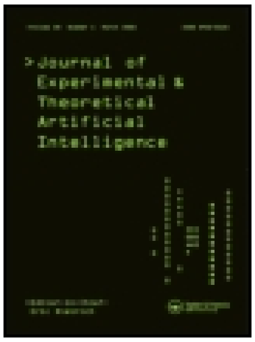

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ARTICLE

The future of endoscopy – what are the thoughts on artificial intelligence?

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ABSTRACT

There is an emerging role of artificial intelligence (AI) in endoscopy with studies on early systems showing promising results. However, various limitations inhibit widespread use. The aim of this study was to ascertain the sentiments of endoscopists and understand the benefits and barriers towards adoption of AI systems into healthcare. An anonymous online 18-question survey was disseminated to gastroenterology and surgical departments across UK. A total of 75 endoscopists completed the questionnaire. The majority felt that AI would increase adenoma detection rate (ADR) (72.8%) and aid lesion characterisation (78.6%). However, only a quarter of respondents were either moderately or very familiar with AI, and there was no consensus on necessity of AI in endoscopy. The key barriers identified were cost, accessibility and lack of guidelines. Endoscopists believe AI systems will have a positive impact on endoscopy; however, these systems must provide quality assurance through large clinical trials before adoption.

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KEYWORDS
Endoscopy; artificial intelligence; computer aided detection; colonoscopy; adenoma detection rate

Introduction

Artificial intelligence (AI) is the simulation of human intelligence by a machine. The use of AI in the field of medicine has been gaining traction in recent years with increasing potential for automation and augmentation of many tasks. AI-assisted endoscopy is one such example where deep learning systems have been used for computer-aided detection and diagnosis (CAD) of polyps during colonoscopies. The two main settings that have been explored are polyp detection (CADe), to detect on-screen polyps which may have been missed by the endoscopist, and polyp characterisation (CADx), to aid histology prediction and avoid unnecessary pathology analysis of diminutive polyps (Hajjar & Rey, 2020; Hoogenboom et al., 2020). As colonoscopies form the basis of colorectal cancer detection and surveillance, improvement in endoscopic performance has significant healthcare impact. Data has shown that with every 1% increase in a physician's adenoma detection rate (ADR), the patient's risk of developing colon cancer over the next year decreases by 3% (Corley et al., 2014). While studies on early systems were largely retrospective and trained on still images, a meta-analysis of six randomised control trials (RCTs) recently published using five AI systems showed a significantly higher ADR of 33.7% vs 22.9% between AI-assisted colonoscopy and conventional colonoscopy (Ashat et al., 2021).

Despite this promising trajectory, many limitations still need to be addressed before widespread use becomes possible. At present, there is substantial heterogeneity between AI models and training

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data, and standardised regulation would need to be established (He et al., 2019; Lui & Leung, 2020). These include potential large number of false positive results and increased time spent per procedure, increased reliance of endoscopists on the software, as well as increased costs (Antonelli et al., 2020).

Effective implementation of any new technology would also need buy-in of both institutional providers (e.g. hospitals) and clinician end users (endoscopists). Models originally developed outside the context of healthcare systems but that have now found wide adoption within, are useful frameworks to look at factors that explain technology acceptance. The Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) are two such models (Ammenwerth, 2019a). The UTUAT is modified from the original TAM and proposes these four variables – perceived usefulness, effort expectancy, social influence (perception of degree to which important others believe one should use the system) and facilitating conditions (perception of organisation and technical infrastructure to support system). These factors determine intention to use which is then often regarded as a surrogate for actual usage (Holden & Karsh, 2009).

AI endoscopy is still in its infancy but assessment and understanding of the current attitude of endoscopists towards AI in their clinical practice is an important part of the evolution process. Currently, the literature is largely focused on the technical aspects such as diagnostic accuracy of AI endoscopy, but little has been done to look at the qualitative aspects of its implementation in the healthcare setting. The aim of this study was to establish the knowledge physicians and surgeons had of AI, and understand their opinions on the benefits and barriers of adoption of AI systems into the clinical setting.

