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# Exploring stakeholder attitudes towards AI in clinical practice

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## ABSTRACT

**Objectives** Different stakeholders may hold varying attitudes towards artificial intelligence (AI) applications in healthcare, which may constrain their acceptance if AI developers fail to take them into account. We set out to ascertain evidence of the attitudes of clinicians, consumers, managers, researchers, regulators and industry towards AI applications in healthcare.

**Methods** We undertook an exploratory analysis of articles whose titles or abstracts contained the terms 'artificial intelligence' or 'AI' and 'medical' or 'healthcare' and 'attitudes', 'perceptions', 'opinions', 'views', 'expectations'. Using a snowballing strategy, we searched PubMed and Google Scholar for articles published 1 January 2010 through 31 May 2021. We selected articles relating to non-robotic clinician-facing AI applications used to support healthcare-related tasks or decision-making.

**Results** Across 27 studies, attitudes towards AI applications in healthcare, in general, were positive, more so for those with direct experience of AI, but provided certain safeguards were met. AI applications which automated data interpretation and synthesis were regarded more favourably by clinicians and consumers than those that directly influenced clinical decisions or potentially impacted clinician–patient relationships. Privacy breaches and personal liability for AI-related error worried clinicians, while loss of clinician oversight and inability to fully share in decision-making worried consumers. Both clinicians and consumers wanted AI-generated advice to be trustworthy, while industry groups emphasised AI benefits and wanted more data, funding and regulatory certainty.

**Discussion** Certain expectations of AI applications were common to many stakeholder groups from which a set of dependencies can be defined.

**Conclusion** Stakeholders differ in some but not all of their attitudes towards AI. Those developing and implementing applications should consider policies and processes that bridge attitudinal disconnects between different stakeholders.

## Summary

### What is already known?

- Very little is known about the attitudes of different stakeholders towards artificial intelligence (AI) applications in healthcare.
- While the AI industry see their applications as promising for improving healthcare, the views of clinicians, patients and other groups directly involved in delivering or receiving care may not be so favourable.

### What does this paper add?

- This paper provides an exploratory analysis of published reports of the attitudes and perceptions of different stakeholder groups towards AI applications in healthcare.
- Stakeholder groups hold similar attitudes towards AI on some attributes but differ in their attitudes towards others.
- In general, attitudes towards AI in healthcare were positive, more so for those with direct experience of AI in care delivery, but with the proviso that certain safeguards were met.
- Those developing and implementing AI applications should consider policies and processes that bridge attitudinal disconnects between different stakeholders.

## INTRODUCTION

Artificial intelligence (AI) refers to advanced computer programs that mimic intelligent human behaviours and assist humans with different tasks. Medical AI applications span a spectrum, from diagnosis and disease screening to treatment selection and prognostication,[1] and aim to optimise care, improve efficiency and enhance clinician and consumer experience. Despite scores of AI applications having received regulatory approval for use in clinical settings in recent years, and many more having passed the proof-of-concept stage, relatively few that purport to directly assist decision-making have been adopted at scale into clinical practice.[2] This limited uptake may be due, at least partly, to misperceptions of what the term AI actually means and negative attitudes towards AI held by key players in the healthcare ecosystem. Multiple stakeholders share interest in the performance and outcomes of AI applications, comprising clinicians, consumers, managers, researchers, regulators and industry. Their perceptions and expectations of AI may differ, and need to be understood and considered by AI developers and implementers if AI applications

are to be designed and operationalised in ways acceptable to all parties.

## METHODS

We undertook an exploratory analysis of articles whose titles or abstracts contained the terms 'artificial intelligence' or 'AI' and 'medical' or 'healthcare' and 'attitudes', 'perceptions', 'opinions', 'views', 'expectations'. Using a snowballing strategy, we searched PubMed and Google Scholar for articles published 1 January 2010 through 31 May 2021. Reference lists of retrieved articles were perused for additional studies. We excluded articles that did not employ a formal survey or interview tool and/or did not report quantified response measures for individual questions among respondents. We only selected articles dealing with non-robotic AI applications used to support clinician-mediated care-related tasks or decision-making, and excluded mobile or wearable applications that were exclusively consumer facing. Key findings were extracted and summarised in narrative form according to four categories of participants. We used these results to derive a thematic synthesis of stakeholder expectations and corresponding requirements (or dependencies) for developers of AI applications to consider.

## RESULTS

A total of 27 articles were included[3–29] of which most (16, 59%) targeted clinicians,[3–18] 8 (30%) focused on consumers (including patients),[19–26] 1 (4%) on health executives[27] and 2 (7%) on industry stakeholders comprising AI vendors, researchers and regulators.[28 29] Detailed study descriptions are provided in the online supplemental appendix and summary results are listed in table 1. Most studies (23; 85%) used online surveys,[3–20 22–24 27 28] of which only three (11%)[15 17 24] were designed using the Checklist for Reporting Results of Internet E-Surveys.[30] Three (11%) studies undertook face to face interviews,[25 26 29] and one used a paper-based questionnaire.[21] A specific definition or example of AI was provided to participants in only 10 (37%) studies,[3 8 17 19 22–27] with generic descriptors (eg, 'computers' or 'machines') used in 6 (22%)[5 13 14 16 28 29] and none in 11 (41%).[4 6 7 9–12 15 18 20 21] Survey response rates were reported in 11 (41%) studies,[5 6 9 12 13 15 17 18 21 23 28] ranging from <0.1% to 66%, with 6 (22%)[7 8 10 11 14 16] reporting no response rates and the remainder using convenience samples[19 20 22–27 29] of which one calculated a required sample size.[19]

### Clinicians

Clinicians practising in imaging-based disciplines, where deep machine learning is most advanced, featured in several surveys. In an Australian survey of 632 specialists (ophthalmology (n=305), radiology/radiation oncology (n=230), dermatology (n=97)),[3] most had never actually used any AI application in practice (81%), but predicted AI would improve their field (71%) and impact future workforce needs (86%). Most considered AI had to perform better than specialists for disease screening

