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Conference news from the workshop in Copenhagen

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AI IN GASTROENTEROLOGY
Workshop | Copenhagen | March 14, 2024
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Workshop | Copenhagen | March 14, 2024

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Efficacy and safety of AI

The significance of artificial intelligence (AI) in medicine, particularly in gastroenterology, was underscored by a dedicated symposium held in Copenhagen. The gathering brought together leading experts in the field to discuss AI from various perspectives.

The scientific organizers:
Prof. C. Hassan, Prof. H. Messmann, Y. Mori, PhD, and Dr. P. Sharma

Contrary to the impression that AI is a development of the 2020s, research in this area has actually been ongoing for over fifty years. What is truly remarkable today is the speed with which the applications are moving into our everyday lives. AI applications have quietly established themselves in many hospitals and medical practices. Now, researchers and practitioners are actively exploring the potential and limitations of AI, playing crucial roles in refining its use in medicine. The symposium provided a forum for sharing their insights with others.

In gastroenterology, AI has a broad range of applications, particularly in endoscopy. AI aids in detecting lesions, serving as a diagnostic tool, and offering therapeutic support from the esophagus to the rectum. But that is not all. Additionally, AI can alleviate physicians' workloads by assisting with appointment scheduling, patient education, and documentation. Typically, AI is both cost-effective and environmentally friendly. However, this raises the question: Why is it necessary to discuss AI rather than simply implementing it?

Like most things in the world, this coin also has two sides. There are critical considerations regarding the safety and reliability of AI outcomes. Is AI more trustworthy than expert human judgment? What are the limitations of AI, and how can users recognize them? Before leveraging AI, "trainees" need to understand how this tool works. How can they go about doing that? We might also ask what an AI "package insert" should contain. Many regulatory questions remain unresolved. Reimbursement by the health care payers has not been settled for the most part.

The topics related to AI are immense. In Copenhagen, opportunities and risks were presented and discussed in great detail. The discussions took the participants far beyond the limits of gastroenterology, showing how diverse and exciting the topic of AI in medicine is. A key takeaway was the accelerating pace of AI development, becoming ever more rapid. That in itself is enough to make it worthwhile to tackle the topic of AI.

Gastroenterology and AI: Inseparable in the future

AI has the potential to facilitate every aspect of GI practices and hospitals, from admission to aftercare. The primary goals of using AI are to free up time for patient interaction, conserve resources, and enhance clinical outcomes. AI proves particularly valuable in scenarios where human error is likely, such as in the diagnosis of rare or difficult-to-diagnose conditions, whether benign or malignant. The symposium highlighted numerous successful applications of AI in gastroenterology, demonstrating its significant benefits.

AI is present wherever gastroenterology professionals are working. AI systems can prepare and coordinate patient visits before they even enter a practice or hospital. Neural network-like engines assist in making diagnoses and may eventually handle complex documentation, potentially allowing health care professionals more time for patient care while requiring less time for administrative tasks. Is this merely a pipe dream? Not at all. Numerous advancements are underway.

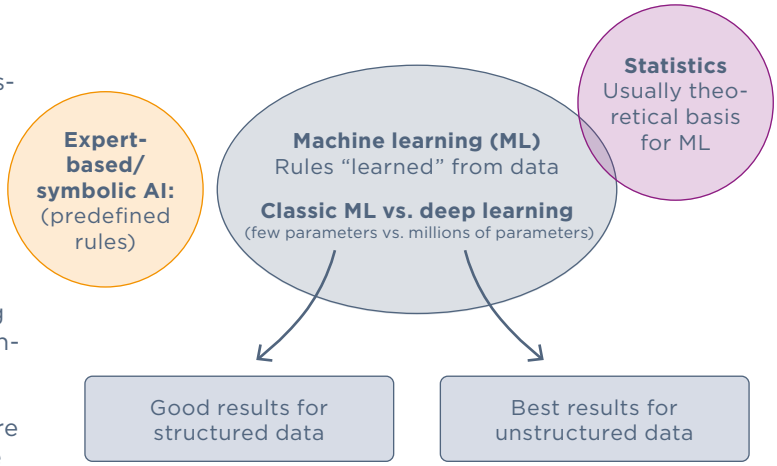


Fig. 1: Different forms of AI. Deep learning is what AI is generally understood to be today. (Modified based on Rösler W et al. J Cancer Res Clin Oncol 2023;149(10):7997–8006)

Prof. Jakob Nikolas Kather, Dresden (Germany), explained how AI works in general and explained the difference between expert-based AI and machine learning (ML), or "deep learning". Expert-based AI, also known as "symbolic learning," operates on predefined rules and expert knowledge. Although this form of AI has been around for over 40 years and is relatively simple, with limited capabilities, the idea behind it is easy to understand. Experts transfer their knowledge to an AI, making learning possible for novices and facilitating training.

However, AI technology has long surpassed this level. According to Kather, machine learning represents the current trend. ML uses a different philosophy. It does not rely on prior expert knowledge. Instead, it learns from examples, such as images and text, to independently identify patterns and rules, filtering similarities and differences. Conventional ML can only consider a few model parameters, making it suitable for structured data. In contrast, "deep learning," another form of ML, can process millions of parameters, generating results without any expert knowledge – a development that raises concerns about the trustworthiness of AI-generated insights.

Deep learning has only been feasible since the 2010s, and this marks the beginning of AI applications in gastroenterology. Artificial neuronal networks have already led to significant advancements in this medical discipline, with promising applications like polyp detection and liver lesion identification. Typically, unimodal models trained for specific tasks are employed. The potential for further applications is vast, particularly with the advent of large language models (LLMs), such as Claude 3 Opus or ChatGPT 4.0 for research and practice. The text-based systems can describe and evaluate images through zero-shot and few-shot learning applications. Kather emphasized that AI will become indispensable in gastroenterology.

Assessing the reliability of AI: How uncertain is "uncertainty"?

If an AI actually operates without expert knowledge, then how certain can health care professionals such as endoscopists be that the AI output can be trusted? **Prof. Christoph Palm**, Regensburg (Germany), addressed this concern by discussing the trustworthiness of AI-generated results. A key issue in deep learning is that the specific features AI uses to make decisions are often unknown, leading to doubts about its reliability. A survey conducted in the United States found that nearly half of the respondents expressed reservations about AI systems' reliability, while only 10% were concerned about issues such as AI potentially replacing their jobs, for example. Similarly, European respondents showed caution with respect to the use of AI for diagnosing illness, with 89% preferring a combination of AI results and expert opinions, 3% trusting AI alone, and 8% rejecting AI-generated results altogether.

