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RESEARCH ARTICLE

# A PROSPECTIVE STUDY ASSESSING PATIENT PERCEPTION OF THE USE OF ARTIFICIAL INTELLIGENCE IN RADIOLOGY

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## ABSTRACT

### OBJECTIVE

Radiology has been at the forefront of medical technology including the use of artificial intelligence (AI) and machine learning. However, there remains scant literature on the perspective of patients regarding clinical use of this technology. This study aimed to assess the opinion of radiology patients on the potential involvement of AI in their medical care.

### DESIGN

A survey was given to ambulatory outpatients attending our hospital for medical imaging. The survey consisted of questions concerning comfort with radiologist reports, comfort with entirely AI reports, comfort with in-part AI reports, accuracy, data security, and medicolegal risk.

### SETTING

Tertiary academic hospital in Melbourne, Australia.

### MAIN OUTCOME MEASURES

Patients were surveyed for their overall comfort with the use of AI in their medical imaging using a Likert scale of 0 to 7.

### RESULTS

283 patient surveys were included. Patients rated comfort in their imaging being reported by a radiologist at mean of 6.5 out of 7, compared with AI alone at mean 3.5 out of 7 ($p<0.0001$), or in-part AI at mean 5.4 out of 7 ($p<0.0001$). Patients felt AI should have an accuracy of mean 91.4% to be able to be used in a clinical environment. Patients rated their current comfort with data security at mean 5.5 out of 7 however comfort with data security using AI at mean 4.4 out of 7, $p<0.0001$.

### CONCLUSIONS

Patients are trusting of the holistic role of a radiologist however, remain uncomfortable with clinical use of AI as a standalone product including accuracy and data security. If AI technology is to evolve then it must do so with appropriate involvement of stakeholders, of which patients are paramount.

**KEYWORDS**: Artificial intelligence; AI; survey; patient

## INTRODUCTION

The clinical specialty of Radiology has always been intimately associated with cutting edge medical technology. As such, it has been no surprise to see artificial intelligence (AI) and machine learning enter the territory of diagnostic medical imaging [1]. This role has been acknowledged by major imaging societies from North America, Europe, and other countries [2,3]. A 2019 joint consensus statement on ethics which included input from the American College of Radiology and the Radiological Society of North America, commented on the potential for the advancing role of AI in medicine [2]. While AI was initially used in a research capacity, advancements in accuracy of image interpretation has now seen this take a clinical role in hospitals. There is a complex interplay between the technical, ethical, and medicolegal obstacles required to implement such technology [2].

There are varying opinions from radiologists on the future of AI in diagnostic imaging [4-7]. While there exists optimism and excitement for new technology [4], there are also those with scepticism and a fear of the potential for future redundancy [7]. These concerns were highlighted in a 2019 survey from Collado-Mesa et al. which assessed perceptions on training and the future role of radiologists [8,9].

Despite these concerns, there is no doubt that AI will have some role in diagnostic imaging moving forward [10,11]. A nation-wide survey of Italian radiologists in 2021 suggested that rather than believing the profession will be replaced, radiologist concern was more towards the potential effects on their professional reputation [7]. At early stages of implementation, it is important to integrate this technology in a manner which suits the ultimate reason for medical practice – our patients. Human nature has arguably been one of the most vital barriers to implementation of existing autonomous technological aids using AI such as self-driving cars and self-flying aircraft.

While literature to support accuracy and training of AI technology is evolving rapidly, there remains little on the perspective of patients in regard to clinical use of this technology. A 2019 study from Haan et al. sought to address this by interviewing 20 patients on the topic of AI in radiology [12]. They identified 6 domains which were important to consider: proof of technology, procedural knowledge, competence, efficiency, personal interaction, and accountability. The authors concluded that patients' level of knowledge of AI is limited. In a 2020 follow-up study the same group developed a questionnaire and implemented this to 155 patients. They concluded that patients remain pessimistic about AI performing the role of radiologists, with patients valuing human interaction. The authors also highlighted the importance placed by patients on ethics and the legal framework for this technology [13]. A 2022 scoping review assessed the opinion of a range of different stakeholders on AI in radiology, including 62 publications of which 4 were from the perspective of the general public [14]. The authors identify a similar framework suggesting radiologists are unlikely to be replaced, but that there is a general lack of understanding and knowledge of AI [14]. Issues of accountability and medicolegal implications remain a question for patients [14]. These views are held by most stakeholders including non-radiologist clinicians [15]

This study aimed to assess the opinion of patients on the potential involvement of AI in their medical care, by seeking to identify whether patients would be happy for AI technology to provide image interpretation for their studies at our centre, comparing the existing radiologist model of care with AI-alone, and a radiologist-AI hybrid model. This study will add to the current very small pool of knowledge on this topic and guide future directions of education concerning AI implementation.