**Table 1** Stakeholder perceptions of clinical AI applications

| Positive perceptions | Negative perceptions |
|---|---|
| *Clinicians* | |
| Improved diagnostic accuracy; fewer errors[3 5]<br>More efficient work flows[4 5 17 18]<br>Less time spent on administrative and other mundane tasks[3 13]<br>Synthesis of clinical information[15 18]<br>Updating of clinical records[14]<br>More time spent with patients[5]<br>Improved access to care[3] | Liability for AI-mediated errors[3]<br>Insufficient training and continuing professional development in AI[3 5 7 8 12]<br>Reputational loss and reduced demand for specialist opinion[9 18]<br>Potential erosion of empathetic communication with patients[13 18]<br>Risk of privacy breaches and loss of confidentiality of patient information[17]<br>Lack of proof of efficacy of AI applications in clinical settings[3 29]<br>Lack of explainability[16] |
| *Consumers* | |
| Second opinions to clinicians[21 22 25]<br>Improved access to care[23] | Dehumanisation of the clinician–patient relationship[18 19]<br>Threat to shared decision-making involving patients[22]<br>Low trustworthiness of AI advice[19 20 23]<br>Insufficient clinician and regulatory oversight[21]<br>Uncertainty around fairness and equity in treatment allocation[26] |
| *Healthcare executives* | |
| Improved operational efficiency, cybersecurity, analytic capacity, cost savings[27] | Uncertainty around patient satisfaction, access to care, improved patient outcomes[27] |
| *Industry professionals* | |
| Shared many of the positive attitudes listed above[27–29] | Limited access to high quality data for model development[29]<br>Unresolved legal liability question[29]<br>Lack of explicit and robust regulatory frameworks[29]<br>Low levels of funding for independent, investigator-led research in AI[29] |

AI, artificial intelligence.

(64%) and diagnosis (80%). The top three perceived AI benefits were improved patient access to screening, greater diagnostic confidence and reduced specialist time spent on mundane tasks. The top three concerns were outsourcing application development to large commercial AI companies, clinician liability due to AI errors and decreased reliance on specialists ('do-it-yourself' medicine). Most respondents (86%) felt their professional colleges were ill prepared for introducing AI into practice, citing need for training curricula, guidelines and working groups with AI expertise.

Radiologist attitudes towards AI were mostly positive. Most surveyed Italian radiologists (n=1032) favoured adopting AI (77%), did not fear job loss due to AI (89%) and anticipated fewer diagnostic errors (73%) and optimised workflows (68%), although at the expense of some reputational loss and decreased demand for their services (60%).[4] Among 270 French radiologists, most anticipated fewer errors (81%), reduced time spent on image interpretation (74%) and more time spent with patients (52%), with most wanting ongoing education in AI (69%).[5]

Trainees and medical students with an interest in radiology expressed more mixed views, with a third of 69 US radiology residents stating, with hindsight, they may have chosen a different career because of AI.[6] Among 484 UK medical students, half (49%) were disinclined towards a radiology career, despite most (89%) seeing expertise in AI as benefitting them (89%) and wanting AI education included in medical degrees (78%).[7] In Germany, 263 medical students thought AI will improve radiology (86%), not replace radiologists (83%), and desired further training in AI (71%).[8] Canadian students (n=322) expressed similar views, but also voiced concerns about reduced radiologist demand (67%).[9]

Clinicians in pathology and dermatology also tended to view AI positively. Among 487 survey respondents in pathology from 59 countries, 73% expressed interest or excitement in AI as a diagnostic tool for improving workflow efficiency and quality assurance.[10] Fewer than 20% feared displacement or negative career impacts, with most (73%) stating diagnostic decision-making should remain a predominantly human task or one shared equally with AI. While only 25% were concerned about AI errors, opinions about medico-legal responsibility were split, with 44% believing the AI vendor and pathologist should be held equally liable and 50% believing the pathologist should bear prime responsibility. Most (93%) pathologists supported AI if it resulted in more time being spent on academic or research efforts in answering questions previously not possible. Similarly, among 1271 dermatologists from 92 countries, 77% saw AI as improving diagnostic accuracy, particularly in regards to dermatoscopic images, and 80% thought AI should be part of medical training.[11] Less than 6% saw dermatologists being replaced by AI, although 18% held non-specified fears of negative impacts. In contrast, being replaced by AI was of great concern to 27% of laboratory workers and non-clinical technicians in a survey of 1721 subjects, although most (64%) expressed support for AI projects within their organisation and 40% believed AI could reduce errors and save time in their routine work.[12]

Clinicians from non-imaging-based disciplines considered the potential of AI to be more limited. Among 720 UK general practitioners, most (>70%) thought human empathy and communication could not be emulated by AI, that value-based care required clinician judgement, and that benefits of AI would centre on reducing workflow inefficiencies, particularly administrative burdens.[13] Similarly, most psychiatrist respondents (n=791) from 22 countries felt AI was best suited to documenting and updating medical records (75%) and synthesising information to reach a diagnosis (54%).[14] Among 669 Korean doctors, most (83%) considered AI useful in analysing vast amounts of clinical data in real time, while more than a quarter (29%) thought AI would fail in dealing with uncommon scenarios owing to inadequate data.[15] Respondents felt responsibility for AI-induced errors lay with doctors (49%), patients consenting to use of AI (31%) or AI companies that created the tools (19%). Most Chinese clinicians (82% of 191) were disinclined to use an AI diagnostic tool they did not trust or could not understand how it would improve care.[16] Among 98 UK clinicians (including 34 doctors, 23 nurses, 30 allied health professionals), 80% expressed privacy concerns and 40% considered AI potentially dangerous (indeed as bad as nuclear weapons, although this response was primed by reference to a film in which Elon Musk expressed similar sentiments).[17] However, 79% also believed AI could assist their field of work and 90% had no fear of job loss. In a survey of 250 hospital employees from four hospitals in Riyadh, Saudi Arabia (nurses=121; doctors=70; technicians=59), the majority stated AI could reduce errors (67%), speed up care processes (70%) and deliver large amounts of high-quality, clinically relevant data in real time (65%).[18] However, most thought AI could replace them in their job (78%) despite AI limitations in being unable to provide opinions in every patient (66%) or in unexpected situations (64%), unable to sympathise with patients (67%) and developed by computer specialists with little clinical experience (68%).

## Consumers

Consumer surveys of AI in healthcare are few and yield mixed views depending on who was surveyed and what AI functions were considered. Most clinical trials of AI tools also omit assessment of patient attitudes.[31] In general, patients view AI more favourably than non-patients, but only if AI is highly trustworthy and associated with clinician oversight.

