

## Authors

D.M. Hudson <sup>a, \*</sup>,  
C. Heales <sup>b</sup>,  
S.J. Vine <sup>c</sup>

<sup>a</sup> InHealth Group, High Wycombe, UK

<sup>b</sup> Medical Imaging, College of Medicine and Health, Exeter University, Exeter, UK

<sup>c</sup> College of Sports and Health Sciences, Exeter University, Exeter, UK

\* Corresponding author. InHealth Group, Beechwood Hall, Kingsmead Road, High Wycombe, Bucks, HP11 1JL, UK.

E-mail address: [Darren.hudson@inhealthgroup.com](mailto:Darren.hudson@inhealthgroup.com) (D.M. Hudson).

# Radiographer Perspectives on Current Occurrence and Management of Claustrophobia in MRI

Introduction:

Demand for Magnetic Resonance Imaging (MRI) continues to follow an upwards trend<sup>1</sup> and is set to increase further as a result of delays and waiting lists following the COVID-19 pandemic and lockdowns of 2020<sup>2</sup>. The number of scanners per head of population within the United Kingdom (UK) remains low compared to other European countries<sup>3</sup> with an increase in availability planned with the forthcoming introduction of Community Diagnostic Hubs<sup>2,4</sup>.

However, as an imaging technique MRI is known for being one of the most anxiety inducing examinations<sup>5,6</sup>. One manifestation may be claustrophobia, either to enclosed spaces or of being trapped<sup>7-9</sup>. However whilst this anxiety and phobia may result from the physical nature of the scanner design, it can also be due to the noise related to the imaging process, having to lie flat for extended periods of time, or simply the fear of the unknown or what the results may show<sup>10-13</sup>.

Whatever the cause, the outcome for the patient can be one of reduced diagnostic quality or failure to successfully complete a scan which impacts on their clinical management, as well as operational and financial impact on scanning units<sup>14-16</sup>. Consideration around their experience overall is equally important, with poor experience having an impact on apprehension around future scan appointments<sup>17</sup>, as well as wider influence over use of services and organisational reputation in an increasingly market driven healthcare setting.

Whilst manufacturers have made significant effort into improving the overall scan experience with improvements in scanner design, coupled with acceleration techniques in the imaging process itself (which reduce scan time)<sup>18</sup>, occurrence of patient anxiety is still seen. Reported incidence rates vary in the literature<sup>9</sup> with little evidence of reduction occurring<sup>19-21</sup> suggesting it still to be a relevant issue in clinical practice. A cross national review in 2017<sup>22</sup> found fear of enclosed spaces to be prevalent in 2.2% of the general population. The pandemic has also contributed to an overall increase in underlying anxiety within the general population<sup>23,24</sup>, in particular exacerbated by the need to attend hospital-based services during lockdowns with increased fear of virus spread<sup>25</sup>. This in itself could have further contributed to an increase in scan related anxiety, with people's anxiety levels already heightened and tolerance levels low. Both of which means patients may then be more vulnerable to stressors such as experiencing an MRI scan which pre-pandemic they may have been more able to cope with.

Despite the technological advances, there are many ways a patient can be supported to manage their anxiety and phobia related to undergoing a scan. Most commonly reported approaches are around information provision on what to expect prior to attendance<sup>26-30</sup> and effective communication between MRI practitioners and patients to build trust and rapport<sup>14,31-34</sup>. However, their effectiveness and use in practice appears variable<sup>35</sup>, coupled with a need to balance enough time for patients with operational demands for increased patient throughput<sup>36</sup>.

The aim of this cross-sectional study was to explore MRI radiographers' perceptions, in the 2020's, on the occurrence and management of scan related anxiety, most notably considered as claustrophobia. The study was focused on MRI services provided nationally by an independent sector organisation within the UK. The specific questions explored were:

- What are MRI radiographers' perceptions on the occurrence of claustrophobia in current clinical practice?
- How is claustrophobia being managed in clinical practice?
- What are the views of MRI radiographers on the effectiveness of common approaches to managing claustrophobia?
- Has there been a perceived increase in scan related anxiety and claustrophobia during the COVID-19 pandemic?