Methods

Study design

This was a cross-sectional study in the form of an anonymous online questionnaire. The questionnaire was hosted online. It contained 18 questions and comprised of a variety of question types including polar (yes/no) questions, a 4-point Likert scale, a ranking question and multiple-response questions. Questions were worded both positively and negatively to reduce the tendency for acquiescence response bias. The questions asked about participant's speciality, level of training, endoscopy experience, knowledge of AI, and views on AI technology in endoscopy. A full copy of the questionnaire can be found in Appendix 1.

Questionnaire distribution

All endoscopists practicing in the UK were eligible to participate. Inclusion criteria included trainee and consultant endoscopists in surgical or gastroenterology departments. Participants were approached to take part in the study through email communication between March and April 2021. Participation was voluntary.

The Qualtrics survey software was used for the questionnaire due to its ease of use and the fact that data could be easily aggregated and exported for analysis. The questionnaire was divided into two parts; part 1 gave information about the study with access to the participant information sheet and consent form, and part 2 was the questionnaire itself. Data was gathered onto a standard spreadsheet.

Statistical analysis

Descriptive statistics were performed to summarise the questionnaire findings. All statistical analysis was carried out using SPSS version 27 (IMB, Armonk, NY). Categorical data were reported as percentages and analysed using the Chi-squared test (or Fisher's exact test when appropriate), to assess statistically significant differences between endoscopist characteristics and views on AI in gastroenterology. Statistical significance was defined as $p < 0.05$.

The UK Key Performance Indicators & Quality Assurance Standards (Rees et al., n.d..) were used to evaluate competency amongst endoscopists and minimal ADR. Those with >200 colonoscopies were considered competent, and an ADR of 15% was defined as the minimum.

Ethical considerations

Full ethical review and approval was obtained through the Science Engineering Technology Research Ethics Committee (SETREC number: 20ICHH6530), and informed consent was obtained from all participants prior to starting the questionnaire.

Results

Population

A total of 186 endoscopists in the UK were invited to participate in the study. Of these 186 endoscopists, 98 agreed to participate in the study and a total of 75 (40.3%) endoscopists completed the questionnaire.

Amongst those that completed the questionnaire, 58.7% were consultants and 41.3% were registrars, fellows or nurse endoscopists. In regard to experience, 68% of participants were experienced, having completed their competency with >200 colonoscopy procedures, and 58.7% had an ADR >15%. The majority of participants worked in the region of London (60%). Participant characteristics is shown in Table 1.

Effects of AI on endoscopy

All responses from the participants are shown in Figure 1. The highest proportion of endoscopists felt they were slightly familiar with AI at 52.8%, while 22.6% were not at all familiar. The majority of endoscopists felt that AI would increase ADR (72.8%), PDR (80%), improve the quality of endoscopy (72.8%) and aid lesion characterisation (78.6%).

A large proportion of endoscopists (62.89%) felt that AI would become part of routine practice in 5 years. Less than 3% of endoscopists felt AI was a threat to their clinical practice and the majority perceived it as a tool (81.4%).

However, 55.7% of endoscopists believed AI would increase the cost of endoscopy. There was also no consensus on whether AI would increase efficiency within endoscopy practice with an equal 37.1% answering 'yes' and 'unsure', as well as whether AI would be necessary to endoscopy with 34.3% answering 'yes' and 34.3% answering 'no'.

Effect of AI on ADR

When comparing role, experience and the ADR of endoscopists, the experience of endoscopists, in terms of number of colonoscopies, had the most significant effect on whether they felt AI would help improve ADR ($p = 0.01$). Of those having completed less than 200 colonoscopies, 52.4% felt AI would increase the ADR whilst 47.6% were unsure. A larger proportion of competent endoscopists (81.6%) answered that AI would improve ADR and only 14.3% were unsure (Table 2).

Sentiments of endoscopists based on experience

Endoscopists with higher experience were more likely than those with less experience to believe that AI would improve the quality of endoscopy (83.7% vs. 47.6%; $p = 0.005$), and to believe that AI would

Table 1. Study population characteristics.