Christoph Palm: **"Establishing trust in AI is a challenge we have to take very seriously. Determining uncertainty is an important factor in meeting this challenge."**

To gauge AI reliability, the probability of a correct result can be estimated using Softmax, although this is a simplistic approach, Palm noted. AI uncertainty manifests in two forms: epistemic (model-related) and aleatoric (data uncertainty). Epistemic uncertainty can be mitigated by acquiring more data, but data uncertainty cannot be eliminated. In scenarios with high aleatoric uncertainty, expert opinions should be prioritized and AI should be viewed with caution. The two types of uncertainty can be determined by different model variation and input-variation methods, highlighting the need for further research in this area.

Gathering data for generating AI is a challenge

Generating deep learning AI requires huge volumes of datasets. This is the only way for AI to recognize patterns and produce reliable results. But this is where the challenges start in gastroenterology. Imaging material from endoscopic examinations is often not kept for long periods and is deleted promptly for data storage capacity reasons. Ideally, AI should not work for just one ethnic group but should be globally applicable. Otherwise, the effort is not worthwhile. For this reason, **Dr. Sravanthi Parasa**, Seattle (USA), recommended establishing close partnerships with hospitals worldwide. The data should be as diverse as possible.

Parasa outlined the following steps for obtaining data:

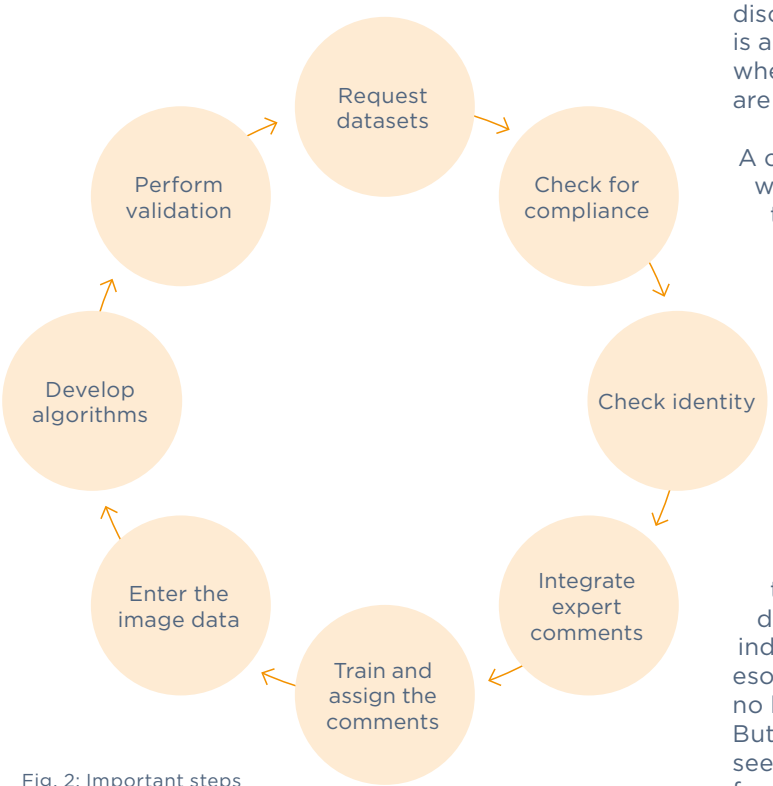


Fig. 2: Important steps for gathering data for generating AI

In principle, decision-making is based on the experience of the health care professional treating the patient and on the disease prognosis. With AI, these same steps are performed, but much faster. In gastroenterology, artificial intelligence could be used for classification, detection, and reporting. No matter where AI is used, the procedure for generation is always the same: Huge volumes of data are provided: images with typical characteristics and a description of what can be seen on the images. AI uses this to create a model. In the test phase, the model is confronted with new image data and the correctness of the results is checked. Only then is external validation initiated. Parasa argued that a declaration of product details should be supplied with every AI that answers the following questions:

- Who developed the model?
- What exactly is the AI to be used for?
- How reliable are the data?
- What datasets were used?

Like nutrition labels on foods, users should be able to identify important AI facts right away. This is the only way that physicians and patients can make knowledge-based decisions for using an AI.

AI is valuable for treating patients with benign conditions

When we think about using AI for support, we often connect it to malignant conditions, for which it is particularly important to identify the preliminary stages of cancer. But we would be neglecting the potential of AI if we did not use it for diagnosing and treating benign disorders. AI is always a helpful tool wherever there is a huge unmet need for medical care, for example, where there is a lack of expertise for conditions that are newly discovered or inadequately researched.

A classic example is eosinophilic esophagitis (EoE), which **Dr. Alanna Ebigbo**, Augsburg (Germany), talked about in his presentation. Many practitioners are not yet fully familiar with the criteria that suggest EoE. These include edema, rings, exudate, furrows, and strictures, all signs of EoE that AI can reliably detect, as Ebigbo determined in a proof-of-concept study. Consider the following statistics: The AI was fed with 401 images from 61 patients with EoE and 872 images from 393 healthy volunteers. For the external validation, another 200 images from 200 individuals were required. The AI was additionally used during endoscopy of the esophagus and displays colors where there are suspected structural or histological changes. A Japanese working group has developed an AI that distinguishes between healthy individuals, patients with EoE, and patients with esophageal candidosis. Ebigbo stated that there are no longer any reasons not to use AI for detecting EoE. But AI can do more in this area, he said. Ebigbo also sees potential for an AI-supported reporting system for EoE that promises to improve workflows.

Another important application for AI involves diagnosing and grading gastroesophageal reflux disease (GERD). An AI developed in China was superior in accuracy to university graduates in the classification of GERD, Ebigbo reported, especially when narrow band imaging was used. There is a lack of expertise in evaluating the results of high-resolution esophageal manometry, another area in which Ebigbo emphasized that AI may be a significant option. A study showed the AI can accurately detect achalasia, with a precision of over 90%.