Methods:

Internal ethics review and study approval was received by the organisations Clinical Quality Sub Committee and Director of Clinical Quality in March 2021.

MRI staff perceptions and views on managing claustrophobia were obtained using an open and closed response survey via Microsoft (MS) Forms (see supplementary 1) over a 4-week period. This approach was used to be able to capture opinions from across the organisation with its national footprint and varied models of MRI service delivery. The survey questions were also intended to be easy to complete so that minimal time was required, thereby supporting a higher response rate.

Questions used were written to explore the intended research questions by seeking insight through ranking style responses as well as open to illicit deeper insight into perceptions and opinions. The survey was piloted with a superintendent MRI radiographer to check relevance and understanding of the questions before wider scale launch. No amendments were considered necessary with feedback suggesting it was easy to complete in around 10minutes.

Convenience sampling was used by accessing those radiographers working within the organisation, acknowledging that responses may not be representative of the wider radiography community but

providing representation nationally and working in a variety of service models. The link and a short summary behind the intentions of the study were emailed out to a group distribution list which included all clinical imaging professionals within the organisation. Those MRI practitioners were invited to participate and in doing so were giving informed consent for the information provided to be used. The survey asked for no identifiable data; just background information on their area of work and years' experience, followed by responses looking at the occurrence and management of scan related anxiety in practice.

Content analysis of open responses was performed within NVivo (QSR international) whilst closed responses were assessed through MS Excel as an output of MS Forms. Ranked and closed responses were analysed and recorded as a frequency, percentage, or average score.

### Results:

65 MRI radiographers, from an approximate sample pool of 350 within the organisation, responded to the survey with their demographics summarised in table 1.

Table 1: Respondent background demographics

Area of work	Static units (hospital or community)		Mobile setting		Specialist UpRight
		51% (33)		42% (27)	
Years of experience in MRI	<2	2-5	6-9	10-14	15+
	9% (6)	11% (7)	22% (14)	20% (13)	38% (25)

62% of radiographers reported that they had to deal with notably anxious patients daily, with a further 30% feeling it was at least weekly, and only 8% stating a lower occurrence of monthly. This suggests that, in practice, scan related anxiety is still prevalent in the eyes of scanning practitioners and is often a daily feature of clinical practice to manage and support.

For the response exploring how patient anxiety presents in practice, accessory words were removed and distilled down, grouping similar meanings as much as possible to reduce the variety of themes. This then provides the word cloud in figure 1, summarising the key themes reported. This shows the variability in patient presentation when anxious, most notably being restlessness or agitation (be that hand wringing, fidgeting), excessive questioning and enquiry into the process, being overly talkative and distracted from the task in hand (looking around, avoiding eye contact), and overtly rude, aggressive, or abrupt. Some physiological responses are also noted, in particularly the