Region of Work	n	%
North East England	2	2.67
North West England	2	2.67
Yorkshire and the Humber	2	2.67
West Midlands	2	2.67
East Midlands	5	6.67
East of England	4	5.33
London	45	60.00
South East England	9	12.00
South West England	4	5.33
Role		
Consultant gastroenterologist	30	40.00
Consultant surgeon	14	18.67
Gastroenterology registrar	20	26.67
Surgical registrar	4	5.33
Clinical fellow in gastroenterology	5	6.67
Clinical fellow in surgery	1	1.33
Nurse endoscopist	1	1.33
Consultant	44	58.67
Non-consultant	31	41.33
Level of Colonoscopy Experience		
0–200 procedures	24	32.00
200–500 procedures	12	16.00
500–1000 procedures	4	5.33
More than 1000 procedures	35	46.67
Competent	51	68.00
Non-competent	24	32.00
ADR		
0–15%	7	9.33
15–25%	13	17.33
25–40%	15	20.00
40–60%	11	14.67
>60%	5	6.67
Unsure	24	32.00

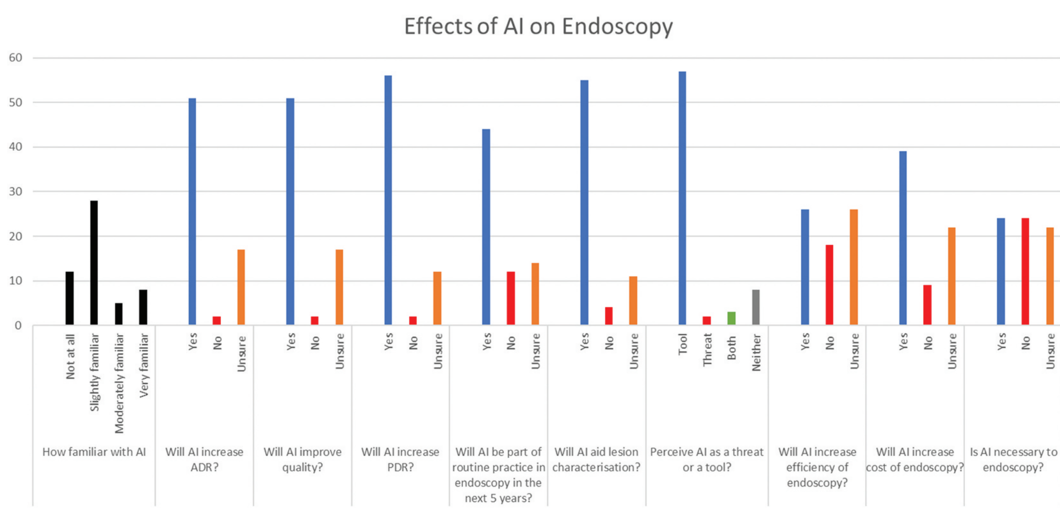

Figure 1. Summary of responses.

Table 2. Comparing role, experience, ADR of endoscopists with views of AI on ADR.

		Improvement in ADR with AI?			
		No (%)	Yes (%)	Unsure (%)	P-value
Role	Consultant	2.60	76.90	20.50	
	Non-consultant	3.20	67.70	29.00	0.69
Experience (no. of colonoscopies)	<200	0.00	52.40	47.60	
	>200	4.10	81.60	14.30	0.01
ADR of endoscopist	<15%	0.00	66.70	33.30	
	>15%	2.40	73.80	23.80	
	Unsure	4.50	72.70	22.70	0.95

Table 3. Sentiments of Endoscopists based on Experience.

		Competence (no. of colonoscopies)		p-value
		<200	>200	
Improve quality	**No**	2 (9.5%)	3 (6.1%)	
	Yes	10 (47.6%)	41 (83.7%)	
	Unsure	9 (42.9%)	5 (10.2%)	**0.005**
Increase PDR	**No**	0 (0)	2 (4.1%)	
	Yes	13 (61.9%)	43 (87.8%)	
	Unsure	8 (38.1%)	4 (8.2%)	**0.008**
Increase efficiency	**No**	2 (9.5%)	16 (32.7%)	
	Yes	8 (38.1%)	18 (36.7%)	
	Unsure	11 (52.4%)	15 (30.6%)	0.085
Increase cost	**No**	2 (9.5%)	7 (14.3%)	
	Yes	11 (52.4%)	28 (57.1%)	
	Unsure	8 (38.1%)	14 (28.6%)	0.690
Routine in 5 years	**No**	4 (19%)	8 (16.3%)	
	Yes	10 (47.6%)	34 (69.4%)	
	Unsure	7 (33.3%)	7 (14.3%)	0.147
Necessary	**No**	9 (42.9%	15 (30.6%)	
	Yes	3 (14.3%)	21 (42.9%)	
	Unsure	9 (42.9%)	13 (26.5%)	0.068
Lesion characterisation	**No**	1 (4.8%)	3 (6.1%)	
	Yes	14 (66.7%)	41 (83.7%	
	Unsure	6 (28.6%)	5 (10.2%)	0.154
Threat/Tool	**Threat**	2 (9.5%)	0 (0)	
	Tool	15 (71.4%)	42 (85.7%)	
	Both	0 (0)	3 (6.1%)	
	Neither	4 (19%)	4 (8.2%)	**0.049**