An online US survey of 50 individuals revealed dehumanisation of clinician–patient relations, low trustworthiness of AI advice and lack of regulatory oversight as significant risks which predominated over potential benefits, although privacy breaches or algorithm bias were not expressed as major concerns.[19] In an online survey

of 6000 adults from various countries, only 27% respondents expressed comfort with doctors using AI to influence clinical decisions.[20]

In a survey of 229 German patients, most (≥60%) favoured physicians over AI for history taking, diagnosis and treatment plans, but simultaneously acknowledged AI could help integrate the most recent scientific evidence into clinician decision-making.[21] Most (>60%) preferred physician opinion to AI where the two disagreed, and were less accepting (≤45%) of AI use in cases of severe versus less severe disease. In a UK case-based questionnaire study involving 107 neurosurgery patients, most accepted using AI for image interpretation (66%), operative planning (76%) and real-time alert of potential complications (73%), provided the neurosurgeon was in control at all times.[22] Among 1183 mostly female patients with various chronic conditions who were considering biometric monitoring devices and AI, only 20% considered benefits (such as improved access to care, better follow-up, reduced treatment burden) greatly outweighed risks and 35% would decline the use of AI-based tools in their care.[23] The majority (>70%) of parents of paediatric patients (n=804) reported openness to AI-driven tools if accuracy was proven, privacy and shared decision-making were protected and care using AI was convenient, of low cost, and not in any way dehumanised.[24] Among 48 US dermatology patients, most (60%) anticipated earlier diagnosis and better care access, while 94% saw the main function of AI as offering second opinions to physicians, and perceived AI as having both strengths (69% believed AI to be very accurate most of the time) and weaknesses (85% expected rare but serious misdiagnoses).[25] A small study found 18 patients with meningioma wanted assurance that use of AI to allocate treatment was fair and equitable, that AI-mediated mistakes would be disclosed and reparations to patients forthcoming and that patient consent was obtained for any sharing of health data.[26]

### Healthcare executives

In a global survey of 180 healthcare executives, 40% of respondents overall favoured increased use of AI applications, although this figure varied according to jurisdiction, with Australian executives (23%) being least in favour.[27] Perceived AI benefits comprised improved cybersecurity (56%) operational efficiency (56%), analytics capacity (50%) and cost savings (43%). However, fewer respondents thought there would necessarily be improvements in patient satisfaction (13%), access to care (10%) or clinical outcomes (6%). Respondents cited success factors for AI implementation as comprising adequate staff training and expertise (73%), explicit regulator legislation (64%) and mature digital infrastructures (62%).

### Industry professionals

Information technology (IT) specialists, technology and software vendors, researchers and regulators—the 'insiders' of AI—may harbour attitudes different to those of AI users such as clinicians, consumers and healthcare executives.

In one German survey (n=123; 42 radiologists, 55 IT specialists, 26 vendors), all three groups mostly agreed (>75%) that AI could improve efficiency of care, provided AI applications had been validated in clinical studies, were capable of being understood by clinicians and were referenced in medical education.[28] However, only 25% of participants would advocate sole reliance on AI results, only 14% felt AI would render care more human and 93% required confirmation of high levels of accuracy. In interviews involving 40 French subjects (13 physicians, 7 industry representatives, 5 researchers, 7 regulators, 8 independent observers), all agreed reliable AI required access to large quantities of patient data, but such access had to be coupled with confidentiality safeguards and greater transparency in how data were gathered and processed to protect the integrity of physician–patient relationships.[29] On other matters there were notable differences. Physicians highlighted many tools lacked proof of efficacy in clinical settings and they would not assume criminal liability if a tool they could not understand produced errors. Industry representatives wanted greater access to more high-quality data, while wanting to avoid injury liability as they believed this would hinder tool development. Regulators were urgently searching for robust procedures for assessing safety of constantly evolving AI tools, and resolving liability for AI error which would otherwise discourage clinicians and patients from using AI. Researchers with no commercial sponsors wanted more funding and more rapid translation of their findings into practice.

### Expectations and dependencies

Our analysis identified certain stakeholder expectations of AI (table 2), with the most frequently cited being a need for accurate and trustworthy applications that improve clinical decision-making, workflow efficiencies and patient outcomes, but which do not diminish professional roles. These expectations, which varied in strength of expression across studies, reflect the dominance of clinician surveys in existing studies. The corresponding self-explanatory dependencies were extrapolated by the authors, and are aligned with those expressed in authoritative reports from the National Academy of Medicine[32] and the WHO.[33] According to these bodies, understanding stakeholder views is essential in formulating clinical AI policy and that AI designers should focus on education, communication and collaboration in bridging attitudinal disconnects between different stakeholders.

## DISCUSSION

### Overview of findings

The diversity in attitudes towards AI of different stakeholders and the cautionary sentiments expressed by many suggest AI applications should be seen as complex sociotechnical systems with many interacting components.[34]

**Table 2** Expectations and dependencies

| Expectations | Dependencies |
|---|---|
| Ensuring accuracy, freedom from bias, trustworthiness.[3–5 8 19 20 23 24 29] | AI applications should be based on models that, in their development, have involved domain experts and have minimised bias related to under-representation of patient groups or contextually inappropriate outcome measures, and have been shown to produce accurate results in the populations for which they are to be used. |
| Improving efficiency and reduced administrative burden.[3–5 10 13–15 17 18,] | AI applications must be fitted to, and complement, routine clinical workflows and, where possible, self-populate the required data with minimal clinician input. |
| Improving clinical decision-making and outcomes.[3 11 18 21 22 25 27 29] | AI applications must be shown to be as or more effective in improving clinical decision-making and patient experiences and outcomes than current care, not just efficacious in controlled research settings, and be accompanied with clinician oversight. |
| Maintaining the integrity of clinician-patient relationships.[5 13 18 19 24] | AI applications should not distract from, or degrade, human to human interaction and shared decision-making. |
| Ensuring explainability and transparency.[16 19 20 23] | AI applications must be developed and assessed with an eye to maximising explainability and transparency in regards to their inner workings, while acknowledging limits to the extent this can be achieved. As much as possible, important features underpinning AI predictions should be identified, and outputs should be presented in ways easily interpretable to clinicians and patients. |
| Preserving professional status.[3–9 11 12 18] | AI applications must be implemented with care regarding potential loss of jobs or professional reputation, highlighting the potential of AI to remove the tedious aspects of work, improve job satisfaction and provide new skills. This must be coupled with careful attention to clinicians' training needs and career development. |
| Obtaining regulatory approval.[3 19 21 27 29] | AI applications should be subject to regulatory standards that are robust, transparent and responsive to updates of existing applications. |
| Determining liability for error.[3 10 19 21 29] | AI applications should be associated with clear lines of responsibility regarding liability for error, including no-fault provisions when, despite good evidence of efficacy and safety, errors occur as a result of technical failures involving applications whose workings are beyond the comprehension and control of the human user. |
| Ensuring data privacy, confidentiality and security.[17 24 27] | AI developers must ensure they adhere to legal and community expectations regarding privacy, confidentiality and security of health and medical data. |
| Ensuring access and equity.[24–26] | AI applications shown to be effective must be equitably accessible to low income, remote or other disadvantaged populations, and not be concentrated in already well-served populations with well-structured digital and data infrastructures. |

AI, artificial intelligence.