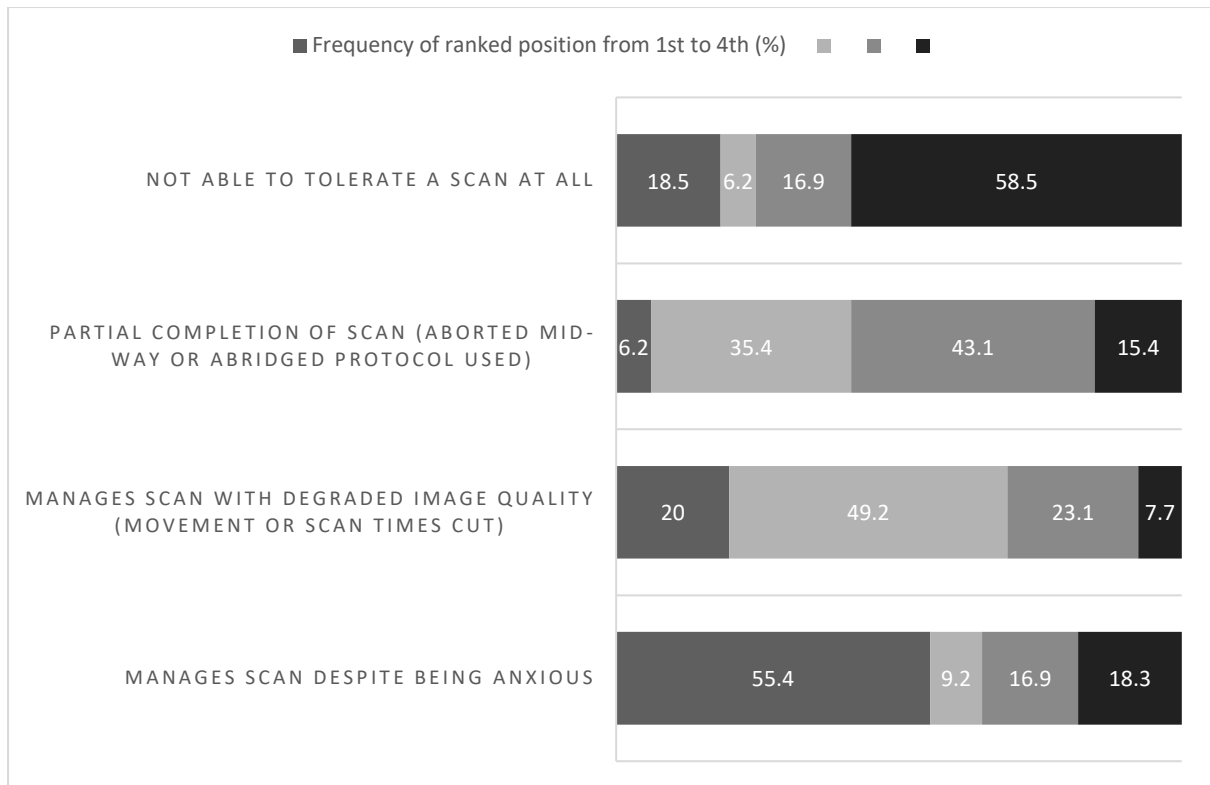
tendency to need the toilet more, often immediately before being called to scan, or noticeable sweating or changes in breathing.

Figure 1: word cloud showing signs of anxiety



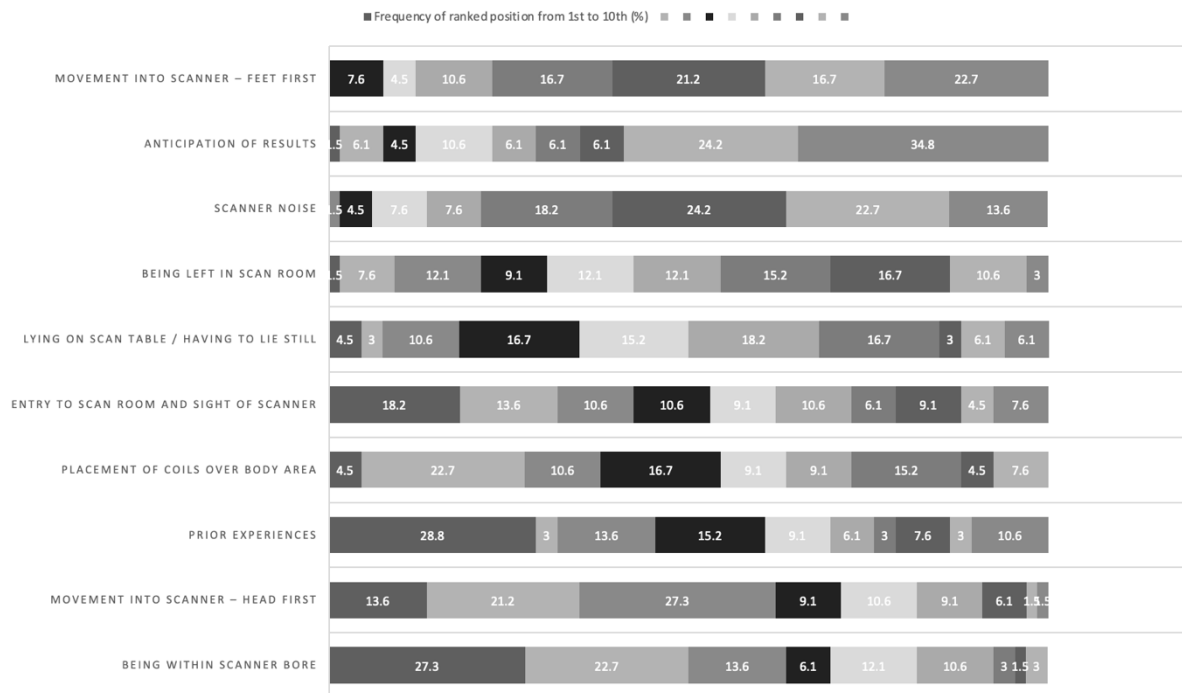
Despite the perceived occurrence, when asked to rank how anxiety affects scanning, in over half of cases a scan was often managed as the main outcome despite the displayed anxiety (55.4%). The second frequently ranked occurrence was managing a scan with some degraded or compromise in image quality (20%), and this was the most common outcome when combining first and second rankings (69.2%). Equal in rating to the most frequent outcome, the least common result seen in practice was a failure to complete any aspect of the scan at all (58.5%), equalled by partial completion when combining third and fourth opinions on outcome. Table 2 provides a breakdown of ratings provided by respondents with their percentage frequency in occurrence.

