacles to encounter and go beyond. Three components are required to enable the development of AI: algorithm model, computing power, and huge data. China's big data development is still in its early phases right now. There should be more robust communication between data centers and more high-quality data. Even the most sophisticated algorithm model won't be of much use without a substantial quantity of high-quality data to work with. Consequently, there is an immediate need to improve interoperability across many centers and standardize massive medical data (Mitsala et al., 2021)(Yin et al., 2023). Additionally, particular issues arise in different AI and imaging omics models. As an example, the majority of models rely on historical data. Strict standards for admission and exclusion apply to the cases. However, the imaging criteria for each center vary to some extent. As a result, a thorough assessment of these models' repeatability and practicality in real-world applications is still pending (Qiu et al., 2022).

Moreover, the outcomes derived by the DL remain uninterpretable. It is unable to accurately determine the root cause and provide a logical justification for the algorithm's internal workings and procedure. In DL, this phenomenon is known as the "black box" problem. The transparency and interpretability of the algorithm have been regarded as the fundamental principles, despite the fact that views about the use of the black box in medicine continue to disagree. By guaranteeing that patients, medical professionals, and other pertinent individuals comprehend clinical judgements completely, it helps to prevent patient privacy violations, ambiguous duties, and other ethical problems (Mantas et al., 2022). Currently, researchers are delving inside the DL model's black box to see how it determines judgements based on pictures and other data. The DNN model was used by Shao et al. to forecast the survival rate of almost 20,000 patients one year after major heart surgery. A creatively defined impact score was used to describe the model prediction's outcomes. There is a growing body of research on interpretable DL (Shao et al., 2021).

AI is still in its early stages of development in medicine, and there are still many obstacles to overcome before it can be widely used in colorectal surgery. In fact, AI has opened up a wide range of opportunities for advancement in this area. This does not imply that AI can take the position of medical professionals. To get across different transformation hurdles, there is a need to improve collaboration between computer specialists and physicians. In addition, we should assess how well physicians embrace various AI systems and reduce the influence of AI on medical diagnosis and treatment.

CONCLUSIONS AND FINAL REMARKS

AI in medicine will advance quickly thanks to huge clinical data's ongoing improvement. AI-based algorithms based on several algorithms combined with many large data sets from medical imaging serve to enhance the early diagnosis and

detection rate of colorectal cancer (CRC), as well as the early and systematic patient assessment. Additionally, it improves patients' prognosis monitoring by enhancing the effectiveness of adjuvant therapy, such as NCRT and targeted treatment. In the age of precision medicine, artificial intelligence will contribute more to the detection and treatment of colorectal cancer (CRC) via ongoing optimization and improvement.

This overview of AI in colorectal cancer (CRC) detection and therapy recognizes theoretical and methodological limitations. The limiting emphasis on English-language publications in the previous five years may create language and timing biases, eliminating significant insights from non-English literature and older research. The absence of grey literature and unpublished research in academic databases may reduce the results' comprehensiveness, raising publication bias issues. The chosen literature's variability in study designs, methodology, and AI techniques makes direct comparisons difficult, underscoring the need for more standardized research methods.

A study agenda addresses these limitations and guides future investigations. Future studies should examine AI's CRC screening accuracy and AI-guided tailored therapy effectiveness. To fully understand their influence, independent factors such AI algorithm types and integration throughout CRC care phases should be examined. To determine how AI affects clinical decision-making and patient outcomes, causal links must be examined. To identify cross-cultural differences in AI efficacy and implementation issues and accomplishments across healthcare settings, researchers should evaluate contexts, nations, and the target of study. By meeting these requirements, future research may improve our knowledge of AI's role in CRC treatment, promote evidence-based practices and ethical concerns, and ensure generalizability across varied populations and healthcare situations.

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	% of contribution of each author				
Task	**A1**	**A2**	**A3**	**A4**	**A5**
A. theoretical and conceptual foundations and problematization:	20%	20%	20%	20%	20%
B. data research and statistical analysis:	20%	20%	20%	20%	20%
C. elaboration of figures and tables:	20%	20%	20%	20%	20%
D. drafting, reviewing and writing of the text:	20%	20%	20%	20%	20%
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