increase the PDR (87.8% vs 61.9%; $p = 0.008$). When comparing the sentiments of higher and lower experienced endoscopists, there was no significant difference towards AI and its effect on efficiency ($p = 0.085$), cost ($p = 0.690$) nor necessity ($p = 0.068$) (Table 3).

Benefits and barriers of AI in endoscopy

Participants felt the top three benefits of AI in endoscopy were its role in improving ADR, improving PDR and increasing confidence when performing the procedure. The key barriers to the adoption of AI in endoscopy were cost, accessibility, and lack of guidelines. Endoscopists ranked the ethical implications of AI in endoscopy as the smallest barrier (Figures 2 and 3).

Use of AI in endoscopy

Responders felt the best use of AI in endoscopy should be in in-vivo lesion detection and characterisation (36.7%) followed by assessment of quality of endoscopy (27.8%) (Figure 4). Endoscopists felt

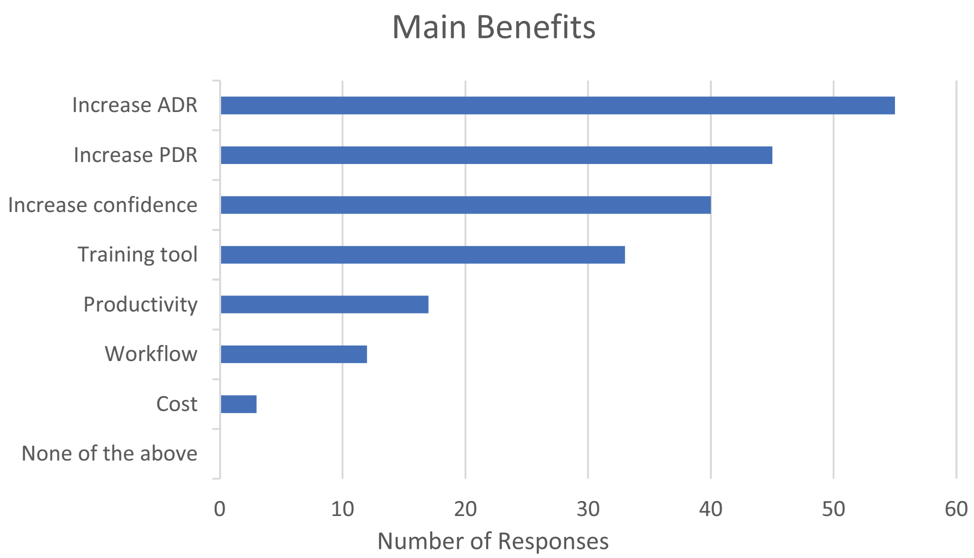

Figure 2. Key benefits of AI in endoscopy.