Table 2: Distribution how anxiety affects scanning.



When asked to rank in order what aspects of the scan experience potentially contribute to the anxiety seen, the top frequently ranked opinions (considering first to third rankings) were being within the scanner bore and movement into the scanner head-first - see table 3. These both relate strongly to the appearance and physicality of the scanner itself. Third, with the most first choices by respondents, was prior experience. Placement of coils and entry into the scan room were also in the top 5 and highly ranked as 1<sup>st</sup> or 2<sup>nd</sup> choices. The noise of the scanner and feet first entry were felt least contributory to any anxiety, and anticipation of results was not felt to be a significant factor.

Table 3: Distribution of views over anxiety inducing aspects of the scan experience.



When looking at the top 5 strategies used in practice, these are highlighted in table 4, along with their considered effectiveness. The top strategy in use, and considered most effective, was communicating with patients over the scanner intercom throughout the procedure. Closely followed by effective conversation on the day to alleviate fears and explain what to expect during the examination. Next in the top 5 were adjuncts used to support patients; having someone in the room, use of a mirror to see outside of the scanner or alternatively an eye mask/closing their eyes. Following these top 5, and considered 3<sup>rd</sup> in effectiveness, was use of oral anxiolytics.

Three other strategies worth commentary are being shown around the scanner, having a visit to the department beforehand, and being able to practice entry and exit into the scanner. These did not make it into the top 5 most used approaches but interesting did score highly with regards to their considered effectiveness.

As reflected in the responses to the top 5 strategies and their effectiveness, oral anxiolysis medication was seen regularly in practice; with further questioning revealing 46% of respondents were aware of patients having taken these on a weekly basis, with 35% coming across their use monthly.

Table 4: Strategies used in practice and their considered effectiveness.

	In Top 5 used (Frequency out of 65)	Effective out of 10
Contact over intercom	45	8.72

On the day conversation	<b>43</b>	<b>8.14</b>
Oral medication to reduce anxiety	30	<b>8.09</b>
Show around scanner	15	<b>7.98</b>
Someone in the room with them	<b>32</b>	<b>7.8</b>
Prisma glasses/mirror on coil	<b>32</b>	7.62
Visit beforehand	8	7.51
Cut down scan times	25	7.49
Eye mask/closing eyes	<b>35</b>	7.35
Practice entry and exit to scanner	23	7.32
Choice of music	16	6.72
Phone call	6	6.09
Video	2	5.48
Information leaflets	11	5.46
Breathing exercises	2	5.45
Visualisation exercises	1	5.28
Scan prone where possible	2	4.62
Scent	0	3.89

*\*Those in bold represent the top 5 in each column*

Content analysis of the reported barriers to being able to provide support to patients is summarised in table 5. The overriding theme by far, with reference made over 40 times, was time. This was lack of time to be able to provide the individualised care needed by the patient and capacity issues placed on maximizing utilization of scanner time. Staff experience, training and team working were other considered relevant barriers, with concern raised around the emotional load dealing with this patient group can have on staff themselves.