AI can allow for quick and easy interpretation of results, train non-experts, help with decision-making during endoscopy, and provide a "second opinion" when interpreting findings that are difficult to assess. It is conceivable that in the future, an AI trained on the results of high-resolution manometric, sonographic, and endoscopic images will construct three-dimensional models that enable high-quality insights into the anatomy and functionality of the esophagus. There is a whole range of other conditions in the upper gastrointestinal tract that can benefit from AI.

Grading in IBD: A prime example of putting AI to good use

When treating patients with chronic inflammatory bowel disease (IBD), such as ulcerative colitis, grading is often difficult and depending on the individual performing the colonoscopy, leads to varying results. The Mayo score is relatively unspecific. While the UCEIS offers finer gradations, the range in assessing the grade of UCEIS varies widely. **Prof. Raf Bisschops**, Leuven (Belgium), addressed this problem in his talk, warning that it should not be underestimated. Different classifications used to grade the severity of ulcerative colitis have led to the exclusion of patients from studies in the past. In addition, new options for therapy have changed the treat-to-target strategy, with mucosal healing possible. This means that objective assessments are needed, and here AI can play a leading role. Deep healing is tantamount to a better prognosis for the patients (fewer hospitalizations and colectomies). In addition, precise grading can be highly significant for assessing efficacy in studies.

Raf Bisschops:
"Machine evaluation of endoscopic videos can be gradually introduced in clinical trials of ulcerative colitis. We anticipate that this will save time and money, will reduce the variability of scoring, and will create the foundation for automatic evaluation of disease activity in clinical practice."

In addition to grading, AI can also be useful for histopathological evaluation of the colon. Here, AI can pursue two objectives:

- automatic prediction of endoscopic scoring (Mayo, UCEIS, Picasso) and
- automatic grading of inflammation based on histology.

To date, AI has been developed that has been trained using images. In the future, training using video material is conceivable. And even farther in the future is the premise of AI-supported prediction of outcomes and treatment recommendations. However, we are already seeing signs that the use of AI has certainly benefited gastroenterology. Artificial intelligence can offset human errors and fluctuations. Today AI can already objectively reproduce endoscopy scores and predict histological remission and outcomes. More prospective studies must be conducted, however, to identify the potential of using AI in clinical trials and for personalized treatment of patients.

Not only medical aspects are relevant: AI streamlines work

At medical practices, endoscopy does not begin with the application of the endoscope, but rather much earlier on: with scheduling, said **Prof. Prateek Sharma**, Kansas City, KN (USA). The pre-procedure often plays a major role in gastroenterology. Here, AI can already perform a number of tasks. For example, it can help with scheduling, asking questions such as whether a female patient would prefer to be treated by a woman or whether there are any preferred dates or time frames. Scheduling could be performed fully automatically. Another good example is the pre-procedure preparation undertaken by the patients. A study with 500 patients showed that apps with a chatbot function were superior to human routine instruction for bowel cleansing. The Boston Bowel Preparation Score (BBPS) was significantly higher with the app, as was the adenoma detection rate. The results can be explained as follows: Patients perceived the health care professionals' instructions as less informative, and in particular, less empathetic than those of the chatbots. Patients were more satisfied with the quality of the chatbots' responses and felt that the content was more scientific. All in all, using the app resulted in more appointments being kept.

Sharma stated that currently very few AI capabilities are actually used in medicine. Clinical documentation, administrative tasks, clinical trials, and training optimization are just a few of the tasks AI can perform. One reason for the failure to use AI could be the continuing reservations about the generation of false responses or about data security.

Greater progress has been made in intraprocedural use of AI, for example, when performing endoscopy. However here too, there is room for improvement. When it comes to detecting adenoma, real progress has yet to be made in reality.

AI also offers a great deal of potential for the post-procedural period. Partially or completely eliminating the need to perform documentation could save tremendous amounts of time that could then be spent with the patients. Systems are thus conceivable that support physician-patient consultations, pick up key words, and create documentation from the conversation, generate a discharge letter, and prepare prescriptions for the drugs that have been mentioned. Statistical assessments of a disease presentation could also be performed using AI in a fraction of the time it takes for the human eye. The possibilities exist and need to gradually be incorporated in practice.

AI is also important for research

Endoscopic research has markedly increased in recent years. This is because endoscopy is no longer used just for diagnostic purposes, but also therapeutically. More than 100,000 publications about endoscopic examinations have appeared in the last five years alone. **Dr. Omer Ahmad**, London (UK), reported these statistics in his talk on the significance of AI in endoscopic research. The challenges associated with endoscopic techniques are different from those linked with pharmaceutical applications, such as drugs, Ahmad said. Endoscopy is in the domain of medical devices. The new European Medical Devices Regulation is posing huge challenges for manufacturers of medical devices. Studies are now required that prove the effectiveness of a medical device and continue to study it after approval has been granted, similar to phase 4 clinical trials.

This is something new for medical devices manufacturers, who previously were able to earmark most of their budgets for marketing rather than for clinical trials. This means that in the future, more randomized controlled trials and real-world studies will be required, which constitutes huge expenditures of both time and money. This has led to the desire to conduct endoscopic research with as few costs as possible. This is where AI comes in, Ahmad stated.

He suggested that AI could be used in endoscopic research to conduct clinical trials but also help with updating guidelines, going so far as to even create a completely new research system that is digitally managed by AI algorithms. To date, AI has not been used for research to the extent it is used for clinical applications or for use with patients.

But AI can always be useful for clinical trials whenever there is a high risk of systemic error. In some cases, endoscopy is very dependent on the individual performing the procedure. To date, studies assume that an endoscopy procedure is performed identically at various centers and by various endoscopists. However, this is not often the case. Here too, AI offers objectivity.

During the preclinical phase, an AI can help screen existing publications to find out what has worked well in other trials and what has worked less well. Polishing the study design in this way could be a task performed by large language models (LLMs). In addition, when recruiting patients, AI could shorten what is usually a time-consuming procedure by having an algorithm evaluate patient records and detecting suitable study participants.

LLMs can be used to write manuscripts and this is already happening. In fact, many journals accept manuscripts written in this way. AI also helps accelerate data processing, evaluation, and publication for meta-analyses. Ahmad stated that the status quo for randomized clinical trials cannot be maintained, because they are too expensive and time-consuming and are not sustainable. Digitalization of data is urgently needed, along with a new research ecosystem.

