Article type : Editorial

AI – Artificial intelligence and the future of endoscopy

Helmut Neumann[1] and Raf Bisschops[2]

[1]Department of Medicine I, University Hospital Erlangen, Germany

[2]KU Leuven, University Hospitals Leuven, Leuven, Belgium

Corresponding author:

Helmut Neumann, MD, PhD, FASGE

Professor of Medicine

Interdisciplinary Endoscopy

Department of Medicine I

University Medical Center Mainz

Langenbeckstrasse 1

55131 Mainz - Germany

Tel.: +49 (0) 6131 17-7395

Fax: +49 (0) 6131 17-5595

E-mail: helmut.neumann@unimedizin-mainz.de

This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1111/den.13391

The future has many names: For the weak, it means the unattainable. For the fearful, it means the unknown. For the courageous, it means opportunity.

Victor Hugo, French poet, 1802-1885.

Over the past few years, we have been continuously learning about the progress of artificial intelligence (AI) systems and their involvement in many facets of our daily life. Autonomous vehicles, computerized border control, and specific search engines such as Google RankBrain, which provide more relevant search results for users, are already in daily use, thereby changing our life by accelerating procedures and making them more effective. With its continuous evolution, it was only a matter of time until AI was adopted for medical procedures, such as luminal gastrointestinal endoscopy. However, for many doctors, AI still represents the "unattainable" or the "unknown," and many still question the benefits of AI systems in endoscopy. However, it is important for us to state that AI is not something that we might experience in the future; in fact, AI is already part of the present endoscopy field. Consequently, we are expecting major changes in practice within the upcoming years.

Accordingly, in this issue, Digestive Endoscopy has decided to focus on the rapidly evolving field of AI by presenting two state-of-the-art reviews by some of the pioneers in this field from Japan. The first article by Kudo et al. focuses on AI for colonoscopy, whereas the second article by Mori et al. highlights the potential of AI in upper endoscopy [1, 2]. In general, AI-based systems for endoscopy are aimed at improving detection rates and predicting histology by at least providing information regarding whether a lesion is neoplastic or non-neoplastic, thereby guiding endoscopic therapy (e.g., resection or no resection). In addition, AI based endoscopy systems might have potential positive effects on image interpretation and early recognition of lesions. Early studies have already shown the potential of AI-based endoscopy systems in the diagnosis of several luminal gastrointestinal diseases, including Barrett's esophagus, esophageal squamous cell cancer, gastric cancer, and *Helicobacter pylori* gastritis, and colorectal polyps .

Most excitingly, the first AI system in endoscopy for commercial purposes has already been launched recently. The EndoBrain (Olympus, Tokyo, Japan) software is delivered in combination with the endocytoscopy system, therefore facilitating real-time in vivo characterization of the tissue. Although exciting, at present, the system only allows for the differentiation between non-neoplastic and neoplastic colorectal lesions. For more enhanced characterization (i.e. invasion depth), application of various dyes to the mucosa is mandatory, thereby limiting the application for its routine use at this time [3].

However, rapid progress of various AI systems will allow for the prediction of more enhanced findings in the near future. In this context, it seems obvious to train computers to learn from already existing classifications, such as from the most recently introduced BASIC classification [4]. The classification was developed by international experts to differentiate subcentimetric hyperplastic and adenomatous polyps and deeply invasive malignant lesions using Blue Light Imaging (BLI), showing its reliability and high concordance among the observers.

However, one challenge with computer learning is that the computer assesses parameters different from those assessed by humans. While we focus on the general appearance and universal surface pattern morphology of a lesion, the computer extrapolates more complex structures, such as the diameter and extent of the tubular branches. Accordingly, the computer compares the findings to its database, extracting the most consistent results and presenting its diagnosis. This explains the two major challenges of computer learning algorithms for endoscopy. First, the computer assesses all structures; for example, the tubular branches of a polyp, “like they are.” While humans make a generic assessment of the lesion to predict histology, for the computer, minor variations—even at the level of micrometers—in tubular branch diameters make a huge difference in the diagnosis. Additionally, it is evident that the diameter changes with the distance of the endoscope from the lesion, and every millimeter counts and may result in relevant differences for the computerized diagnosis. This brings us to the second major challenge of computer learning algorithms for endoscopy. The computer needs a large database to compare all the findings. The more the data included, the more exact is the diagnosis. This means that hundreds of thousands of images need to be included. Again, taking into consideration the example of the polyp, the difficulty in gaining acceptable diagnostic results from the machine is obvious.

The process could be simplified by ensuring that all pictures are at the same distance from the endoscopy lens, so that the computer would need far less images to make a comparison. Thus, the current generation of the EndoBrain software uses endocytoscopy. Endocytoscopy is similar to contact light microscopy, normally not providing any depth information. Accordingly, either images are in focus, and accordingly in one plane, or not. That means, the systems require less data to predict the final histology. This circumstance also explains why the system in the current version does not work with normal endoscopes.

However, providing hundreds of thousands of images from different diseases is not realistic, and therefore, the classic approach to machine learning does not seem to be feasible for endoscopy in general. With this knowledge, how can we be so optimistic when we are discussing about the future of endoscopy and AI? One answer is that computer learning has become more efficient over time. The so-called deep structural learning methods including deep neural networks have been applied already to various fields, including natural language processing, speech recognition, and social network filtering, producing results comparable to those of human experts. In deep learning, the computer learns to transform its input data (e.g. diameter of the tubular branch) into a more abstract and composite representation using a cascade of multiple layers. It is noteworthy that each successive layer uses the output from the previous one as an input. Finally, the process can identify on its own the specific levels at which the features are to be placed. As a result, the computer system learns to perform tasks by considering examples, generally without task-specific programming. For example, in image recognition, the computer learns to identify images that contain polyps by analyzing example images that have been manually labeled as "polyp" or "no polyp" and using the analytic results to identify polyps in other images. As deep learning algorithms require much less images for machine training, the implementability for endoscopy appears real and plausible.

Specific algorithms for endoscopy are already under development and successfully being used in clinical trials; therefore, we are expecting their official introduction very soon.

Coming back to Victor Hugo, indeed, “*The future has many names.*” Specifically for endoscopy, AI means a huge “*opportunity”* to facilitate endoscopic procedures in the near future.

References,

1. Kudo SE, Mori Y, Misawa M, et al. Artificial intelligence and colonoscopy: current status and future perspectives. *Dig Endosc 2019. In Press.*
2. Mori Y, Kudo SE, Mohmed HEN, et al. Artificial intelligence and upper gastrointestinal endoscopy: current status and future perspective. *Dig Endosc 2019. In Press.*
3. Mori Y, Kudo SE, Mori K. Potential of artificial intelligence-assisted colonoscopy using an endocytoscope (with video). Dig Endosc. 2018;30:52-53.
4. Bisschops R, Hassan C, Bhandari P, et al. BASIC (BLI Adenoma Serrated International Classification) classification for colorectal polyp characterization with blue light imaging. Endoscopy. 2018;50:211-220.