Artificial intelligence applications in gastroenterology: steps ahead

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Abstract

Artificial intelligence (AI) applications are used in gastroenterology for automatic imaging diagnostic methods such as ultrasonography, computer tomography, magnetic resonance imaging, but also in endoscopy, capsule endoscopy and biopsy followed by automatic digital pathology evaluation. The accuracy of AI-based systems is superior to human expertise. Furthermore, in reality, a very small percentage of the patients are being investigated by a human expert in endoscopy, so implementing AI in this investigation would only increase the diagnostic accuracy. The existence of an unimaginable number of digital images and different types of medical information made possible the analysis and training of convolutional neural network (CNN), which consists of multilayers of artificial neural networks (ANN) with step-by-step minimal processing, creating a fundamental resource for any AI-based system to learn by itself how to automatically perform medical tasks, which were performed only by human experts in the past. The main objectives for AI applications used in gastroenterology are to improve the medical procedures with enhanced precision, to reduce the number of medical errors and to perform repetitive tasks.

Keywords: abdominal ultrasound, artificial intelligence, automatic diagnosis, endoscopy, future of medicine, gastroenterology

Introduction

Artificial intelligence (AI) is defined as a combination of advanced computer technologies that are able to perform human tasks such as calculating, evaluating, learning, understanding and even an extent of creative activities [1-4].

Unlike other computer programs, AI is programmed to learn by itself how a task is done, and then perform that task. As it is expected, there is a learning curve with a direct correlation between the precision that is required for the task and the amount of time spent by the program learning it [5-9]. Furthermore, the system has the capacity to self-diagnose and self-correct its own errors. Subsequently, for reducing the errors of the first stage of learning, supplementary data is introduced in the system by human experts. With time, human intervention is no longer necessary as the system achieves the maximum peak of the learning curve and can perform a task independently [6-10].

Artificial intelligence became a relevant topic in the 1950s, and by the 1980s we were already talking about machine learning - supervised, unsupervised and semi-supervised. In the last two decades, individual unconnected web networks have developed into incredible interconnected platforms, each one specialized in certain areas of medical sciences, from radiology, digital pathology, to surgery [1-6].

If we were to set a few milestones, in 1964 the first chatbot, Eliza, made its appearance; 20 years later, in 1986, the release of Dxplain: a decision support system, was happening. Fast forward to 2010, CAD is being applied to endoscopy. 2011 and 2014 introduce us to Apple's and Amazon's first virtual assistants, Siri and Alexa, which are expected to have also medical options soon [7-10].

Telemedicine, the electronic prescription of medicine, automatic diagnosis in Imagistics and the healthcare card, represent the palpable elements

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which already exist and would be integrated in future AI technologies. Nevertheless, the impalpable elements are the ones that will radically change the course of medicine.

A great advantage is that AI-based systems can also be used for advanced statistics, since the information they collect is easily introduced into an extensive medical data base. Analyzing large amount of data leads to a better prediction, therefore using more efficiently the available resources [10].

No matter the field they are applied to, the mechanisms behind are the same, for all AI based technologies. In the medical field, AI finds its utility in multiple specialties from gastroenterology to radiology, digital pathology, genetics, ophthalmology, and surgery [10].

When it comes to the surgical specialties, there has been an amazing progress in the last decade for automating surgical interventions, including gastrointestinal surgery, with advanced surgical robots now available on the market [10].

Initially used for long distance surgeries, robots are now able to perform an intervention independently, without the human intervention. In gastroenterology, automated robotic techniques in laparoscopic surgery are less advanced compared to the process of automated diagnosis [7-10].

Applications in gastroenterology

In gastroenterology, AI is being tested with extraordinary results in imaging diagnostic methods such as ultrasonography, computer tomography, magnetic resonance imaging, but also in endoscopy, capsule endoscopy and biopsy followed by digital pathology evaluation [11-20].

Using data collected from the previous mentioned diagnosis methods and from blood tests, AI systems can now fully manage the entire medical process, providing outcomes such as: detection, diagnosis, classification, staging, treatment plan, evaluate surgery risk, prediction of prognosis, prediction of treatment response, prediction of risk of metastases, follow-up monitoring, prediction of disease progression, of complications and providing individual targeted therapy [11-20].

Abdominal ultrasound, computer tomography and MRI provide images that are also collected and used for immediate recognition of hepatic steatosis, hepatic tumors or hepatic metastases, even with non-specific modifications or extremely reduced in size [12-27].

Even though there is no completely autonomous system in digestive endoscopy, colonic polyps, angiodysplasia, incipient gastric tumours which are not visible to the human expert, can be detected by AI systems more efficiently [12-26].

The accuracy of AI-based systems is superior to human expert accuracy. Furthermore, in reality, a very small percentage of patients are being investigated by a human expert in endoscopy, so implementing AI in this investigation, would only increase the diagnostic accuracy. As an example, in the Ulcerative Colitis Endoscopic Index of Severity, AI has a 92.9% accuracy for predicting histologic remission without the need of mucosal biopsy [18,19].

The years between 2018 and 2021, represent the start of AI trials in gastroenterology, which are the most important steps in the process of complete digitalization [1-8].

Because we already enter the big data era, the existence of an unimaginable number of digital images and different types of medical information, made possible the analysis and training of convolutional neural networks (CNN), which consists of multilayers of artificial neural networks (ANN) with step-by-step minimal processing, creating a fundamental resource for any AI-based system to learn by itself how to automatically perform medical tasks which were performed only by human experts in the past [1-4].