Electronic patient records are already available. They can be supplemented by additional data, such as information collected with the help of patients' "wearables" (all types of health trackers). Ahmad said that to store the vast amounts of data in the future, we will need entirely different storage solutions in large, satellite-based data clouds. Two questions have yet to be resolved, however: Who will be paying for the data infrastructure and what will be the legal implications?

Regulatory requirements for AI are under development

A significant breakthrough in the legal assessment of AI data collection and processing was achieved in Europe just one day before the symposium. In his second talk, Ahmad reported that the European Union (EU) had passed the EU Artificial Intelligence Act. From an ethical perspective, AI offers the opportunity to avoid variations and helps standardize processes. However, the way false-positive and false-negative results are handled must be clearly defined. Who is responsible? In all likelihood the AI provider.

This means it is crucial to significantly improve the trustworthiness of AI systems that no longer require human intervention. Currently, two autonomous diagnostic AI systems have been approved. The US Food and Drug Administration (FDA) has approved an AI system for diagnosing diabetic retinopathy. In the EU, an AI system for detecting abnormal mammograms is ready to be brought to market. The AI system filters abnormal findings, which are then evaluated by experts.

A major unresolved question is how to handle the data when patients wish to revoke their consent for its evaluation. The right to "be forgotten" cannot be upheld when AI is used. The algorithms are black boxes and it is also not clear for the manufacturers where exactly individual data have been input. It is possible that the right to the personal data will have to be relaxed to some extent.

What's next?

So far, AI has always been inferior to human performance due to the superior capabilities of the human brain. According to **Dr. Michael F. Byrne**, Vancouver (Canada), however, today we have reached a point where AI's capabilities are nearly equal to those of humans. Sooner or later, AI will outperform humans. When viewing the innovation cycles of the past, we can clearly see that the cycle period has become shorter and shorter. This means that we can assume that advancements in AI will impact humankind very quickly. When it comes to the use of AI, gastroenterology now ranks fifth among all medical disciplines.

Michael F. Byrne:
"The future of AI in medicine holds enormous potential for revolutionizing health care in a whole range of ways."

Byrne mentioned the following future applications of AI in gastroenterology:

1. Gastroenterological diagnostics/image analysis
The goal is to improve real-time detection and diagnosis of gastrointestinal tumors and other conditions. The human eye is often not accurate enough. For this reason, resolution is being refined using light and color technology. However, this is not bringing about any revolutionary improvements. This is where AI comes in. One example is intestinal ultrasound, which can determine real-time disease activity in patients with IBD. This method is less invasive and has advantages over endoscopy.

2. AI-assisted sugery
AI can be integrated into endosurgical procedures to improve precision and reduce invasiveness. Endoscopists can benefit from real-time data analysis and guidance during endoscopic procedures.

3. Drug discovery and development
AI can accelerate drug discovery by analyzing large datasets, predicting potential drug candidates, and identifying patterns in molecular structures. This can considerably reduce the time and cost involved in bringing new drugs to market.

4. Predictive analysis
AI algorithms can analyze patient date to predict disease progression, identify potential health risks, and recommend preventive measures. This proactive approach can lead to early intervention and improved patient outcomes.

5. Virtual health assistants
AI-supported virtual assistants and chatbots can provide health information, answer questions, and help with scheduling at any time of the day or night. They can also remotely monitor the patient's health status send timely warnings.

6. Efficient administration
Using AI can streamline administrative tasks such as invoicing, scheduling, and record-keeping, enabling medical staff to place more focus on patient care.

7. Continuous monitoring and wearable devices
AI-enabled portable devices can monitor patients in real time and continuously deliver data to health care providers. This is especially valuable for managing chronic conditions and for early intervention.

8. Reimbursement
There is significant room for improvement in reimbursing health care-related costs. Authorities have not fully recognized the regulatory requirements and have yet to adequately define AI. Guidelines for using AI are almost nonexistent, resulting in unsettled reimbursement issues and high costs. Overall, the framework for widespread use is still lacking.

9. Trends and expectations
The research community is responsible for implementing AI applications in practical settings. In the future, it will be unacceptable to overlook conditions such as polyps if an AI is available that could have prevented them. AI costs can be reimbursed if its quality is defined, published, and plausible.

10. Global guidelines
When defining guidelines for using AI, several key questions need to be answered: What is the AI's objective? For which applications has it been created? Who is the target patient cohort? Additionally, information on its analytical value must be provided. For example, it is important to know the research findings that underpin the AI and whether there is existing real-world data on its use. The clinical validity must be robust, and its trustworthiness and security must be clearly described. Finally, information on its usefulness (outcome parameters) is crucial.

Overall, it is evident that the development of AI in the future can no longer rest solely on researchers' shoulders. Byrne proposed that joint ventures with tech giants such as Microsoft cannot be excluded.

In conclusion, the future of AI in gastroenterology lies in a more personalized, efficient, and technologically advanced health care system where AI serves as a valuable tool for diagnosis, treatment, and general patient care.

Along the GI tract: Benefits and limitations of AI

Whether it is the esophagus, stomach, bowel, pancreas, or gallbladder, specific artificial intelligence systems are available for lesion detection, diagnosis, and treatment throughout the GI tract. AI is also playing an increasingly important role in research. In the future, it will be able to navigate patient flows, assist with education, and relieve administrative tasks. However, users need significant know-how to leverage these benefits. The symposium in Copenhagen provided deep insights into the use of AI, the cost savings it can generate, and its benefits for environmental technology.

AI enables expert endoscopy of the upper GI tract

During endoscopy, risk factors for tumors can be overlooked in both the colon and the upper GI tract. According to **Prof. Helmut Messmann**, Augsburg (Germany), the cancer miss rate is around 6%. There is a direct correlation between the experience of the individual performing the endoscopy and this miss rate. Diminutive and flat lesions in particular are frequently overlooked.

Messmann pointed out that increasing the neoplasia detection rate by 1% would reduce post-endoscopy Barrett's neoplasia by around 3.5%. Detection is the key to reducing esophageal tumors, a position also supported by the European Society of Gastrointestinal Endoscopy (ESGE). This means that each and every endoscopist should be an expert. AI can play a crucial role in meeting this goal.