The main barriers with patients were related to preconceptions they bring with them from their prior experiences or misinformation from friends, family, or the internet. A theme that was shared regarding patients and referrers, was also misinformation, with referrers commonly misinforming or overpromising, which in turn leads to difficult conversations and heightened anxiety on attendance. Poor communication from referrers to imaging departments on patient condition and any anxiety or claustrophobia was also raised (being forewarned is forearmed).

The final theme was equipment itself, partly around ageing scanners that do not utilise the latest technology or design benefits, and partly around dealing with faulty equipment. The uniqueness of the mobile scanning environment was also highlighted; with the small nature of the unit itself often



contributing to claustrophobic experiences, as well as often having less resources to hand to support patients than maybe a static unit and relying on host sites to provide suitable information beforehand.

Table 5: Summary of themes around barriers to providing support.

<b>Theme</b>	<b>Sub-theme</b>	<b>Respondent quotes</b>
<b>Time</b>	Operational demand	<i>Time pressures also make it difficult to dedicate and support an anxious patient  Some things like showing them around the scanner will take up some of their scan time and could potentially make us late for our next patient  Bookings are such that we do not have time to spend with the patients resulting in delays and anxiety with the patients following a claustrophobic patient.</i>
	Lack of to provide support	<i>there is never enough allocated time booked to give an anxious patient the necessary time needed without running late the rest of the day the time needed is not spent on the patient to get them through the examination and sedation medication is resorted to at a further appointment time.</i>
<b>Staff</b>	Experience	<i>Staff dismissing signs of anxiety and fully supporting patients at times.  Needs empathetic staff but also experience in adaptive technique coils and scanning</i>
	Training	<i>Lack of training for staff, meaning there is an inconsistent approach.</i>
	Teamworking	<i>co-operation from colleagues</i>
	Emotional load	<i>it becomes a draining job to convince a patient to stay and finish</i>
	Prior experience	<i>previous experiences</i>

		<i>other people's poor past experiences</i>
<b>Patient</b>	Misinformed	<i>patients not being informed correctly about the examination by their referrers (multiple times patient states that their doctor said their head did not have to go in for that examination) Scare mongering form other patients / family or friends. Patients arrive already with a negative expectation of exam.</i>
	Condition	<i>non-English speaking, disability deafness etc, PTSD, mental illness</i>
<b>Referrer</b>	Misinformed	<i>Whoever requests the MRI never gives the correct information to the patients. They don't even explain the format of the machine and what the experience might be, being inside of a tube with loud noise in it. Doctors should be more aware on how the MRI works and what state is the patient's mental health (prior experiences). Referring clinicians not understanding MRI complexity, and giving patients false or unrealistic expectations/ information</i>
	Poor communication	<i>Knowledge beforehand that the patient is claustrophobic Lack of communication between the referral and the MRI department. If we are made aware in advance additional time can be allocated but very often this isn't the case</i>
	Mobile environment	<i>The small room on the mobiles has an impact to anxiety. Avoiding mobile scanners as the mobile environment can be a trigger.</i>
<b>Equipment</b>	Faults	<i>Constant faults with the music system not allowing music choice for patients.</i>
	Old design	<i>Considering use of wide bore scanners when booking</i>

Responses as to whether the COVID-19 pandemic has had an impact on patient anxiety when attending for scans were split; 40% had found it had no impact, 35% felt it had, with 25% stating a little. Those who felt it had had an impact stated various possible reasons for this. Most noted was an associated fear of having to attend a hospital setting for a scan where there was concern over catching the virus. This was also linked with a general fear amongst the public, particularly in the lockdowns, around leaving home and being exposed to the virus.