## MATERIALS AND METHODS

### ETHICS

Ethics approval was provided for this prospective study by our institutional review board. Participation was voluntary and implied informed consent.

### SURVEY

The survey used is shown in Appendix 1 and included questions relating to age, gender, education, confidence with technology, knowledge of imaging interpretation, opinion on AI, report accuracy, data security, and medicolegal implications. Patient perspectives were assessed using numerical ranges, Likert scale from 1 to 7 (7 being highest relevant to the question type), or yes/no response as appropriate to the question type. The model of AI integration was framed as AI alone, hybrid AI and radiologist (e.g. decision support), or radiologist-alone. This

distinction was chosen as it reflects potential directions for the use of this technology in the future based on previous literature [16].

## INCLUSION CRITERIA

The Hospital is a state-wide tertiary and teaching hospital with **a** University. Patients were invited to voluntarily participate in the study on attendance to the department for any outpatient ambulatory imaging. The study recruited patients from 1 August 2018 to 1 December 2018.

All patients over the age of 18 years were invited and the written survey was in English. 500 surveys were printed, and reception staff asked to hand out the survey to any patient attending for a scan or procedure. Completed surveys were placed by the patient into an anonymous collection box and were collated by study investigators. Surveys were excluded if they were not fully completed, or if the answers not legible.

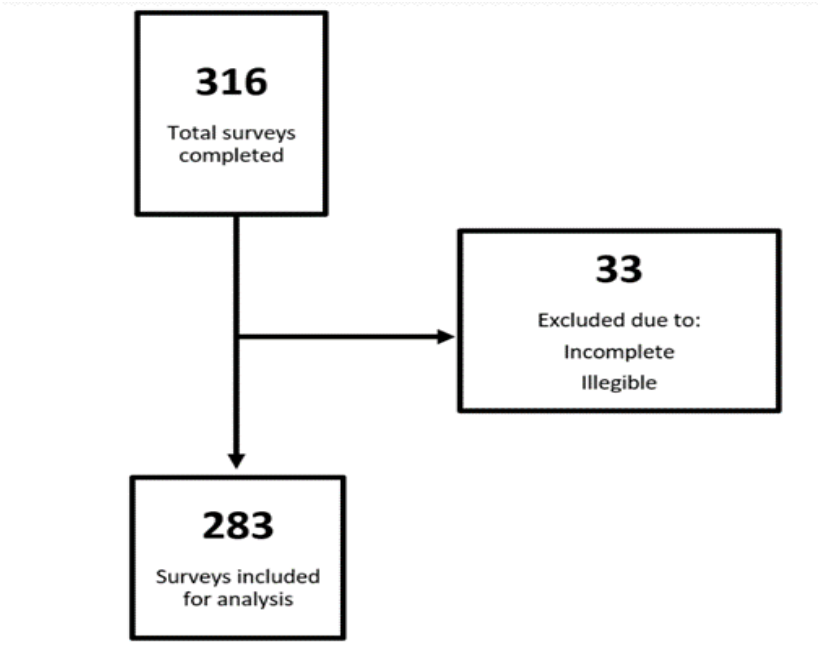
## STATISTICAL ANALYSIS

Data was pooled using Microsoft Excel (Microsoft, USA) and analysed using the Real Statistics Resource Pack software (Release 6.8) [17]. Presentation of the data was appropriate to the data type using mean (standard deviation), median (range), or frequency (percentage). Using student's t-test, a two-sided p-value less than 0.05 was chosen to indicate statistical significance.

# RESULTS

During the time period, 316 surveys were completed (63.2% response). 33 surveys were excluded including 32 where the second page of the survey was not completed, and 1 which contained illegible notes and the survey itself was not filled. 283 surveys were included for the final analysis as shown in figure 1.