Initial studies on AI systems trained with images clearly showed that AI used by non-experts yielded significant benefits with respect to the neoplasia detection rate. Today, more and more devices are available that extend the possibilities of AI for use in endoscopy in the upper GI tract. Using AI, non-experts can also achieve very good detection rates. While experts benefit less from AI, the detection rate of non-experts is up to 12% higher, Messmann explained. A study on standalone AI for the detection of neoplasia has just been published. It showed that the performance of standalone AI is now superior to manual endoscopy, even when it is assisted by AI. Messmann advised the participants to be more confident in AI. In addition to detection, differentiation, and staging, quantification of the affected area and 3D models constitute new tasks that could be performed by AI. Furthermore, in the near future, we can expect to see instructions for endoscopic therapy.

AI must be able to overcome cultural differences

Research on the use of AI for gastric cancer is very heterogeneous. To date, only one randomized controlled trial exists. There are indications, however, that AI could also play a significant role in diagnosing gastric cancer. The mortality rate for gastric cancer is quite high. Early diagnosis and endoscopic resection offer a chance for cure and help reduce morbidity and mortality. In contrast to Asia, there are less cases and therefore lower detection rates in Western countries. For example, in the United States, the rate of gastric cancer is particularly high in areas in which a high percentage of Asians live, as **Dr. Carolina Ogawa Matsubayashi**, New York, NY (USA) explained. AI could offset the lack of experience in diagnosing the condition. Detecting gastric cancer is just one option for using AI. Computer-based algorithms are also conceivable for tumor grading and prognosis. Ogawa Matsubayashi showed that the paths to diagnosis vary greatly among different cultures, which may make creating a "one size fits all" AI unrealistic. One option could entail standardizing diagnostic procedures and integrating experience from Asia into Western standards to a greater extent.

AI should improve colonoscopy outcomes and lower costs

Computer-assisted detection systems (CADe) can improve the adenoma detection rate and reduce the adenoma miss rate. However, these systems have weaknesses in detecting advanced adenomas. Computer-assisted detection of colorectal polyps offers advantages and is also economically efficient in the real world. When it comes to colorectal neoplasia, there is still a lack of convincing data for sufficient efficiency of CADe.

Computer-assisted diagnosis (CADx) for polyps has been developed for the distal colon. This means that these systems can only be reliably used in the distal colon and are unsuitable for the proximal colon. **Prof. Cesare Hassan**, Milan (Italy), stated that with proper use of AI, patient outcomes can be improved and costs reduced, leading to greater patient and user satisfaction.

AI for colonoscopy is being continuously refined

Dr. Yuichi Mori, Oslo (Norway), reported that a person's lifetime risk of developing adenoma is around 50%, whereas it is only 5% for colorectal cancer. This means that while not all adenomas become cancerous, it is challenging to detect cancer as early as possible and determine the risk class. AI can help do both – and more. There are now methods to detect muscle layers during colonoscopy, reducing the risk of perforation when removing polyps or taking biopsies. AI-assisted vessel identification is also possible. Polyp size can be measured, for example, by comparing the diameter of the water jet with the tissue It is also possible to perform 3D reconstruction of the bowel and determine the share of "blind spots" during the colonoscopy. Mori stated that the number of AI applications is significantly increasing. However, evidence-based proof and regulatory guidelines for standardizing the technology is still lacking.

AI also offers support when treating the pancreas and gallbladder

Dr. Dominik Schulz, Augsburg (Germany), shared insights on large language models (LLMs). He stated that if LLMs, such as Perplexity, which he discussed in his talk, are queried about the state of the art of research on AI for endoscopic ultrasound (EUS) or endoscopic retrograde cholangiopancreatography (ERCP), the results tend to be very superficial. However, a literature search in medical databases revealed a significant increase in efforts to deploy AI systems with EUS, which is not the case for ERCP.

One motive for using AI with EUS is the fact that the results of EUS are still very user-dependent. AI could help standardize the procedure, ensuring that the EUS examination is performed at eight defined sites in a set sequence. The AI assists in locating these sites and guides the ultrasound from one site to the next. Schulz noted that this procedure is very successful, as the precision of EUS significantly improved with AI. Compared to EUS without AI, which had an error rate of 14.3%, the error rate with AI assistance dropped to 4.5%.

Another new application for AI involves identifying the ampulla and determining the difficulty of carrying out selective cannulation during an ERCP examination. Both applications provide valuable support, Schulz said. "Heat maps" and colored boxes facilitate the identification of the ampulla. If ERCP takes longer than five minutes or requires multiple attempts at cannulation, it indicates a higher difficulty level. During cholangiography, AI can distinguish between benign and malignant stenoses. Schulz explained that detecting and classifying biliary structures is challenging but clinically significant, and AI support is becoming increasingly important for the pancreas and gallbladder.

AI in oncology: Detecting biomarkers, making prognoses

Prof. Jakob Nikolas Kather, Dresden (Germany), highlighted that artificial intelligence can do more than just detect objects; in the future, it will be able to detect biomarkers in GI oncology. Patient records of tumor patients contain numerous pathological images that can be used to determine conditions such as microsatellite instability. Tedious tasks in pathology, such as counting cells, could be assigned to AI. However, this requires data to be available in digital form, which is common in many European countries. In Germany, however, most microscopy is performed manually, so pathological images are rarely available in digital form.

Jakob N. Kather:
"In the future, AI will be able to make prognoses, such as
- **determining the risk of recurrence,**
- **predicting the overall survival rate,**
- **and predicting therapy response."**

AI is developing rapidly. Currently, "foundation" models or basic models are being trained. These are deep learning algorithms created with unlabeled images. It takes only a few labeled datasets to make the AI functional. Kather described these pretrained models as a turning point in AI development. The models can generalize knowledge across different domains and apply it, meaning AI can now transfer acquired knowledge to various tasks. In the future, LLMs too will also evolve beyond being pure knowledge databases; they will be able to record patient data, compare it with guidelines, and provide guideline-based therapy recommendations.

AI during training: A gradual introduction is the most promising approach

Today, training for physicians learning to become endoscopists varies widely, with curricula that are not universally defined. In both the United States and the EU, too few endoscopy procedures are required as a training unit, and the feedback trainees receive is often unstructured. **Dr. Nasim Parsa**, St. Cloud, MN (USA), shared observations in her talk, noting that this variability affects the training experience for future endoscopists. To remedy this problem, AI could be used to set standards.