However, stated positive or negative perceptions of AI may not consistently translate into adoption or resistance, or necessarily track what is possible or even probable in a still-developing technology. The failure of many survey studies to cite concrete examples of AI applications in the prelude to questionnaires (some justifying this as a way of avoiding the conjuring up of negative 'Terminator' or 'cyborg' images) may have caused confusion among respondents as to what they were being asked to conceptualise and respond to. Response rates were either low (<50%) or incalculable, with respondents more likely than non-respondents to hold strong attitudes. Priming effects in how AI was introduced and questions were worded may have biased some responses. Finally, responses in some studies appeared internally inconsistent in that, for example, radiology residents and students acknowledged AI would improve their discipline and wanted more AI training, but, at the same time, feared loss of professional status and held concerns about career choice.

Individuals without direct experience of AI who perceived it in the abstract tended to be more guarded in their views compared with the more optimistic views of direct users or recipients of AI. However, this optimism was more often grounded in views of workflow improvements and error minimisation, rather than perceptions of improved clinical outcomes, greater fairness of access or less risk to patient autonomy compared with current clinical practice. All stakeholders voiced concern about potential harm to patients from AI that lacks human oversight in its design, development and deployment, that the expected benefits of AI were by no means guaranteed, and that explicit regulatory standards must be formulated.

Applications which automate image interpretation and data synthesis were regarded more favourably by clinicians than those directly influencing clinical decisions or having potential to negatively impact clinician–patient relationships or clinician autonomy. Repetitive tasks using digitised data, such as radiological or dermatological diagnosis, are seen as more amenable to being performed by AI applications than interactive or procedural tasks such as consultations or surgical operations.[35] Privacy breaches and inability to understand or control AI applications worried clinicians, while loss of clinician oversight and inability to properly share in decision-making worried consumers. There was a common desire to ensure humans remained at the centre of decision-making and preserve

empathetic, contextualised communication in clinical encounters.[36] Case studies have confirmed consumers prefer human advisers who can appreciate their unique circumstances, and see AI assisting, rather than replacing, clinician advice.[37]

All stakeholders wanted reassurance that AI-generated advice was trustworthy, and that this level of trust was context-dependent, with clinician opinion trumping AI advice where the two were discordant or where decisions relating to serious illness were being made. As others have also shown,[38] stakeholders tend to be less forgiving towards error made by AI than error made by humans. Who should bear liability for error was much more contentious, both between and within stakeholder groups, and subject to considerable ongoing debate.[39] In a very recent US survey study of 750 physicians and 1007 members of the public, the majority of both groups believed the physician should be held responsible for AI error, although more of the public held this view than did physicians (66% vs 57%; p=0.02).[40] In contrast, more physicians believed the AI vendor (44% vs 33%; p=0.004) should share liability, while equal proportions of both groups conferred liability on regulatory authorities (23% vs 23%) or healthcare organisations purchasing the application (29% vs 23%).

Despite their reservations, clinicians overall were keen to receive further education in AI in recognition of its potential to increase diagnostic accuracy and workflow efficiencies, and this need is increasingly recognised.[41] While some clinicians in imaging specialties were worried about potential negative impacts on job prospects and professional status, most clinicians felt AI could enhance professional satisfaction.

### Perceptions and expectations

Understanding what drives stakeholder perceptions of AI is important as they critically influence predisposition towards accepting AI.[42] Further in-depth research into why differing views of AI are held should assist in formulating operational solutions that accommodate such diversity of views. We note few studies considered the extent to which age, sex, clinical setting, level of expertise in computing or mathematics, personal beliefs and values, or other attributes of individuals impacted on their perceptions of AI in healthcare, which some investigators suggest as being important.[43]

Notwithstanding these considerations, certain expectations were inherent to many studies from which dependencies can be defined. While these dependencies are not necessarily unique to AI applications, being relevant to other computer-based technologies, the rapid evolution and potentially huge scope of AI magnifies the imperative for these dependencies to be enshrined in governance and ethics policies of government and industry.

## CONCLUSION

A wide range of stakeholders have interest in how AI applications can be used in delivering better healthcare. In general, attitudes towards AI are positive, provided certain safeguards are met. While some concerns about AI are common to most groups, others are unique to a more select few. The challenge for AI developers and implementers is to understand these various concerns and respond appropriately if their applications are to be adopted at scale.

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## REFERENCES

1 Rajkomar A, Dean J, Kohane I. Machine learning in medicine. *N Engl J Med* 2019;380:1347–58.
2 Shaw J, Rudzicz F, Jamieson T, *et al*. Artificial intelligence and the implementation challenge. *J Med Internet Res* 2019;21:e13659.
3 Scheetz J, Rothschild P, McGuinness M, *et al*. A survey of clinicians on the use of artificial intelligence in ophthalmology, dermatology, radiology and radiation oncology. *Sci Rep* 2021;11:5193.
4 Coppola F, Faggioni L, Regge D, *et al*. Artificial intelligence: radiologists' expectations and opinions gleaned from a nationwide online survey. *Radiol Med* 2021;126:63–71.
5 Waymel Q, Badr S, Demondion X, *et al*. Impact of the rise of artificial intelligence in radiology: what do radiologists think? *Diagn Interv Imaging* 2019;100:327–36.
6 Collado-Mesa F, Alvarez E, Arheart K. The role of artificial intelligence in diagnostic radiology: a survey at a single radiology residency training program. *J Am Coll Radiol* 2018;15:1753–7.
7 Sit C, Srinivasan R, Amlani A, *et al*. Attitudes and perceptions of UK medical students towards artificial intelligence and radiology: a multicentre survey. *Insights Imaging* 2020;11:14.
8 Pinto Dos Santos D, Giese D, Brodehl S, *et al*. Medical students' attitude towards artificial intelligence: a multicentre survey. *Eur Radiol* 2019;29:1640–6.
9 Gong B, Nugent JP, Guest W, *et al*. Influence of artificial intelligence on Canadian medical students' preference for radiology specialty: ANational survey study. *Acad Radiol* 2019;26:566–77.
10 Sarwar S, Dent A, Faust K, *et al*. Physician perspectives on integration of artificial intelligence into diagnostic pathology. *NPJ Digit Med* 2019;2:28.
11 Polesie S, Gillstedt M, Kittler H, *et al*. Attitudes towards artificial intelligence within dermatology: an international online survey. *Br J Dermatol* 2020;183:159–61.