**FIGURE 1: FLOW CHART SHOWING RECRUITMENT OF PATIENTS INTO THE STUDY.**




As shown in table 1, of the cohort who responded to the survey, 52.7% were male. The median age range of participants was 51-60 years old (range 18-30 to 71+ years). Participants who responded to the survey were in attendance at our department for a range of different imaging studies including MRI in 31.4%, ultrasound in 21.9%, plain radiograph in 21.2%, CT in 6.7%, procedure in 2.8%, and an other study in 15.9%. Other studies included nuclear medicine scan, bone densitometry, and mammography. 33.2% of patients reported completing high school, 27.9% a bachelor degree, 27.6% a master's degree, and 11.3% other.

**TABLE 1: PARTICIPANT INFORMATION AND BACKGROUND**

| | |
|---|---|
| Participants | 283 |
| Male gender (number, percentage) | 149 (52.7%) |
| Age of participants in range of years (number, percentage) | 18-30: 32 (11.3%)<br>31-40: 39 (13.8%)<br>41-50: 42 (14.8%)<br>51-60: 71 (25.1%)<br>61-70: 53 (18.7%)<br>71+: 46 (16.3%) |
| Reason for attendance at radiology department (number, percentage) | CT: 19 (6.7%)<br>MRI: 89 (31.4%)<br>Plain radiograph: 60 (21.2%)<br>Ultrasound: 62 (21.9%)<br>Procedure: 8 (2.8%)<br>Other: 45 (15.9%) |
| Background highest level of education (number, percentage) | High school: 94 (33.2%)<br>Bachelor's degree: 79 (27.9%)<br>Master's degree: 78 (27.6%)<br>Other: 32 (11.3%) |
| Background use of technology aids including smart phone, tablet, and computer in range of number how hours per week (number, percentage) | 0-5: 44 (15.5%)<br>6-10: 41 (14.5%)<br>11-20: 65 (23.0%)<br>21+: 133 (47.0%) |

Patient comfort with day-to-day technology use was a mean of 5.1 (SD 1.8) out of 7. 70% of participants used technology for over 11 hours a week. Patients were also familiar with the system of medical image interpretation, with 97.9% of respondents aware of the role of a radiologist, and the mean score for familiarity of the steps in performing, acquiring, and reporting imaging was 5.0 (SD 1.6) out of 7. Only 105 patients (37.1%) were aware clinical AI technology that could provide image interpretation was available.

Patients rated their comfort in their imaging being reported by a radiologist at a mean 6.5 out of 7 (SD 1.1) as shown in table 2. However, patient comfort in AI providing a report without radiologist involvement was a mean of 3.5 out of 7 (SD 1.8), $p<0.0001$. This compared to patient comfort in AI providing a report in part by AI and part radiologist at a mean of 5.4 out of 7 (SD 1.6), $p<0.0001$ (figure 2). Patients felt that AI would provide a faster time to report (AI 63.3%, radiologist 15.9%, equal 20.8%), that radiologists would provide better accuracy (AI 10.6%, radiologist 52.3%, equal 37.1%), whilst AI would provide a less expensive solution (AI 54.8%, radiologist 13.1%, equal 32.2%). Patients reported that AI should have an accuracy of mean 91.4 +/- 16.6% to be able to be used in a clinical environment, and 94.4% of patients wanted AI to be either the same or of higher accuracy to a radiologist in order to be implemented.

**FIGURE 2: BAR GRAPH COMPARING THE MEAN SCORE ON A LIKERT SCALE (OUT OF 7) FOR PATIENT COMFORT IN REPORTS BEING ISSUES BY RADIOLOGIST, AI, OR A HYBRID MODEL. ASTERIX INDICATES P<0.05 USING STUDENT'S T-TEST.**