#### Discussion:

This study explored radiographer perceptions, rather than patient experiences. These results suggest radiographers consider themselves to be well attuned at recognising the social signs of possible anxiety in patients attending for MRI. Presentation appears variable and dependent on the individual with many of those signs noted commonly related to human responses to stress and fear<sup>37</sup>. It is important for radiographers to be aware of the varying ways anxiety or concern over a scan can present so that this can inform modification in their approach to provide required support. This was echoed by radiographers in a focus group study<sup>36</sup> where two of the themes identified were around the variation in patient presentation seen in practice and the importance of picking up cues to anxiety which can be at different extremes and often unexpected.

It is also evident that scan related anxiety, which may present as claustrophobia, is still considered a regular occurrence in practice, with an overwhelming majority of 92% of radiographers stating it is evident in their practice daily or weekly. This suggests no real change in practice since a similar survey was asked of radiographers over 10 years ago, where 72% stated anxiety was a common problem in their centre<sup>13</sup>. The percentage may be slightly skewed due to inclusion of radiographers working in the specialist UpRight service (although their numbers were low), which is aimed at patients experiencing claustrophobia and unable to tolerate a conventional style scanner. Another consideration in interpretation is the context in which respondents were working regarding patient volume. Working hours or estimated patient throughput was not obtained as part of the survey tool so it is not clear how many patients their judgement is based on, although if numbers seen were low this does potentially highlight the issue being greater.

From the perspective of the radiographer, the source of the concern or anxiety can also vary, with radiographers suggesting the physicality of the scanner and aspects of the procedure itself as the main sources of apprehension and stress. These perceived triggers align with findings in the literature which have shown that the most anxiety inducing components of the procedure are entry

into the scan room and first sight of the scanner itself, followed by placement of receive coils and movement into the bore<sup>12,38,39</sup>. Prior experience was also noted which too has been shown to be of relevance<sup>6,17</sup>.

Although it may not necessarily be the scanner itself at the root of any anxiety and it was interesting that radiographers felt that anticipation of results and diagnosis was a low contributory factor, where various studies have shown this to be one of the main concerns raised by patients<sup>5,6,40,41</sup>.

Understanding where any anxiety is coming from can be useful in tailoring the approaches to support the patient experience and completion of a scan. The top strategies ranked as used by radiographers recognises the importance of connection and communication skills with patients to help alleviate their anxiety. Munn et al<sup>9</sup> also found strong acknowledgment by radiographers on the use of communication around what to expect from a scan as being a key strategy. Likewise, Tishler<sup>13</sup> found this to be the main approach used by radiographers to prepare and alleviate anxiety prior to a scan.

The effectiveness of communication approaches was also considered the highest. As well as supported by radiographer views, this has been evidenced in practice and studies have shown positive outcomes as a result of communication training; increased efficiency, less no shows, less scans abandoned, less image degradation from movement and increased patient satisfaction<sup>14,34,42</sup>.

Another well used and considered effective strategy was the use of oral anxiolytics. Respondents in an earlier study<sup>13</sup> similarly showed a high response on the use of oral sedation. Despite increasing caution over the use of anxiolytics and push back from many General Practitioners to prescribe these for patients, it appears that this suggestion is still a common go to for many radiographers. It could be in part that this relates to the length of experience many of the respondents had working in MRI where oral anxiolytics have been the mainstay for many years. This high reliance on medication is maybe considered a 'quick fix' for patients and an easy approach, deferring the patient on rather than necessarily having the time to provide more personalised support and coaching. That said, use of oral anxiolytics have recently been shown to increase the chances of head scan completion in severe claustrophobics by 6 times<sup>43</sup>.

Adjuncts to help support the patient experience were also in common use. Although for some there is a lack of evidence behind their effectiveness but clearly for radiographers they are used and do work (blindfolds or prism glasses). The main interventions supported in the literature are around distraction or sensory based techniques during a scan, such as music or aromatherapy<sup>44-46</sup>. Guidance on meditative strategies to help distract and calm patients through the experience seem to be rarely used and considered ineffective, but again can be supported within the wider evidence base<sup>47-49</sup>.