AI-based systems are already used in endoscopy, for the identification of neoplasia, detection of gastrointestinal bleeding, and polyp detection [11-25]. Further, AI technologies are used for the diagnosis of hepatic fibrosis, fatty liver disease, hepatic focal lesions and the assessment of liver cirrhosis.

In the domains of gastroenterology and hepatology, pathological analysis is the gold standard for determining the cause of illness. Because the global lack of pathologists, pathological analysis accuracy is decreasing. With the advancement of the whole-slide imaging scanners and AI-based technologies, reduction of medical costs has become possible without affecting diagnosis accuracy [1-3,25].

Limits and controversies

There are also a few limits that should be discussed. We mention that limits of AI-based technology are nearly the same for all medical specialties. The most frequent limit in most studies is related to rare diseases. Unfortunately, there is a very limited resource of images for testing in this case [26]. The lack of images, in general is another limit, caused by the mistrust of patients, who do not give their consent on using their data for research [27].

Recent studies have looked at the utility of AI-based technologies and shown promising outcomes. However, most of them were done retrospectively: as a case-control study from a single site, or by employing endoscopic pictures from certain endoscopic modalities that were unavailable at many institutions [1].

To correctly test the accuracy of AI, physicians must first understand the impacts of overfitting and spectrum bias on AI performance, and then attempt to evaluate the performance while avoiding these biases [1].

Other limitations include the need of permanent human surveillance, cultural, cultural variables, the fear unemployment, susceptibility to security risks, viruses,

malware, spyware, and grayware.

At the moment when AI will be implemented in the clinical settings, medical personnel will have more time to spend with patients, while the diagnosis and treatment will become an automated process.

Because the healthcare business is crucial for patient care, medical professionals, patients and international authorities need a scientific proof that AI will be beneficial, as well as a strategy for convincing investors that their investment would be worthwhile. Everyone who works with AI technology must know what it is and how it can help them with their daily jobs.

Another limitation of AI-based systems is represented by the considerable number of available algorithms, that can be used in research area. Because each study results are given using various approaches on different populations with distinct sample distributions and characteristics, objective comparison of algorithms across research is difficult.

Algorithms must be compared on the same independent test set, which is representative of the target population, using the same performance criteria, in order to make fair comparisons. Researchers and clinicians will struggle to figure out which algorithm is best for their study.

Since weare on the limits topic, we should discuss an extremely important question: when an AI system fails to make a correct diagnosis, who is responsible for error? There are no specific laws yet to define the answer to this question. The physician, the technician, the patient and the company that provides those technologies must understand and accept all the limits [27]. Besides that, we must not forget that human error is a lot more frequent.

Furthermore, we don't know what effect AI applications will have on the doctor-patient relation, which is a critical component of healthcare usage and medical practice. As a result, at a time when AI research is ramping up, ethical guidelines related to AI model creation should be created [1-5].

Future perspectives

After all these advantages, the question that comes into our minds may be: why aren't they implemented yet? The progress may be extraordinary, but it's a slow process until we'll use these tools in our daily medical activities, because there's a high amount of skepticism around those technologies, from insurance companies, patients, patients' families, but also from medical personnel [1-5].

A common fear amongst the medical personnel is: will we be replaced? Nobody has a confident answer. Nevertheless, doctors and nurses will still play their part in finding a way to increase the efficiency through AI-based systems, building a multidisciplinary team empowered by AI.

In all medical specialties, using AI systems should be a priority for dealing with a humongous amount of data and choosing a personalized and unique treatment for each patient, taking into consideration all their investigations and individual genetical characteristics.

From wearable health equipment like the Apple Watch and FitBit to digital consultations on directly on the smartphone, AI can help consumers keep track of their own health while also delivering vital information to healthcare providers [1-5].

COVID-19 pandemic had horrendous consequences in most of the domains, including the medical system, which did in fact accelerate the implementation of AI systems, with a new legal approach. Telemedicine has been of an enormous help during this pandemic; the non-critic patients opted for online consultations. There was a crisis of medical equipment in hospitals, everyone was social distancing, so AI came as a feasible solution in this situation. Autonomous AI-based systems are much needed in this situation, because we are also witnessing a crisis of medical personnel.

Precise and reasonable regulations, laws and guidelines from international authorities and a reimbursement for all technical investments are mandatory for integrating AI-based systems in clinical practice [27]. Physicians should prepare for the significant changes and effects of AI on real clinical practice in this decade.

Clinical research, medical records, and genetic information, all of which can aid medical practitioners in making a diagnosis, can be analyzed considerably faster by AI-enabled technology than by humans [1,27]. Time is money in every industry. AI is speeding up medical procedures at medical facilities, allowing medical personnel to save valuable working hours. Thus, AI has the potential to save a lot of money.

Convoluted neural networks may be used to develop models to predict disease outcome in relapsing and remitting disorders such inflammatory bowel disease, irritable bowel syndrome, functional dyspepsia, liver cirrhosis and autoimmune hepatitis, hence improving a tailored therapy. GI surgery can also benefit from the use of AI and surgical robots.

Conclusions

The main objectives of AI applications used in gastroenterology are to improve the medical procedures with enhanced precision, to reduce the number of medical errors and to perform repetitive tasks.

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