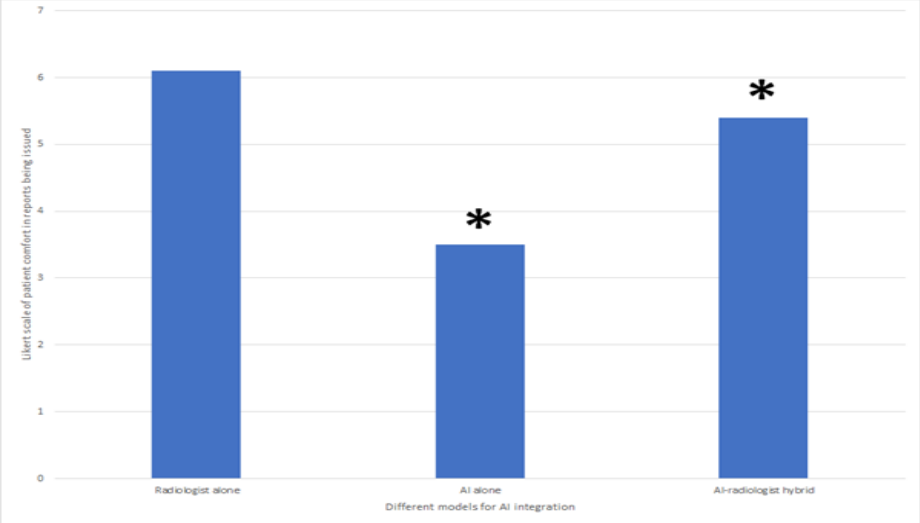



**TABLE 2: PATIENT COMFORT WITH ACCURACY OF REPORT**

| PARAMETER # | MEDIAN (RANGE) | MEAN (SD) |
|---|---|---|
| Patient comfort in report being issued by radiologist alone | 7 (1-7) | 6.1 (1.1) |
| Patient comfort in report being issued by AI alone | 4 (1-7) | 3.5 (1.8)* |
| Patient comfort in report being issued in part by AI | 6 (1-7) | 5.4 (1.6)* |

# reported on Likert scale 1 to 7, with 7 indicating highest comfort

* p<0.0001 compared to radiologist alone

Comparing male (n=150) and female (n=133) participants, males rated their comfort in radiologist reporting as a mean of 6.4 (SD 1.2) out of 7 compared with females who reported a mean of 6.6 (SD 0.9) out of 7, p=0.02. No mean difference was seen between genders for reports entirely by AI (males 3.7 (SD 1.8), females 3.3 (SD 1.8), p=0.10) and for reports in part by AI (males 5.5 (SD 1.6), females 5.3 (SD 1.6), p=0.27).

Comparing the background technology usage with comfort in reporting, participants were grouped as 10 or less hours technology use per week (n=85), or 11 or more hours (n=198). The results on a Likert scale from 1 to 7 showed no difference in the mean comfort for radiologist reports (10 or less 6.3 (SD 1.3), 11 or more 6.6 (SD 1.0), p=0.11) and there was no difference in the overall comfort of AI providing a report entirely on its own (10 or less 3.4 (SD 1.6), 11 or more 3.6 (SD 1.9), p=0.11). However, those who used 10 or less hours technology per week were less comfortable in AI issuing a report in part compared with those who used technology for 11 or more hours per week (10 or less hours mean 4.8 (SD 1.6), 11 or more hours mean 5.6 (SD 1.6), p=0.0001).

Comparing the influence of background participant highest education level, participants were grouped as high school education (n=94) or university education (n=157). Patients in the "other" category (n=32) were not included in this sub-analysis. The results on a Likert scale from 1 to 7 showed no difference in the mean comfort for radiologist reports (high school mean 6.3 (SD 1.3), university mean 6.6 (SD 1.0), p=0.06) and there was no difference in the overall comfort of AI providing a report entirely on its own (high school mean 3.9 (SD 1.8), university mean 3.5 (SD 1.8), p=0.10). However, those with high school education were less comfortable in AI issuing a report in part compared with those who had received university education (high school mean 5.0 (SD 1.7), university mean 5.5 (SD 1.1), p=0.008).

Patients overall rated their comfort with data security in the

current radiologist reporting model as a mean of 5.5 out of 7 (SD 1.7) however, when proposed that AI would be involved in data assessment, patients rated their comfort with data security as a mean of 4.4 out of 7 (SD 2.0), p<0.0001. This is shown in table 3.

**TABLE 3: PATIENT COMFORT WITH DATA SECURITY**

| PARAMETER # | MEDIAN (RANGE) | MEAN (SD) |
|---|---|---|
| Patient comfort in data security with radiologist | 6 (1-7) | 5.5 (1.7) |
| Patient comfort in data security with AI technology | 4 (1-7) | 4.4 (2.0)* |

# reported on Likert scale 1 to 7, with 7 indicating highest comfort

* p<0.0001 compared to radiologist alone

In terms of clinical accuracy and responsibility, patients rated the following healthcare stakeholders as having medicolegal responsibility for any potential error in AI imaging reports using a yes/no answer: hospital or healthcare network 76.3%, computer program 60.1%, radiologist 37.5%, referring doctor 10.3%, patient 4.2%, and other 1.8%. Of the 5 patients who selected "other", 4 out of 5 wrote in free text that they would place responsibility on the government and 1 patient wrote they were unsure.