According to Parsa, CADe and CADx improve the trainees' results, such as improving the adenoma detection rate and decreasing the adenoma miss rate. AI can guide the examiner's eye to lesions that are difficult to identify and provide certainty during polyp resection. CADx helps improve the learning curve and increase accuracy. With AI, learners achieve results similar to those of experts. AI can enable learners to examine higher-risk areas by providing endoscopic determinants for the malignant potential of a lesion, improving diagnostic accuracy for conditions such as Barrett's esophagus.

Different algorithms may be used as AI applications, ranging from AI for evaluation and for feedback on the resection technique to assessing the accuracy of polyp size determination, as well as quality indicators of an examination. The challenge is not to become overly dependent on AI or place undue trust in it. Learners should train their eyes and must be able to evaluate the organs examined and therapeutic procedures without AI assistance. Over-reliance on AI can undermine one's self-confidence.

Nasim Parsa:
"Integrating AI into endoscopic training offers enormous potential, but must be carefully monitored."

She proposed a three-step scheme for integrating AI into training. The first six months should focus on learning content, defining AI, and understanding data acquisition. Trainees should be aware of the variability of diagnoses among endoscopists and understand the benefits and challenges of AI systems. After this initial period, AI can be used for feedback and skills assessment to evaluate acquired skills and identify gaps. Trainees should not engage with AI applications for diagnosis and therapy until after the first year of training. Ethical and data security aspects should be discussed throughout the entire training period. The objective is to raise awareness about AI capabilities without overwhelming learners. This step-by-step training plan could standardize and improve the comparability of endoscopy training, Parsa said.

Potential cost savings in gastroenterology

To make AI a standard application in gastroenterology, reimbursement-related issues must be addressed. **Dr. Yuichi Mori**, Oslo (Norway), discussed this topic using the example of CADe implementation during mammography. In 2002, health care payers approved reimbursement, leading to a significant increase in AI, which now occurs in 80% of all mammography procedures. Gastroenterology, however, has not yet reached this level of adoption. Numerous AI applications have been developed and tested in studies, with many receiving approval. Despite this, many are not eligible for reimbursement and are not included in guidelines, limiting their widespread use. Mori highlighted Japan's decision to reimburse AI assistance during colonoscopy with the equivalent of €5.00 as a positive example. While the impacts are not yet clear, this decision could serve as a model for Europe.

For AI in colonoscopy to be reimbursed, it must be approved, and a cost-effectiveness study must be performed. In addition, position papers by experts or its inclusion in guidelines are important criteria. The budget of the payers plays a crucial role in this decision. In most cases, using AI increases the costs of a colonoscopy in the short term. However, in the medium to long term, it leads to significant cost savings. Early detection and resection of polyps would require fewer future polypectomies and could be considered to be a form of tumor prevention. Mori estimated cost savings of $57.00 per person.

The European Society of Gastrointestinal Endoscopy (ESGE) is currently the only professional association with an expert opinion on reimbursement in colonoscopy, last updated in 2019. Since then, ten more randomized controlled trials have been conducted on this topic. However, the guidelines have not been updated, meaning that the recommendation level and additional recommendations have not been adapted. Given the rapidly evolving state of knowledge, quicker updates would be desirable to put AI applications in practice. Ideally, "living guidelines" should be developed that can be adapted immediately after publication

Yuichi Mori:
"AI in colonoscopy has the potential to cut costs in the health care system. Two things are essential for implementing AI: We need to call for reimbursement and draw up a recommendation for its use in guidelines."

"Green" gastroenterology: AI can cut carbon emissions

Prof. James East, Oxford (UK), stated that using AI can reduce carbon emissions in all processes of gastroenterology. The reduction starts with selecting procedures and continues through follow-up, which can occur in person at the hospital or practice, or virtually. According to East, carbon reduction is closely linked to cost reduction.

To illustrate this, East highlighted the carbon emissions associated with processing histological specimens. Processing three histopathology slides produces carbon emissions equivalent to those generated by driving two miles. In the United States, biopsy processing currently generates emissions equivalent to those produced by 2.1 million miles of driving.

During endoscopy, high carbon emission volumes come from various sources, with nearly half (45%) attributed to the transportation of patients and medical staff to and from the procedure. Each endoscopic procedure generates between 5 and 28 kg of carbon emissions. In comparison, a biopsy leaves behind a carbon footprint of 0.29 kg and an MRI some 20 kg of carbon. East suggested that reducing the number of endoscopic procedures needed would decrease the associated transportation emissions.

One solution is colon capsule endoscopy, which brings the procedure to the patient and links with a cloud-based report. This method is significantly more time-efficient and, according to East, the AI involved is around 16 times more productive than conventional endoscopy with somewhat better accuracy. This approach would also enable doctors to work from

home. Other AI options include optical biopsy, which is digitally scalable, for diagnosing conditions such as Barrett's esophagus or for scoring in patients with ulcerative colitis. For these procedures, diagnostics are performed fully automatically. However, we must continue consider how we can benefit from AI. Conferences and professional development events could take place virtually to a greater extent and patient consultations could be conducted online. AI offers numerous ways for gastroenterology to reduce its carbon footprint.

Obstacles to implementing AI in practice

According to **Prof. Prateek Sharma**, Kansas City, KN (USA), AI has the potential to revolutionize gastroenterology in practice. It plays a role in

- automatic lesion detection,
- real-time classification,
- personalized therapy planning,
- automated documentation,
- quality control,
- predictive analyses.

Despite this, the obstacles to implementing AI in everyday gastroenterology practice are high.

AI is always useful in situations in which there are only limited numbers of patient cases and thus little material for practicing. This is the case for gastric cancer, which is rare and offer little opportunity for routine. Another key element of using AI successfully is high quality of the data it has been fed with. It is important for the AI data to correspond to that of the actual population. The images used to train the AI should be carefully selected and the associated text should be neutral. The AI must be able to correctly capture the necessary variables. To reduce deviations, ongoing evaluation is needed, a data audit, diversification of data, and the consideration of different perspectives when inputting data. Some AI systems perform well in randomized controlled trials but not in practice.