12 Ardon O, Schmidt RL. Clinical laboratory employees' attitudes toward artificial intelligence. *Lab Med* 2020;51:649–54.
13 Blease C, Kaptchuk TJ, Bernstein MH, *et al*. Artificial intelligence and the future of primary care: exploratory qualitative study of UK general practitioners' views. *J Med Internet Res* 2019;21:e12802.
14 Doraiswamy PM, Blease C, Bodner K. Artificial intelligence and the future of psychiatry: insights from a global physician survey. *Artif Intell Med* 2020;102:101753.
15 Oh S, Kim JH, Choi S-W, *et al*. Physician confidence in artificial intelligence: an online mobile survey. *J Med Internet Res* 2019;21:e12422.
16 Fan W, Liu J, Zhu S, *et al*. Investigating the impacting factors for the healthcare professionals to adopt artificial intelligence-based medical diagnosis support system (AIMDSS). *Ann Oper Res* 2020;294:567–92.
17 Castagno S, Khalifa M. Perceptions of artificial intelligence among healthcare staff: a qualitative survey study. *Front Artif Intell* 2020;3:578983.
18 Abdullah R, Fakieh B. Health care employees' perceptions of the use of artificial intelligence applications: survey study. *J Med Internet Res* 2020;22:e17620.
19 Esmaeilzadeh P. Use of AI-based tools for healthcare purposes: a survey study from consumers' perspectives. *BMC Med Inform Decis Mak* 2020;20:170.
20 Pega Inc. What consumers really think about AI: a global study. Insights into the minds of consumers to help Businesses reshape their customer engagement strategies. Cambridge, MA: Pega, 2017. Available: https://www.ciosummits.com/what-consumers-really-think-about-ai.pdf
21 Lennartz S, Dratsch T, Zopfs D, *et al*. Use and control of artificial intelligence in patients across the medical workflow: single-center questionnaire study of patient perspectives. *J Med Internet Res* 2021;23:e24221.
22 Palmisciano P, Jamjoom AAB, Taylor D, *et al*. Attitudes of patients and their relatives toward artificial intelligence in neurosurgery. *World Neurosurg* 2020;138:e627–33.
23 Tran V-T, Riveros C, Ravaud P. Patients' views of wearable devices and AI in healthcare: findings from the ComPaRe e-cohort. *NPJ Digit Med* 2019;2:1–8.
24 Sisk BA, Antes AL, Burrous S, *et al*. Parental attitudes toward artificial intelligence-driven precision medicine technologies in pediatric healthcare. *Children* 2020;7:145.
25 Nelson CA, Pérez-Chada LM, Creadore A, *et al*. Patient perspectives on the use of artificial intelligence for skin cancer screening: a qualitative study. *JAMA Dermatol* 2020;156:501–12.
26 McCradden MD, Baba A, Saha A, *et al*. Ethical concerns around use of artificial intelligence in health care research from the perspective of patients with meningioma, caregivers and health care providers: a qualitative study. *CMAJ Open* 2020;8:E90–5.
27 Consulting A. *Injecting intelligence into healthcare. Accenture executive survey on AI in healthcare Australia*. Australia: Accenture, 2018. https://www.accenture.com/_acnmedia/PDF-93/Accenture-AI-Health-Survey-Au.pdf#zoom=50
28 Jungmann F, Jorg T, Hahn F, *et al*. Attitudes toward artificial intelligence among radiologists, IT specialists, and industry. *Acad Radiol* 2021;28:834–40.
29 Laï M-C, Brian M, Mamzer M-F. Perceptions of artificial intelligence in healthcare: findings from a qualitative survey study among actors in France. *J Transl Med* 2020;18:14.
30 Eysenbach G. Improving the quality of web surveys: the checklist for reporting results of Internet E-Surveys (cherries). *J Med Internet Res* 2004;6:e34.
31 Perlmutter A, Benchoufi M, Ravaud P, *et al*. Identification of patient perceptions that can affect the uptake of interventions using biometric monitoring devices: systematic review of randomized controlled trials. *J Med Internet Res* 2020;22:e18986.
32 Matheny M, Israni ST, Ahmed M. Artificial intelligence in health care: the hope, the hype, the promise, the peril. Available: https://nam.edu/wp-content/uploads/2019/12/AI-in-Health-Care-PREPUB-FINAL.pdf [Accessed 10 Jul 2021].
33 WHO. *Ethics and governance of artificial intelligence for health: WHO guidance*. Geneva: World Health Organisation, 2021.
34 Gerke S, Babic B, Evgeniou T, *et al*. The need for a system view to regulate artificial intelligence/machine learning-based software as medical device. *NPJ Digit Med* 2020;3:53.
35 Mesko B. The impact of digital health technologies on the future of medical specialties in one infographic. the medical futurist. Available: https:// medicalfuturist.com/towards-creativity-in-healthcare-the-impact-of-dig ital-technologies-on-medical-specialties-in-an-infographic?utm_source=The%20Medical%20Futurist %20Newsletter&utm_campaign=b07238 ce29-EMAIL_CAMPAIGN_2019_08_12&utm_medium=email&utm _term=0_efd6a3cd08-b07238ce29-420645589 [Accessed 10 Jul 2021].
36 Mittelman M, Markham S, Taylor M. Patient commentary: stop hyping artificial intelligence-patients will always need human doctors. *BMJ* 2018;363:k4669.
37 Longoni C, Bonezzi A, Morewedge CK. Resistance to medical artificial intelligence. *J Consum Res* 2019;46:629–50.
38 Dietvorst BJ, Simmons JP, Massey C. Algorithm aversion: people erroneously avoid algorithms after seeing them err. *J Exp Psychol Gen* 2015;144:114–26.
39 Price WN, Gerke S, Cohen IG. Potential liability for physicians using artificial intelligence. *JAMA* 2019;322:1765–6.
40 Khullar D, Casalino LP, Qian Y, *et al*. Public vs physician views of liability for artificial intelligence in health care. *J Am Med Inform Assoc* 2021;28:1574–7.
41 Rampton V, Mittelman M, Goldhahn J. Implications of artificial intelligence for medical education. *Lancet Digit Health* 2020;2:e111–2.
42 Lee MK. Understanding perception of algorithmic decisions: Fairness, trust, and emotion in response to algorithmic management. *Big Data Soc* 2018;5:205395171875668.
43 Thurman N, Moeller J, Helberger N. My friends, editors, algorithms, and I. *Digit J*2018.