## DISCUSSION

There is no doubt that the future of medical practice, including diagnostic imaging, will involve the use of artificial intelligence in some capacity [1,11]. While literature to support machine learning and accuracy of AI is growing [11], there is a relative lack of evidence supporting patients' perception on the use of this technology as a health care decision maker, at an individual patient-level. The majority of patients in this study (62.9%) were not even aware that AI technology to interpret imaging was in existence, let alone already in clinical use.

This study showed that patients have an extremely high level of confidence in reports being issued by radiologists but are significantly less trustworthy with the use of AI in health care at this stage. This is more evident in patients with low technology use compared to those who use technology more than 11 hours per week, and in those who do not have university-level education - both these groups were shown to have less trust in a hybrid radiologist-AI reporting model compared with radiologist alone. This information supports the recent study from York et al. who assessed the perception of 216 patients on the use of AI in skeletal radiology. The authors concluded that patients held clinician assessment in the highest regard [18] and this acknowledges the nuances of the radiologist role in providing a holistic report taking into consideration the entire medical history, not just the current imaging. Other studies have suggested a similar level of distrust in emerging AI technology both within healthcare and in non-healthcare settings [19-22]. While there was a similar degree of comfort in AI technology between males and females, females showed a significantly higher confidence in radiologist reports than for males, although the reason for this is not clear from our study.

Our study also showed that patients' confidence in data security with the introduction of AI was significantly lower than for the current radiologist-model of healthcare interaction. The 2019 North American and European position statement expressed the importance of data security and accountability in the ethics of AI [2]. In addition, a recent commentary from Peterson describes the challenges in assessing health information from the patients' perspective. The author describes privacy as a unique factor individual to each patient and which can take many forms and that we must use our emotional intelligence to understand and balance the needs of our patients. Kerasidou describes current day as a point where there is the potential for AI to cause a fundamental shift in the empathy, compassion, and trust in healthcare, and that we must re-evaluate how we can incorporate these values in the early adoption of AI [23]. However, Feldman et al. suggested that some patients don't fully understand modern medicine anyway, and that there are multiple facets of their health care treatment which currently already requires them to place their trust within the care of their physician [19,24]. In this context, Feldman suggests that rather than developing trust in AI from the ground up, we should place more of a focus on *shifting* their trust from medicine and their physician to a new model involving AI.

If an AI report were to be inaccurate, it is interesting to see in our study that patients felt a range of different stakeholders were to be accountable. Patients felt that the developer of the technology (60.1%) and the healthcare facility (76.3%) would be afforded the most responsibility. Even radiologists who weren't issuing the report were considered accountable (37.5%). Interestingly a small percentage of patients even held themselves or their referring doctor accountable. Until this is tested in a court of law, we won't know which parties will ultimately be held

most liable. However, as supported by major consensus statements [2,3], the ethics of responsibility should be decided before the technology fully matures. Considering patients will apportion blame to their referring doctor, we must also consider their opinion on the use of AI and this is an area which has yet to be explored.

The majority of patients reported that they felt AI would be faster and less expensive than a radiologist, but also less accurate. Patients expected AI to be a mean of 91.4% accurate to be used in clinical medicine, and 94.4% of patients expected this accuracy to either meet or exceed radiologist accuracy before being used. This supports the argument from Haan et al. that a degree of scepticism remains amongst patients regarding AI technology [12], and they are acknowledging that the technology must be proven to be accurate as we enter this life-changing era in radiology. This also acknowledges the high regard patients currently hold for the integral work that radiologists do in their healthcare interaction [18].

The results of this study suggest to us all that if we are to integrate with AI, we must work on a number of factors to improve patient perception and trust [25]. This should start with education, with our study showing a higher trust in both radiologists and AI for those with university-level education compared to high-school education. This education concept would be no different to educating patients that magnetic resonance technology is safe or that ionizing radiation in diagnostic imaging is also safe when used appropriately. Education responsibility can be shared amongst radiologists, hospital networks, major societies, specialty colleges, and even computer technology companies. The study also implied that increasing background technology usage will be positively correlated with improving patient comfort. Finally, for patients to adopt the technology as a physician-assistant then there must be transparency on data use, security, and the role of consent [20].