An important factor for implementing AI in everyday routine is its practicality and ease of integration. An AI system should be able to integrate itself into workflows, be clinically validated, user friendly, and cost-effective. It should be obvious that an AI can only deliver reliable results if it is used for what it has been trained for. For this reason, there should be a model description with certain basic information for each AI that answers the following questions: Who trained the AI and for what purpose? How reliable were the results in a study? What results are known from practice? An organization that addresses AI in gastroenterology could help provide structure in dealing with AI and pave the way for using AI in practice.

How large language models (LLMs) can be used in gastroenterology

Large language models are advanced AI systems trained on vast amounts of unlabeled data, enabling them to understand and generate human language, as well as process other types of data such as images and audio files. Unlike traditional AI, which often requires a separate model for each application, LLMs work in a generalized manner, supporting a wide range of applications. For example, an AI could potentially record and evaluate patient consultations, compose discharge letters or referrals within minutes, enter data into electronic patient records, and search databases for possible diagnoses and treatment recommendations in databases. This approach can save significant time typically spent on research.

Currently, obtaining suitable answers from LLMs requires asking the right questions. But the LLMs of the future are expected to have even more advanced capabilities. **Dr. Sravanthi Parasa**, Seattle, WA (US), for example, suggests that AI will be able to search through clinical trial data to identify substances that have yielded good medical outcomes for patients with similar conditions, presenting this information in a way that allows doctors to quickly understand study data.

Another important application of AI in research and in practice could involve structuring documents to clearly present the information they contain. In the future, models may access digital patient data from practices and hospitals, facilitating real-world evaluations of treatment effectiveness. The trend is moving toward deep learning, generalized applications, and pretrained AI models.

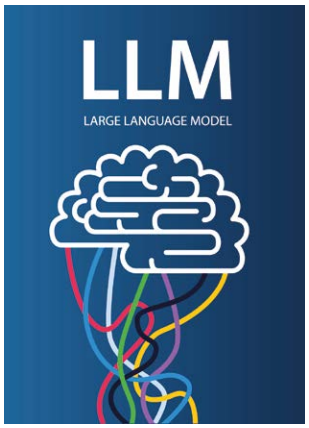
AI in gastroenterology: The industry perspective

As an industry representative, **Mert Öz** from Microsoft in Vienna (Austria) shared his views on the use of AI in medicine, particularly in gastroenterology. He reported that around two-thirds of doctors experience burnout in the course of their career due to the extensive effort required for documentation and heavy workloads. AI systems can significantly alleviate these burdens while also improving patient outcomes.

Currently, AI predominantly employs specific intelligence for concrete applications, operating at nearly an expert level.

Mert Öz:
"Specific intelligence is clearly defined and handles tasks within a precisely delimited area, while general intelligence spans a broad range of areas and tasks, including learning new skills."

However, the goal is to develop general intelligence capable of handling a wide array of tasks. Öz cited scheduling, workflow optimization, and patient education as examples. AI is now at the "emerging level" of performance in this area, akin to unskilled workers, but it is progressing toward the "competence level", where it will be able to perform tasks at the level of skilled workers. As AI is developing at an exponential pace, gastroenterologists, who spend about 13 hours a week on documentation, could soon find significant relief.



Mert Öz:
"The 'I' in AI stands for 'intelligence' meaning the ability of a machine to perform cognitive functions typically attributed to humans, such as:

- **solving problems,**
- **logical thought,**
- **decision-making,**
- **abstract thought,**
- **symbolic representation,**
- **using and manufacturing tools,**
- **planning,**
- **tracing, and,**
- **creativity."**

Sravanthi Parasa:
Clinicians should consider the following points when deploying AI models in clinical care:

1. **Data-driven tools:** AI can assist in early diagnosis, reduce medical errors, and help select the most effective treatment. However, it cannot replace doctors.
2. **Legal responsibility:** Decision support tools purport to inform expert decision-makers ("you") about the performance of the model. But at the end of the day, it is you who are responsible for the decision. For this reason, it is crucial to understand the models being used.
3. **Explainability:** Higher evidence requirements apply to decision support tools compared to administrative or public health applications. Would you trust a black box with diagnosing or treating your patients, especially if you bear responsibility? Always ask why a model delivers a certain result.
4. **Workflow integration:** The tools have to fit your clinical workflow, not the other way around.
5. **Accuracy/clinical benefits:** AI tools should be both accurate and robust, offering clear clinical benefits (i.e., clinical criteria should be met).
6. **Hypothesis/validation:** Ensure that models used for hypothesis generation are not presented as validated models for supporting clinical decisions.
7. **Scientific methodology:** Evaluate AI methods based on biological plausibility and data signals to ensure their reliability and relevance.
8. **Peer review:** Ensure models are well-documented with transparent data, model performance metrics, and clinical performance metrics.
9. **Bias:** Check for bias in data, algorithms, model training, use, evaluation, and interpretation. Ensure models are trained using data from patients similar to your own.
10. **Statistics:** If you are overwhelmed by the statistics from clinical AI models, focus on the positive and negative predictive values of clinical AI models (to avoid false-positive and false-negative results).
11. **Security/transparency:** Understand data security and patient data protection issues. Verify the legal implications when using natural language processing (NLP) for tasks like transcribing clinical notes.

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“Improving quality is at the focus of artificial intelligence”

Prof. Dr. Helmut Messmann is an internist and gastroenterologist. Ten years ago, as the Head of the Department of Internal Medicine at Augsburg Medical Center, he gained recognition for his work in AI. Prof. Messmann serves on the Board of the ESGE and is actively involved in various professional associations.

Artificial intelligence (AI) didn’t just appear out of thin air. People and their ideas are behind these advances. One of the pioneers of using AI in gastroenterology, Prof. Helmut Messmann, Augsburg (Germany), has agreed to answer questions about the latest developments and the future of AI.

Prof. Messmann, when did you first engage with the topic of artificial intelligence? Did something specific pique your interest?

Prof. Messmann: I started working on the topic of artificial intelligence very early on, before it was discussed in context of gastroenterology. In 2014, I approached Prof. Christoph Palm in Regensburg, an IT specialist and expert in detecting patterns, on using AI to better detect esophageal cancer. This turned into a very fruitful collaboration. We were then in fact the world’s first group to use an AI system for diagnosing Barrett’s esophagus. Based on this collaboration, we continued to develop the project.

So, that’s when AI in gastroenterology became a core research component of your working group?

