Artificial inelegance in endoscopy: An updated auricle of Delphi!

See article on page 13

In ancient Greece (1400 BC), the Auricle of Delphi used to be a window into the future, and the Pythia (priestesses of Apollo) would be consulted before making decisions by rulers as well as common folk. We could look at the Auricle of Delphi as a metaphor for machine learning and the black-box deep neural networks that host the complex machine learning algorithms equivalent to the adyton (the room) where the Pythia would enter to look into the future. We might also think of the training data we provide for the machine learning software as sacrifices that are presented prior to getting our "glimpse" of the future. Hopefully, our results with artificial intelligence (AI) are better than the Pythia who inhaled gases and mumbled incomprehensible words that required deciphering and resulted in the defeat of Croesus of Lydia when he asked the Auricle advice (predicting the future) before raging a war on the Persians.

AI as a concept has been around for decades and has flourished recently in many industries including healthcare. The terminology that is used can be confusing[1,2] as well as the potential benefits and drawbacks and should be examined rigorously prior to rolling out its use into everyday practice.[3,4]

In this issue of the Saudi Journal of Gastroenterology, Liu *et al.*[5] published a study on the use of a real-time computer-aided diagnosis (CAD) using a convolution three-dimensional neural network in a randomized controlled trial (RCT). The real-time CAD resulted in a higher average number of polyps detected by colonoscopy from 0.57 in the control group compared to 0.87 in the CAD intervention group ($P < 0.01$), with an odds ratio (OR) of 1.57 (95% confidence interval (CI); 1.59 to 2.48). This RCT also demonstrated that not only the number of polyps detected was higher using the CAD system but also the average number of adenomas was higher in the CAD intervention arm with an average number of adenomas of 0.52 compared to 0.34 in the control arm ($P < 0.01$) with an OR of 1.51 (95% CI; 1.42 to 2.02).

In another RCT examining the performance of an automatic polyp detection system using an algorithm of deep convolutional neural network, it resulted in a higher adenoma detection rate (ADR) (29.1% vs. 20.3%, $P < 0.01$) as well as a higher mean number of adenomas per patient (0.53 vs. 0.31, $P < 0.01$) but this deference was derived from a higher detection of diminutive adenomas (185 vs. 102, $P < 0.01$) rather than larger ones (77 vs. 58, $P < 0.08$).[6] Notably, in this study the majority of cases were symptomatic and the screening colonoscopy sub-population was less than 10%. These findings are consistent with the RCT by Liu *et al.*[5] where the majority of the increase in the ADR is from detecting smaller adenomas with no difference in the detection rate of advanced adenomas. The authors reported that the false-negative rate of polyps using the AI system was 0%. This would be difficult to ascertain, as the study design did not include a tandem colonoscopy to be performed on the same patients to verify whether the AI algorithm, as well as the endoscopists, had not missed any polyps. The literature suggests that there are some false positives as well as missed lesions when using CAD.[7]

Although studies using CAD in the differentiation between the histological types of polyps during colonoscopy[8-10] or for the detection of polyps[11] have been published, these are usually uncontrolled studies and not real-time analyses of the images obtained during colonoscopy. Thus, we believe that this study is an important addition to the literature given its RCT design as well as the short latency period associated with the computer analysis of the images obtained, allowing for its real-time application during endoscopy.

The presumed beneficial effect of an increased ADR with the use of CAD systems hinges on the assumption that unfavorable outcomes, namely missed polyps, are due to not recognizing polyps that were in the visual field of the endoscopist. This might not be the case, as missed polyps might have not been in the visual field at all (e.g., behind a fold) and as such the CAD would also not detect these missed lesions. This emphasizes the need for pristine colonoscopy preparations as well as a good technique when performing colonoscopies. One way to look at CAD software during colonoscopy is a second observer during the procedure.

Although at first glance the cost of incorporating these innovative CAD systems would be low, there are costs associated with acquiring this technology (devices and hardware) that is required whether it be computers, or in the case of cloud computing, the cost of the internet connection.[12] Moreover, the costs associated with the removal of polyps and histological processing and examination should also be incorporated in the eventual cost. Whether these incurred costs would result in meaningful patient-centered outcomes is not clear and would require a proper health-technology assessment evaluation. These outcomes would include and not be limited to: the incidence of colorectal cancer, interval cancer incidence, and decreasing the interpersonal variability in ADRs.

Whether combining a CAD detection AI system with CAD diagnosis software, that enables real-time histological classification of polyps to enhance the decision and confidence of the endoscopist to "resect and discard" diminutive polyps in the distal colon, would eliminate the cost/workload associated with the increased ADR, resulting in a cost-beneficial model for colon cancer screening, remains to be seen. As it stands now, we believe the real benefit of image-based AI aided colonoscopy is probably in quality control, i.e. reducing interoperator variability in detecting larger polyps. It would also be interesting and of value to perform an RCT of polyp detection in a community setting rather than in an academic center, which would demonstrate how these technologies would perform in everyday practice.

What other potentials might the future hold? Well, areas that could benefit from AI in colonoscopy include surveillance colonoscopy in patients with inflammatory bowel disease, high-risk populations including Lynch syndrome, and detecting serrated polyps. Another value of these CAD systems could be in the automated reporting of some of the key performance indicators of colonoscopies such as preparation quality, withdrawal time, landmark documentation, description of lesion size, and morphology.[12] There have been significant advances in some of these areas already.[13,14]

In addition, in the field of upper gastrointestinal endoscopy, CAD has been used for the detection of Barrett's esophagus, squamous cell carcinoma of the esophagus, early gastric cancer, as well as *Helicobacter pylori*.[15] Other areas that could benefit from AI in endoscopy include predicting the malignant potential of strictures seen in fluoroscopic images during endoscopic retrograde cholangiopancreatography, characterization of lesions/cysts during endoscopic ultrasound, as well as mucosal lesions detected during digital cholangioscopy.