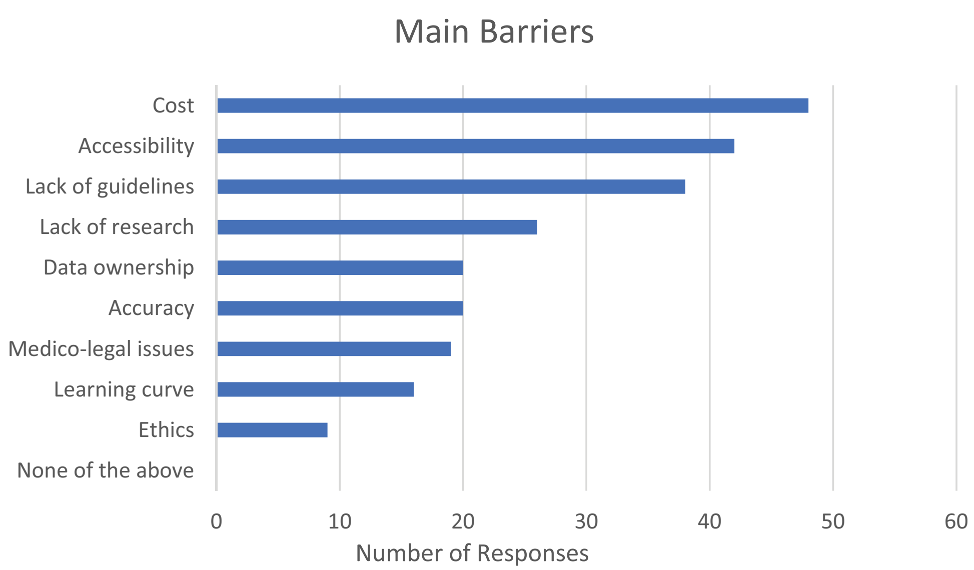

Figure 3. Main barriers of adoption of AI in endoscopy.

that the highest priority area for AI use is in video capsule endoscopy and in descending priority hepatobiliary (e.g. ERCP), upper GI, endoscopic ultrasound and lastly lower GI (Figure 5).

Discussion

The introduction of AI in endoscopy has already begun, but the views of the end-user has not been fully explored. This study demonstrates that the majority of endoscopists felt that the adoption of AI in endoscopy would increase the ADR (72.8%), PDR (80%) and improve the quality of the endoscopy

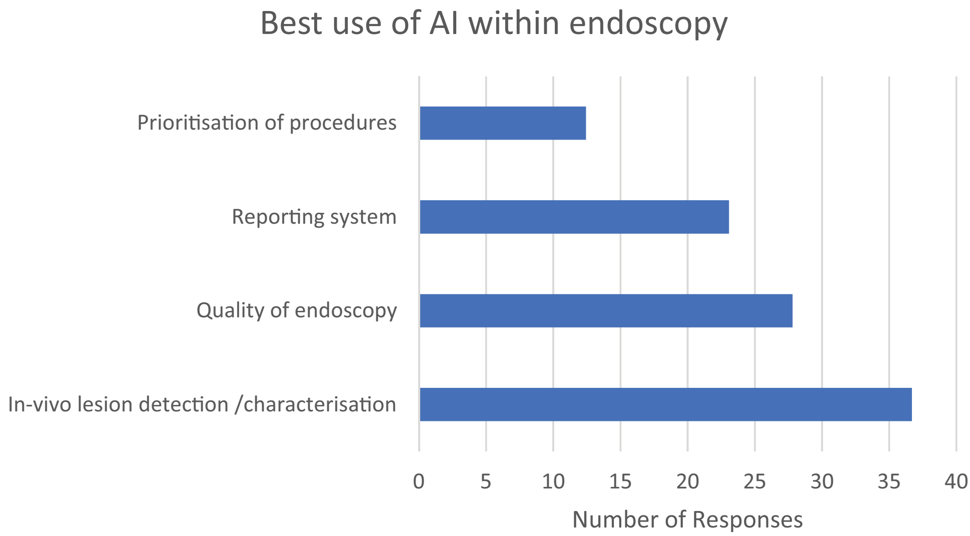

Figure 4. Best use of AI within endoscopy.

Figure 5. Priority area for AI use.

(72.8%). Endoscopists also believed it would have a positive impact on their practice and perceived AI as a tool rather than a threat.

Although this study highlights the acceptance of AI into endoscopy, it also demonstrates that most endoscopists are not yet familiar with the AI systems and lack a complete understanding. This may explain why there was no consensus as to whether AI is actually necessary in endoscopy. Over 75% of respondents were either only slightly familiar or not familiar at all with AI. In this way, there is still a large gap between studies showing the positive impact of AI on polyp detection and characterisation (Nazarian et al., 2021) and the implementation of these systems into clinical practice. Many commercial devices have been developed by endoscopy manufacturers who have opted to protect their intellectual property despite a lack of studies reporting results of the use of AI systems in real-time in a healthcare setting (Attardo et al., 2020; Togashi, 2019). True confidence in these novel systems is needed through large randomised controlled trials comparing AI to standard colonoscopy, adequate teaching and training of clinicians and through creation of evidence-based guidelines.