Prof. Messmann: Yes, that’s right. We expanded our ideas and extended our work to areas beyond the esophagus. This led to the growth of my working group and that of Prof. Palm. The teams grew, along with the ideas. In Augsburg, a team of around five doctors worked on the topic of AI. Another five-member group of IT specialists collaborates with us in Regensburg. The esophagus is still one of our focuses. This is where we have made the most progress. But we are also working on artificial intelligence in the area of endoscopic retrograde cholangiopancreaticography and endoscopic ultrasonography; in other words, on the pancreas and gallbladder. We are also very interested in using AI in a therapeutic context. For example, during endoscopic procedures, we are striving to use AI to prevent hemorrhage or perforations, simply by improving our identification of structures.

Where do you see the greatest benefits of using AI in medicine in general, and in gastroenterology in particular?

Prof. Messmann: The European Society of Gastrointestinal Endoscopy (ESGE) has published a position paper that should answer this question (see info box). To put it in a nutshell, as a GI endoscopist, I expect an AI to help all endoscopists perform at the same level, regardless of their training level, and by this, I mean expert level. Endoscopists who are very familiar with a medical condition because they encounter it frequently already have expertise in this area and will then derive fewer benefits from AI.

Where are the limitations of using AI at present?

Prof. Messmann: Currently, most AI developments are organ-specific and focus on one issue. Of course, that means that we are already a step further than we were before, because in the past, an AI was given descriptions of the appearance of a polyp in the bowel, for example (machine learning). AI learned the rules and looked for characteristics during endoscopy. Today, we use deep learning. AI is fed with thousands of images of polyps and it recognizes the pattern. In this way, AI recognizes polyps in the bowel, for example, but would not be capable of recognizing them in a patient with irritable bowel disease, because it is not familiar with images of polyps in inflamed tissue. We are now moving toward generalization. While AI would then still be organ-specific, it would be able to distinguish an adenoma from a hyperplastic polyp and make further distinctions.

What characteristics of AI do you worry about the most?

Prof. Messmann: There are different aspects. Let me mention data privacy. When patients come to our hospital for treatment, we inform them about what we will do with the images we obtain during endoscopy. We declare that we also use them for research, and this also applies to AI training. But we cannot always

guarantee that consent has been obtained. I would dare to say that today, there are pictures of nearly every person on the internet. In many cases, they aren't aware of this. For this reason, data privacy in conjunction with AI is a major concern. This situation is aggravated by the fact that the AI algorithm, meaning the logic according to which it identifies a polyp as a polyp is not known to us scientists. It's a black box. Another set of concerns is trustworthiness. As long as the AI reaches the same decision as humans, everything is okay. But who is right when the assessments do not coincide? Who assumes responsibility here? At present, it is still the examiner.

How can the costs of AI development be amortized? Is there a chance of AI becoming a reimbursable service?

Prof. Messmann: The use of AI is not currently reimbursable and it will take a few years until this could be the case. For this to happen, studies must prove that using AI cuts costs. This is difficult to prove, however, because in actual fact, costs initially increase when AI is used. The more AI is used, the more polyps are detected, to stick to the example of colonoscopy. Removing these polyps then generates more expenses for the payers. In the long term, however, it saves money, because this intervention keeps fewer tumors from developing, which eliminates the need for expensive cancer drugs. We are talking about a 20-year period, more or less. Refining AI takes months rather than years. At medical practices, AI could be offered as an individual health service (IGeL in Germany). We obtain funding for research by writing grants for research funding from the German government (German Ministry of Education and Research (BMBF) or the German Research Council (DFG)) of from third-party funding (collaboration arrangements with industry). Things will stay this way for some time still.

Where do you see the future of AI in gastroenterology?

Prof. Messmann: I am afraid that we are unable to fathom what is in store for us. The developments are rapid. I can imagine – and when it comes to mammography, it is nearly conceivable – that the images that have been captured can be uploaded to a website and that AI can evaluate them within a very short period. The patients could also upload images or videos of a colonoscopy to check whether any polyps had been overlooked because the endoscopists did not have AI. That would be an example of a bad development. What we want is better quality. AI will certainly become a standard part of our work, and we need to engage with it. We will also have to learn to live with the fact that in the future, school homework and doctoral dissertations at the university will be written with AI support. I advise everyone to engage with this topic and to think about how and where they can use the new technology to their advantage.

In your view, how important are international workshops on AI in gastroenterology?

Prof. Messmann: I think they are extremely important. But in my opinion, in-person meetings, without any AI and all kinds of technology, are preferable to video conferences. The interaction with the experts from other countries and continents after the talks and during the breaks is invaluable. Networking really only works if we are all on site. And considering how quickly AI is developing, I think talking about it is especially important. I heard this from so many different people in Copenhagen. I would even find it fascinating to expand our horizons and to organize a workshop that not just restricted to those of us working in gastroenterology, but dedicated to "AI in Medicine". We need to think beyond the boundaries of our own discipline. What other visions are out there? Where will we be in five years? I personally think that we could still use more of a workshop character and work in small groups to derive even more benefits from the symposium. We can learn from others, so we should also involve more legal experts, IT specialists, policy-makers, and payers.

Professor Messmann, thank you very much for taking the time to talk to us.

ESGE Position Paper:

The complete position paper of the European Society of Gastrointestinal Endoscopy (ESGE) can be downloaded here:
https://www.thieme-connect.com/products/ejournals/pdf/10.1055/a-1950-5694.pdf

Poster prizes: Awards for young researchers

The Falk Foundation e.V. symposia have a longstanding tradition of recognizing young scientists for their outstanding research work. The following young researchers were honored at the Copenhagen symposium:

Bobby Lo, Hvidovre (Denmark): *Validating and enhancing real-time endoscopic disease severity classification in ulcerative colitis: Artificial intelligence as a second opinion trigger*

Tommy Rizkala, Milan (Italy): *Computer-Aided Diagnosis for the Reset and Discard Strategy for Colorectal Polyps: A Systematic Review and Meta-Analysis*

David Roser, Augsburg (Germany): *Human-Computer Interaction: Examining the Influence of Artificial Intelligence on the Diagnostic Confidence of Endoscopists in the Evaluation of Barrett's Esophagus*

From left: Tommy Rizkala, David Roser, Bobby Lo, Dr. Martin Falk

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