There are unlimited potential uses for AI in the medical field, and although the predictions are usually correct, the interpretation of the findings might not be as such. Similar to the case of Croesus of Lydia, the Auricles prediction that "If Croesus made war on the Persians, he would destroy a mighty empire" was true. He thought that he would destroy the empire of the Persians, but in reality, it was his empire that he would destroy. It was in the end, a small misinterpretation.

What we know for sure is that these technologies are here to stay and they will get better as larger training data sets (sacrifices) are used. With the number of studies that have been published in 2019 and the technological advances that have been realized, we can truly say that the future is here!

Majid A. Almadi[1,2], Khek Yu Ho[3]

[1]Division of Gastroenterology, Department of Medicine, King Khalid University Hospital, College of Medicine, King Saud University, Riyadh, Saudi Arabia, [2]Division of Gastroenterology, The McGill University Health Center, Montreal General Hospital, McGill University, Montreal, Canada, [3]Department of Medicine, National University Hospital, Singapore

Address for correspondence: Dr. Majid A. Almadi, Division of Gastroenterology, King Khalid University Hospital, King Saud University, Riyadh, Saudi Arabia.
E-mail: maalmadi@ksu.edu.sa

REFERENCES

1. Min JK, Kwak MS, Cha JM. Overview of deep learning in gastrointestinal endoscopy. Gut Liver 2019;13:388-93.
2. Ebigbo A, Palm C, Probst A, Mendel R, Manzeneder J, Prinz F, *et al.* A technical review of artificial intelligence as applied to gastrointestinal endoscopy: Clarifying the terminology. Endosc Int Open 2019;7:E1616-23.
3. Ahmad OF, Soares AS, Mazomenos E, Brandao P, Vega R, Seward E, *et al.* Artificial intelligence and computer-aided diagnosis in colonoscopy: Current evidence and future directions. Lancet Gastroenterol Hepatol 2019;4:71-80.
4. Kudo SE, Mori Y, Misawa M, Takeda K, Kudo T, Itoh H, *et al.* Artificial intelligence and colonoscopy: Current status and future perspectives. Dig Endosc 2019;31:363-71.
5. Liu WN, Zhang YY, Bian XQ, Wang LJ, Yang Q, Zhang XD, *et al.* Study on detection rate of polyps and adenomas in articial-intelligence-aided colonoscopy. Saudi J Gastroenterol 2020;26:19-25.
6. Wang P, Berzin TM, Glissen Brown JR, Bharadwaj S, Becq A, Xiao X, *et al.* Real-time automatic detection system increases colonoscopic polyp and adenoma detection rates: A prospective randomised controlled study. Gut 2019;68:1813-9.
7. Klare P, Sander C, Prinzen M, Haller B, Nowack S, Abdelhafez M, *et al.* Automated polyp detection in the colorectum: A prospective study (with videos). Gastrointest Endosc 2019;89:576-82 e1.
8. Min M, Su S, He W, Bi Y, Ma Z, Liu Y. Computer-aided diagnosis of colorectal polyps using linked color imaging colonoscopy to predict

histology. Sci Rep 2019;9:2881.
9. Chen PJ, Lin MC, Lai MJ, Lin JC, Lu HH, Tseng VS. Accurate classification of diminutive colorectal polyps using computer-aided analysis. Gastroenterology 2018;154:568-75.
10. Misawa M, Kudo SE, Mori Y, Takeda K, Maeda Y, Kataoka S, *et al.* Accuracy of computer-aided diagnosis based on narrow-band imaging endocytoscopy for diagnosing colorectal lesions: Comparison with experts. Int J Comput Assist Radiol Surg 2017;12:757-66.
11. Yamada M, Saito Y, Imaoka H, Saiko M, Yamada S, Kondo H, *et al.* Development of a real-time endoscopic image diagnosis support system using deep learning technology in colonoscopy. Sci Rep 2019;9:14465.
12. Vinsard DG, Mori Y, Misawa M, Kudo SE, Rastogi A, Bagci U, *et al.* Quality assurance of computer-aided detection and diagnosis in colonoscopy. Gastrointest Endosc 2019;90:55-63.
13. He YS, Su JR, Li Z, Zuo XL, Li YQ. Application of artificial intelligence in gastrointestinal endoscopy. J Dig Dis 2019;20:623-30.
14. Zhou J, Wu L, Wan X, Shen L, Liu J, Zhang J, *et al.* A novel artificial intelligence system for the assessment of bowel preparation (with video). Gastrointest Endosc 2019. doi: 10.1016/j.gie.2019.11.026.
15. Mori Y, Kudo SE, Mohmed HE, Misawa M, Ogata N, Itoh H, *et al.* Artificial intelligence and upper gastrointestinal endoscopy: Current status and future perspective. Dig Endosc 2019;31:378-88.

Access this article online

Quick Response Code:	
	Website: www.saudijgastro.com
	DOI: 10.4103/sjg.SJG_636_19

How to cite this article: Almadi MA, Ho KY. Artificial inelegance in endoscopy: An updated auricle of Delphi! Saudi J Gastroenterol 2020;26:1-3.