**Appendix – Description of studies**

| Reference (no.) | Type of AI application as the focus | Stakeholder respondents | Survey method | Attitudes/perceptions expressed by majority (>50%) | Expectations | Dependencies |
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| Scheetz et al (3) | Defined by authors as AI algorithms for image analysis. | 632 trainees/fellows of ophthalmology (305; response rate 20%), radiology-radiation oncology (230;l response rate 5%), dermatology (97; response rate 13%) colleges of Australia and New Zealand. | On-line questionnaire of 18 multiple choice questions and additional open-ended questions. | AI would improve their field.<br>AI would impact on future workforce needs.<br>Concerns about outsourcing application development to large AI companies, clinician liability for AI errors and decreased reliance on specialists (‘do-it-yourself’ medicine). | Requirement of AI to perform better than specialists for disease screening and diagnosis.<br>Improved patient access to screening, provide greater diagnostic confidence and reduce specialist time spent on mundane tasks.<br>Exposure to liability for error would be disincentive to use AI. | AI applications must be accurate, integrated with routine clinical workflows, shown to improve clinical decision-making, and not usurp specialists.<br>Clinicians must be protected from liability for error. |
| Coppola et al (4) | Not defined by authors<br>Respondents (66%) defined AI as ‘an aid to daily working practice’. | 1032 radiologists from Italian Society of Medical and Interventional Radiology.<br>Response rate 9%. | On-line questionnaire of 10 single choice and 3 multiple choice questions. | AI would optimise and expedite image interpretation and detection and characterisation of lesions on images reduce diagnostic error.<br>AI would optimise work flows | Fewer diagnostic errors<br>Faster turnaround time<br>Loss of professional status and career development.<br>Need for regulatory policies. | AI applications must be accurate, integrated with routine clinical workflows, shown to improve clinical decision-making, and not usurp specialists. |

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| | | | | AI may reduce professional reputation of radiologists, decrease learning opportunities and lower salaries and recruitment. | | Professional status and career development of radiologists must be protected. |
| Waymel et al (5) | Defined by authors as 'AI-based solutions'. | 70 radiology residents and 200 senior radiologists registered with department of health in Nord and Pas-des-Calais.<br>Response rate 44%. | On-line questionnaire of 42 questions with Likert scales. | AI would automatically detect and measure lesions on images and improve image post-processing.<br>AI would positively impact future practice.<br>Radiologists should remain liable for AI error.<br>Interest expressed in AI research partnerships.<br>Concerns around AI shifting practice from diagnostic to interventional radiology.<br>Mammography, CT scanning, plain X-rays and MRI most likely to be affected by AI.<br>Training in AI currently insufficient | Fewer diagnostic errors.<br>Faster turnaround time.<br>More time spent with patients.<br>Adverse impact on some professional roles. | AI applications must be accurate, integrated with routine clinical workflows, shown to improve clinical decision-making.<br>Role of the diagnostic radiologist needs to be preserved. |
| Collado-Mesa et al (6) | Not defined by authors. | 69 registered radiologist trainees in a single US | On-line questionnaire of 13 questions, 12 multiple choice and | Potentially unfavourable impact on career prospects.<br>Willingness to help create | Major impact on the role and daily work of radiologists. | Role of the diagnostic radiologist must be protected. |

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| | | radiology training program. Response rate 66% | one Likert scale score. | or train AI application to do some of the tasks of a radiologist. | | |
| Sit et al (7) | Not defined by authors. | 484 medical students from 19 of 34 UK medical schools. Response rate not stated. | On-line survey of 11 questions with 5-point Likert scales. | Teaching in AI would be beneficial for career development.<br>Some specialties would be replaced by AI over next 30 years, with radiology being most likely. | Major impact on the role and daily work of radiologists. | Professional roles must be protected by providing adequate training in AI. |
| Pinto dos Santos et al (8) | Authors defined AI in generic terms but in a sub-section of the questionnaire referred to specific radiology applications | 263 undergraduate medical students in three German universities. Response rate not stated. | On-line questionnaire with four sections and total of 18 questions with Likert agreement scale scores. | AI could potentially detect pathologies on images and improve radiology.<br>AI would not be able to establish a definite diagnosis.<br>AI would not replace human radiologists. | Fewer diagnostic errors.<br>Adverse impacts on professional role if training in AI is inadequate. | AI applications must be accurate.<br>Professional roles must be protected by providing adequate training in AI. |
| Gong et al (9) | Not defined by authors although questionnaire included questions about students' understanding of the principles of deep learning. | 322 medical students from all 17 medical schools in Canada, with target population being students wanting to pursue radiology. Estimated | On-line questionnaire of 17 items including multiple choice questions, true/false questions, Likert scale items, slider scale question and narrative question. | AI will augment radiologist capability and make radiologists more efficient.<br>AI would not replace radiologists.<br>AI will reduce number of required radiologists<br>Radiologists should embrace AI and work with IT industry for its application.<br>Students understanding of | Faster turnaround time.<br>Adverse impact on professional role if not adequately trained in AI. | Professional roles must be protected by providing adequate training in AI. |

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| | | response rate of all students 2.8%.<br>Estimated response rate of students favouring radiology 34%. | | basic principles of deep learning was poor | | |
| Sarwar et al (10) | Not defined by authors. | 487 pathologists in 59 countries (mostly Canada, US and UK) listed on faculty websites ascertained by Google search.<br>Response rate not stated. | On-line questionnaire of 43 questions. | AI as a diagnostic tool would facilitate improvements in workflow efficiency and quality assurance.<br>Diagnostic decision-making will remain a predominantly human or shared task.<br>AI should allow more time to research unanswered questions.<br>Half of respondents felt liability for error lay with pathologist. | Fewer diagnostic errors.<br>Faster turnaround times.<br>Liability for error is undecided. | AI applications must be integrated with routine clinical workflows.<br>Clinicians must be given adequate training in AI.<br>Clinicians must be protected from liability for error. |
| Polesie et al (11) | Not defined by authors. | 1271 dermatologists listed as members of the International Dermoscopy Society from 92 countries.<br>Response rate not stated. | On-line questionnaire of 29 questions. | AI will improve dermatological diagnosis.<br>AI will not replace dermatologists.<br>AI will revolutionise dermatology and make medicine in general more exciting.<br>Insufficient training in AI. | Fewer diagnostic errors.<br>Greater professional satisfaction. | AI applications must be accurate.<br>Clinicians must be given training in AI. |