While this study has a large sample size in an area without significant pre-existing literature, we must acknowledge that this study was single-centre and performed without a formally validated questionnaire. It is also open to selection bias due to the specific catchment of our hospital and reflects social and educations biases within our country. This includes the relatively high background level of education reported in our cohort which, based on the results, may positively influence patient comfort with AI. In addition, the authors have no documentation of patients who declined to participate or where patients weren't offered the opportunity to participate, both are biases inherent with written surveys. Finally, the authors acknowledge that there was a wide variability in results with all scaled questions receiving opinions varying from 1 to 7, resulting in a large standard deviation. This reflects healthy individual opinions, but doesn't affect the ability to interpret the mean in a dataset which was normalised.

## CONCLUSIONS

The authors remain cautious of the longer-term implications of AI on the profession of diagnostic radiology. Patient expectations remain that human interaction is essential in medical care as evidenced by significantly higher confidence in radiologist involvement in their healthcare than for AI. If AI technology is to evolve then it must do so with appropriate involvement of stakeholders, of which patients are paramount. This will include balancing data security and medicolegal risk. This must happen before it is implemented, otherwise the technology is at risk of advancing too rapidly for the contentment of our patients.

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## APPENDIX

### APPENDIX 1: SURVEY ON PATIENT PERCEPTION OF ARTIFICIAL INTELLIGENCE IN DIAGNOSTIC RADIOLOGY

| | |
|---|---|
| Age | 18-30<br>31-40<br>41-50<br>51-60<br>61-70<br>71+ |
| Gender | Male<br>Female<br>Non-binary |
| Reason for attending outpatient radiology service | CT<br>MRI<br>X-ray<br>Ultrasound<br>Procedure<br>Other |
| Highest level of education | High school<br>Adult higher education<br>Bachelor's degree<br>Masters' degree<br>Other |
| What is the average number of hours per week that you use computer technology | <5 hours<br>5-10 hours<br>11-20 hours<br>20+ hours |
| Rate your comfort with using technology in day-to-day activities | Likert scale 1 (uncomfortable) to 7 (comfortable) |
| Rate your familiarity with the steps in which your imaging will be taken and reported | Likert scale 1 (unfamiliar) to 7 (familiar) |
| Today there is a specialist doctor called a radiologist who will look at and interpret your scans after they are done. They will send the report/ results to your referring doctor. Were you aware of this? | No<br>Yes |
| How comfortable are you with having your imaging interpreted and results issued by a specialist radiologist doctor? | Likert scale 1 (uncomfortable) to 7 (comfortable) |
| Are you aware that there are computer/artificial intelligence programs being developed that may be able to analyze your radiology scans and issue and report? | No<br>Yes |
| How comfortable would you be with having your imaging interpreted and results issued ENTIRELY by a computer program without a specialist radiologist doctor input? | Likert scale 1 (uncomfortable) to 7 (comfortable) |
| How comfortable would you be with having your imaging interpreted and results issued IN PART by a computer program without a specialist radiologist doctor input? | Likert scale 1 (uncomfortable) to 7 (comfortable) |

| | |
|---|---|
| In the following categories, which do you believe would perform better: computer/artificial intelligence, specialist radiologist doctor, or equal? | Time to report<br>Accuracy of the report<br>Cost of imaging |
| Currently the specialist radiologist doctor assesses and reports on your imaging. How comfortable are you about your PRIVACY and SECURITY of this data | Likert scale 1 (uncomfortable) to 7 (comfortable) |
| If your imaging was assessed by a computer program/AI, how comfortable would you be about your PRIVACY and the SECURITY of your data? | Likert scale 1 (uncomfortable) to 7 (comfortable) |
| How accurate should a computer/AI program be in making the right diagnosis before you would feel comfortable with having your imaging ENTIRELY reported by a computer without a specialist radiologist doctor reviewing the scan? | Likert scale 0 – 100% |
| How accurate should a computer/AI program be compared to a specialist doctor radiologist before you would trust it to interpret your imaging? | Less accurate<br>Same accuracy<br>More accurate |
| If your report was made entirely by a computer program/AI without a specialist radiologist doctor reviewing your imaging, who's responsibility should it be if the computer program missed an important medical condition on your scan or made the wrong diagnosis? | Answer yes/no for the following:<br>Computer program company<br>Hospital / radiology practice<br>Referring doctor<br>You, the patient<br>The radiologist<br>Other |