Otherwise, there is significant evidence around pre-scan information and the different ways this can be delivered to support patients<sup>27-31,50</sup>. However, interestingly, it appears that radiographer views on information resources, both use and effectiveness, is low. Comparatively, Tischler<sup>13</sup> found information leaflets and phone calls beforehand to be widespread and a link between receiving information and lower perceived anxiety has been shown<sup>31,51</sup>. It maybe the shift towards more technological means of portraying information and the use of the internet as a resource accounts for the view on leaflets. Likewise, phone calls require staff time and resources which means their use may be less than it may have been. Internally, within the organization a lot of co-production work has been carried out with patient involvement to develop resources that fit their needs. It was interesting to see that these may not be in use as much as intended, or it may be that patients do not access them as readily as anticipated. With a good proportion of respondents working in the mobile setting, provision of preparatory information falls to host sites who may or may not use them, or staff are less aware what these contain or is on offer.

The other approaches worth mentioning were around being able to see the scanner and practice the experience in advance of starting the scan. Whilst these appear not to be commonly used their considered effectiveness was relatively high on the ratings. Patients themselves value the opportunity to try entry and exit into the scanner before commencement so that they know what it is like and alleviate concern<sup>10,38</sup>. This is further supported by studies that have shown patients undergoing serial scans reduce anxiety over time as they become familiar with the process<sup>8,52,53</sup>.

As anticipated, time, both having it to provide support and the pressure of it for throughput, was the main barrier highlighted to being able to provide effective patient support. This conflict of having enough time to be able to achieve a successful scan in an anxious patient, or even simply partake in meaningful interaction, has previously been acknowledged by radiographers<sup>36,54</sup>. Many strategies, such as practicing, can add time, as well as many of the personal connection approaches requiring additional time and resources. Successful performance despite communications training has shown how this is time dependent within the MRI setting<sup>34</sup>. It has been argued how this is a common trait within the profession<sup>33</sup>; often being more task oriented around getting patients scanned and utilising equipment rather than having time to spend necessarily meeting their needs.

It is an ongoing consideration when further reduction in scan times is considered, particularly with the introduction of artificial intelligence to further shorten acquisition time, but the question then is whether this gain in time is either used to increase throughput (i.e. to scan more patients) or to provide a more patient centric experience. Being able to adapt appointment times accordingly to be able to provide the required support needed by the individual would be a truly patient centered approach. Detecting those with heightened anxiety or claustrophobia in advance to then allow

additional resources and time could be one way of achieving this. Studies have shown how use of a screening tools in advance can help detect where enhanced intervention may be beneficial, such as the fear survey<sup>55,56</sup> or claustrophobia questionnaire<sup>57,58</sup>.

With patient information being a common approach and underutilized and considered ineffective, it perhaps is no surprise that misinformation and a lack of awareness of what a scan involves was seen as a barrier for both patients and referrers. This concern has been highlighted previously<sup>36</sup> with this needing to be taken into account as part of explanation on the day, thereby adding time, and then usually not being considered as bad as anticipated by the patient. A recent study has shown that for many patients the source of their information about a scan comes from mainly friends and family or their referring clinician<sup>20</sup>.

Staff having the skills to support and manage patient anxiety was highlighted and is well recognised as a key aspect to success. With MRI often learnt on the job and experientially from others this can very much depend on the sharing and role modelling of experienced staff. Although as outlined, training has been shown to improve many aspects<sup>14,34,59</sup>. A framework to guide staff, drawing on the key principles of supporting scan related anxiety, has previously been proposed<sup>60</sup> - see figure 2.

Figure 2: 8Cs to support



The barrier of equipment is interesting and reflects some key points. Firstly, working with older scanner designs and technology means advancements in these areas to optimise time is not always available. This is more widely supported by records that suggest a doubling in scanners within the UK which are over 10years old<sup>1,3</sup>. Secondly, there is consideration over having equipment adjuncts

available and working. For instance, not having music systems or call bells functioning, or eye masks or prism glasses available, limits the options available to staff to offer patients. Both, but particular the second, can then have real impact on not only the patients coping, but also the staff, serving as an additional stressor for themselves. This in turn affects their experience of being able to provide the level of service that they may want to deliver, which therefore affects the patient experience. This relationship between staff and patient experience is well noted<sup>61,62</sup> but often overlooked.