Almost 80% of endoscopists felt that AI will aid lesion characterisation, and of those almost 75% were experienced endoscopists. The Preservation and Incorporation of Valuable endoscopic

Innovations (PIVI) initiative, set by the American Society of Gastrointestinal Endoscopy (ASGE), has set out a desired threshold for the introduction of new endoscopic technologies, including the optical diagnosis of diminutive colorectal polyps (Cohen et al., 2012; Rex et al., 2011). A multi-centre study has highlighted that the accuracy of optical diagnosis requires imaging advances before it can be used to determine surveillance without histology (Rees et al., 2016). However, in the long-term, a 'resect and discard' strategy for lesions would reduce the use of an additional workforce and save resources. In this study, endoscopists ranked the ability of AI to increase their confidence as one of the top three main benefits. This being said, expert endoscopists able to either support or refute the output of an AI prediction tool with an existing high level of confidence would have to drive such strategies since, irrespective of financial savings, ethical and medico-legal concerns of AI are yet to be resolved. For this reason, the use of AI systems may be more helpful as a training tool to increase the confidence of non-expert endoscopists.

The financial implications of the adoption of AI technology in endoscopy are still undetermined. Endoscopists in this study felt that cost was the main barrier to adoption of AI in endoscopy. Recent cost-effectiveness analyses show that optical diagnosis of diminutive polyps using AI is expected to reduce polypectomy-related costs substantially, supporting a widespread implementation of such technology (Areia et al., 2022; Mori et al., 2020). However, the cost savings of polyp detection systems are still unknown. The cost of a missed polyp and a diagnosis of a post-colonoscopy colorectal cancer may completely outweigh the cost of an AI system able to accurately detect adenomas, but without studies to show this, clinicians and healthcare systems cannot allocate their funding based on such assumptions. In order to persuade essential stakeholders to accept AI and provide reimbursement for its use, more studies based on large clinical trials are required to highlight the cost-benefit related outcomes of this technology.

There are several limitations to our study. Firstly, this was a cross-sectional study and susceptible to misclassification due to recall bias with regard to the experiences of endoscopists with AI. However, given this questionnaire aimed at understanding the sentiments of endoscopists rather than recalling on specific events, the degree of bias could be reduced. Secondly, there was a low response rate from participants. Although more than half of those invited agreed to participate, only 40% completed the questionnaire, which may have been due to the busy schedule of endoscopists. The response rate may have been improved using telephone or face-to-face interviews instead. Furthermore, the questions in this study were not open-ended and therefore did not allow the various stakeholders to develop their ideas, or even to digress into subjects not directly related to the initial question. This may have contributed to an incomplete understanding of endoscopist views and may have resulted in skewed results. This being said, open-ended questions can be difficult to analyse and may affect the quality of the data. Additionally, as this analysis involved the use of descriptive and not inferential statistics, it was not possible to provide further information on the strength of the relationship between factors such as endoscopist experience and their opinion on how AI would affect ADR/PDR. Lastly, this was a national study, taking into consideration the views of endoscopists in the UK. Stakeholders in the UK who work in a public healthcare setting may have differing views and priorities to endoscopists in other countries where private healthcare systems are in place. A previous study in the US has assessed the views of physicians towards AI, and found that gastroenterologists had a strong interest in the application of AI to colonoscopy (Wadhwa et al., 2020). However, this is once again another national study. Conducting an international questionnaire study may have given a broader perspective on the views of AI in endoscopy.

Conclusion

With the growing interest and development of AI systems in endoscopy, the views of stakeholders and endoscopists have not been fully explored. This study shows that endoscopists believe AI systems will have a positive impact on endoscopy and view the technology as a tool rather than a threat to their clinical practice. We have also highlighted key challenges and barriers to application which would need to be addressed for greater buy in of end users and ultimately increase the trust of patients. There is still a lack of large randomised controlled trials which are required to create evidence-based guidelines and highlight the cost-benefit outcomes of this novel technology.

Disclosure statement

Ara Darzi is the Chair of Flagship Pioneering UK Ltd and the Preemptive Medicine and Health Security initiative. No other potential conflict of interest was reported by the authors.

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