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| Ardon et al (12) | Not defined by authors. | 1721 non-clinical personnel in pathology laboratories in Utah.<br>Response rate 42%. | On-line questionnaire of 6 knowledge/attitude questions, 4 demographic questions. | AI may result in job loss and decreased human interaction.<br>AI may augment diagnostic functions. | Adverse impact on job security. | Role of the laboratory technician has to be protected. |
| Blease et al (13) | Authors used generic descriptors of 'machines' and 'future technology'. | 720 UK general practitioners as listed on a clinician marketing service.<br>Response rate 49%. | On-line questionnaire relating to 6 primary care tasks and a open-ended narrative question. | AI cannot emulate human empathy and communication that underpins evidence-based, patient-centred care.<br>AI requires clinical judgement in determining value-based care.<br>AI best suited for reducing administrative burden and improving clinician productivity. | Inability to assist history taking, physical examination and other tasks requiring a 'human touch'.<br>Inability to reason within complex clinical contexts. | Human interaction and shared decision-making need to be preserved.<br>AI applications must be able to be integrated with administration systems. |
| Doraiswamy et al (14) | Authors used generic descriptors of 'machines' and 'technology'. | 791 psychiatrists from 22 countries listed on a global online platform used for networking and research.<br>Response rate not stated. | On-line survey of 10 questions. | AI would never be able to provide empathic care as well or better than psychiatrists.<br>AI would be unable to perform mental status assessments, evaluate suicidality or formulate personalised treatment plans.<br>AI best suited for in documentation tasks (eg updating medical records) | Inability to assist interviewing and other tasks requiring a 'human touch'.<br>Inability to reason within complex clinical contexts. | Human interaction and shared decision-making need to be preserved.<br>AI applications must be able to be integrated with administration and decision support systems. |

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| | | | | and synthesising information to reach a diagnosis.<br>Uncertainty about potential benefits of AI outweighing potential risks. | | |
| Oh et al (15) | Not defined by authors. | 669 Korean doctors (and some medical students) graduated from, or affiliated with, a university, mainly physicians and surgeons.<br>Response rate 22% | On-line questionnaire of 11 closed-ended questions with Likert agreement scales or open-ended format. | AI able to quickly obtain large amounts of clinically relevant, high-quality data in real time.<br>Using this data, AI may assist diagnosis and forming a treatment plan.<br>AI is not superior in performance to, and would not replace, doctors, especially in regards to uncommon scenarios associated with limited data. | Inability to assist interviewing and other tasks requiring a 'human touch'.<br>Inability to assist with uncommon or complicated scenarios.<br>Mixed views as to the carrier of liability for AI errors. | AI applications must ensure human interaction and shared decision-making are preserved.<br>AI applications must be able to be integrated with decision support systems.<br>Question of who carries liability for error needs to be resolved. |
| Fan et al (16) | Defined by authors as 'AI-based medical diagnostic systems' | 191 Chinese doctors affiliated with single hospital or listed on professional platform.<br>Response rate not stated. | On-line and paper questionnaire of 43 items related to 10 constructs. | Disinclined to use AI tool unable to be understood in how it improves care, or was considered to be untrustworthy. | Requirement of AI to perform as good as or better than doctors for making diagnoses. | AI applications must be accurate. |
| Castagno et | Not defined by | 98 clinicians (38 | On-line | Major privacy concerns. | Privacy had to be | AI developers must |

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| al (17) | the authors – reference in one question to 'deep learning' and 'machine learning'; another to 'speech recognition' or 'transcription applications'. | doctors, 23 nurses, 30 allied health) employed at the Royal Free Hospital, London. Response rate: 1.3%. | questionnaire of 7 closed-ended questions. | AI could be useful in their field of work.<br>No fear of job loss. | safe guarded. | adhere to legal and community expectations regarding data privacy and security. |
| Abdullah et al (18) | Not defined by authors. | 250 clinicians (121 nurses, 70 doctors, 59 technicians) employed at 4 hospitals in Riyadh, Saudi Arabia.<br>Calculated response rate <0.1% | On-line questionnaire of 14 items with Likert agreement scale. | AI could reduce errors.<br>AI could improve work efficiencies and accelerate work processes.<br>AI can deliver high quality relevant data in real time.<br>AI could replace clinicians over time.<br>AI is still unable to provide reasoned opinions in every case or in unfamiliar situations.<br>AI cannot sympathise and consider emotional well-being.<br>AI is often developed by specialists with little clinical experience. | Fewer diagnostic errors.<br>Faster turnaround time.<br>Adverse impact on some professional roles.<br>Inability to assist with uncommon or complicated scenarios.<br>Inability to assist tasks requiring a 'human touch'. | AI applications have to be accurate.<br>AI applications must be able to be integrated with administration and decision support systems.<br>AI applications must be developed with involvement of domain experts. |
| Esmaeilzadeh et al (19) | Authors defined a detailed scenario about an AI-supported device | 307 US adults recruited through Amazon's | On-line survey whereby, after reading the scenario, | AI has inherent risk of technical malfunction.<br>AI may result in loss of human social interaction. | Minimal vulnerability to malfunction.<br>No loss in human | AI applications must be accurate.<br>AI applications, as much as possible, |

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| | able to analyse clinical data and make recommendations about diagnosis and management. | Mechanical Turk (MTurk) survey tool. 427 analysable surveys returned which satisfied sample size required (400) based on power calculations. | respondents were asked questions about their perceptions of risks, benefits, and intention towards future use. | Ai may not be trustworthy in its diagnostic or management predictions, more so as the level of AI autonomy increases. AI acceptance is less likely in the absence of regulatory standards or clear demarcation of who is accountable for error. | interaction. AI performance as good or better than clinicians for making decisions. Formulation of regulatory and accountability standards. | must be immune from technical failure. AI applications must ensure human interaction and shared decision-making are preserved. AI applications must have associated regulatory and accountability standards. |
| Pega Inc (20) | Not defined by authors. | 6000 adults recruited globally through Pegasystems customer engagement software. | On-line survey of AI uses (9 questions) which included a question on healthcare applications. | AI has risk of error and doctors should avoid using it. | AI performance as good or better than clinicians for making decisions. | AI applications must be accurate. |
| Lennartz et al (21) | Not defined by authors. | 229 patients undergoing elective radiological; procedures at a single German hospital radiology | Paper-based questionnaire of 7 items with Likert agreement scales and binary responses, and given to patients in waiting room. | AI can assist clinicians in making diagnostic and treatment decisions by integrating the most recent scientific evidence into clinical decisions. AI is less trustworthy in making decisions related | Better informed clinical decisions for less severe diseases. Clinician decisions more dependable when managing severe disease. | AI applications must be accurate and accompanied by clinician oversight. |

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| | | service.<br>Response rate 48%.<br>Met sample size calculation of 200. | | to more severe disease.<br>When AI disagrees with clinician opinion, the latter is preferred. | | |
| Palmisciano et al (22) | Authors defined 5 case scenarios of how an AI system could assist a neurosurgeon in diagnosing brain lesions or planning or assisting surgery. | 107 patients who had undergone brain surgery at a London neurosurgery hospital. | Questionnaire of 4 questions with Likert scale agreement scales for each case scenarios, administered in person using tablet computer. | AI can assist the surgeon in brain image interpretation, operative planning and real-time alert to operative complications, but with surgeon maintaining control at all times. | Better informed decisions. | AI applications must be accurate and accompanied by clinician oversight. |
| Tran et al (23) | Authors defined 4 case vignettes related to use of AI-enabled biometric monitoring devices and chatboxes. | 1183 patients with at least one chronic medical condition recruited from the Community of Patients for Research (ComPaRe) e-cohort in France.<br>Response rate 51%. | On-line survey which first asked two general questions on BMD/AI technologies, and then readiness to switch from current care to BMD/AI in response to four vignettes. | AI can assist clinicians in making diagnoses.<br>In most instances risks of AI (loss of human interaction, risk of hacking, risk of data misuse) outweighed benefits (improved access to care, better follow-up, reduced treatment burden. | Better informed diagnostic decisions. | AI applications must be accurate.<br>AI applications must be accurate.<br>AI applications must be immune from technical failure.<br>AI applications must ensure human interaction is preserved. |
| Sisk et al (24) | Authors opted to use 'computer programs' and | 804 parents of children recruited | On-line questionnaire of 14 questions. | Openness to AI technologies if assurances around quality, | Better informed decisions.<br>Secured privacy. | AI applications must be accurate.<br>AI applications |

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| | 'devices' rather than AI/ML as terminology, as applied to four functions: diagnosis, risk prediction, treatment selection, medical guidance. | through Amazon's Mechanical Turk (MTurk) survey tool. | | convenience and cost.<br>Concerns about inaccuracy, loss of privacy, interference with human interaction and shared decision-making, inconvenience, expense, and social discrimination. | No loss in human interaction.<br>No access barriers.<br>No prohibitive costs.<br>No disadvantage to minorities. | must ensure human interaction is preserved.<br>AI developers must adhere to legal and community expectations regarding data privacy and security.<br>AI applications must not disadvantage minorities. |
| Nelson et al (25) | Authors defined direct to patient and clinician decision support tools for skin cancer screening. | 48 patients attending a US hospital melanoma clinic. | Face to face semi-structured interviews with transcribed texts subject to thematic analysis. | AI can provide clinicians with a second opinion, and improve diagnostic accuracy.<br>Skin biopsies are warranted when AI disagrees with clinicians. | Better informed decisions. | AI applications must be accurate and accompanied by clinician oversight. |
| McCradden et al (26) | Authors defined 3 vignettes: data driven approaches to research; use of ML in clinics; commercialisation of data, | 18 patients with meningioma attending neurosurgical clinic at Toronto hospital; 7 caregivers; 5 healthcare providers. | Face to face interviews with transcribed texts subject to thematic analysis. | Non-consented use of health data endorsed provided there was disclosure and transparency about its use.<br>Decisions around allocation of resources should not be delegated to computers.<br>Commercialisation of data | Disclosure and transparency about use of data.<br>No use of AI applications for resource allocation decisions.<br>No monetisation of AI applications. | AI developers must adhere to legal and community expectations regarding data privacy and security.<br>AI applications must have associated |

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| | | | | is not supported. | | regulatory and accountability standards.<br>AI applications must ensure equity if they are to be used for allocating resources.<br>AI applications must not be commercialised. |
| Accenture (27) | Authors defined AI as natural language processing, intelligent agents, computer vision, machine learning, expert systems, data analysis software, data-based diagnostic tools, chatbots, voice recognition. | 180 health service executives from six countries in Europe and Asia-Pacific. | On-line survey of 41 questions with various response options. | Improved cybersecurity.<br>Greater operational efficiency.<br>Enhanced analytics capacity. | Adequate staff training.<br>Explicit regulator legislation.<br>Mature digital infrastructures. | Clinicians must be given adequate training in AI.<br>AI applications must have associated regulatory and accountability standards. |
| Jungmann et al (28) | Authors referred to 'AI solutions in radiology.' | 123 participants attending national German meeting for AI, e-Health and IT infrastructure.<br>Response rate | On-line survey comprising 28 items with Likert agreement scale responses. | Improved efficiency of care, especially in regards to image lesion measurement and support in reporting.<br>Alert functions to enable triage of examinations.<br>Clinicians make final | Appropriate validation of AI applications.<br>Comprehensibility of AI outputs. | AI applications must be accurate and accompanied by clinician oversight.<br>Clinicians must be given adequate training in AI. |

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| | | 44%. | | decisions and bear sole responsibility when using AI.<br>AI outputs had to be plausible and understandable to users and be validated in clinical studies involving domain experts.<br>AI will change working environment.<br>AI must be included in medical education. | | |
| Lai et al (29) | Authors referred to 'AI in imaging'. | 40 participants with AI interest identified by their presentations at several public symposia | Face to face or telephone semi-structured interviews with 13 questions, with transcribed texts subject to thematic analysis. | Reliable AI required access to large quantities of patient data.<br>Access to data had to be coupled with confidentiality safeguards and greater transparency in how data were gathered and processed.<br>Many AI tools lack proof of efficacy in clinical settings.<br>Clinicians will not assume liability for error from a tool they could not understand.<br>Industry desire to avoid liability as a hindrance to tool development.<br>Need to formulate | Appropriate validation of AI applications.<br>Comprehensibility of AI outputs.<br>Disclosure and transparency about use of data. | AI applications must be accurate.<br>AI developers must adhere to legal and community expectations regarding data privacy and security.<br>AI applications must have associated regulatory and accountability standards.<br>Question of who carries liability for error needs to be resolved. |

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| | | | | regulatory standards. More funding for AI research and more rapid translation of findings into practice. | | |