The final point of note was around a mixed perception of how much the COVID-19 pandemic has had on prevalence of scan related anxiety seen in practice. The use of PPE itself, in particular face masks, has caused a physical barrier between staff and patients which affects the building of trust and connections needed to establish rapport. For those experiencing claustrophobia, and in particular concerned around aspects associated with suffocation as opposed to being restricted, having their mouth covered only adds to this before even being placed within the scanner. Expectations of the clinical environment and cleanliness have further contributed to anxiety, with patients wanting to see cleaning being carried out to reassure them it is safe. Reducing the number of people attending for appointments has also been an area raised, with patients asked not to bring someone with them for their scan, where for some this is a useful coping strategy. And finally, the delays caused by clinic cancellations (either from lockdown or staff sickness) has added to worry and concern over the impact on result outcomes, as well as providing more time for anticipation and anxiety around scans to build. All of which reduces people's abilities to cope with additional stressors, such as attending for MRI scans, meaning that it takes only small things to tip them over the edge.

Whilst an insightful review of current practice the study does have some limitations to consider. Results are based on the views of radiographers and how they perceive occurrence and management in practice, therefore are subjective in nature. With participation being voluntary it is likely that those engaging with the survey may naturally be more patient focused practitioners, thereby limiting generalisability of the views obtained.

#### Conclusion:

Support from radiographic staff is a significant factor<sup>10-12,53</sup> and has been shown to make a real difference to the experience and successful completion of a scan<sup>33</sup>. Indeed radiographers themselves recognise the role they have to play in providing support, but operational pressures limit this and being able to utilise other interventions in practice<sup>36</sup>.

As with earlier studies with radiographers, it remains acknowledged the importance of being aware of the manifestation of anxiety and claustrophobia so that approaches can be adapted to meet the

patients' needs. This study suggests scan related anxiety is still a common occurrence in practice and therefore an area requiring ongoing support. Continual awareness and additional training on the presentation and management of scan related anxiety would be beneficial. Along with exploration into the use of more novel, updated approaches, where many studies are now outdated or lacking implementation in practice.

More can be done to utilise the range of coping strategies available with the key focus being on interventions that reduce perceived threat and increase ability to cope. Current means of preparatory information appear under utilised, with those considered more effective relying on the time to allow patients to experience the scan in advance or be able to be coached. Use of technological advances to provide more realistic preparation for a scan beforehand could be one means of improving support and help with managing the current time constraints.

## References

1. The Royal College of Radiologists. *Magnetic Resonance Imaging (MRI) Equipment, Operations and Planning in the NHS Report from the Clinical Imaging Board.*; 2017. [www.ipem.ac.uk](http://www.ipem.ac.uk)[www.sor.org](http://www.sor.org)
2. Richards M. *DIAGNOSTICS : RECOVERY AND RENEWAL.*; 2020. <https://www.england.nhs.uk/wp-content/uploads/2020/10/BM2025Pu-item-5-diagnostics-recovery-and-renewal.pdf>.
3. Denjoy N. *Medical Imaging Equipment Age, Profile & Density.*; 2016. [http://www.cocir.org/uploads/media/16052\\_COC\\_AGE\\_PROFILE\\_web\\_01.pdf](http://www.cocir.org/uploads/media/16052_COC_AGE_PROFILE_web_01.pdf).
4. NHS. The NHS Long Term Plan <https://www.longtermplan.nhs.uk/publication/nhs-long-term-plan/>. 2018.
5. Lo Re G, De Luca R, Muscarneri F, et al. Relationship between anxiety level and radiological investigation. Comparison among different diagnostic imaging exams in a prospective single-center study. *Radiol Medica*. 2016;121(10):763-768. doi:10.1007/s11547-016-0664-z
6. Forshaw KL, Boyes AW, Carey ML, et al. Raised Anxiety Levels Among Outpatients Preparing to Undergo a Medical Imaging Procedure: Prevalence and Correlates. *J Am Coll Radiol*. 2018;15(4):630-638. doi:10.1016/j.jacr.2017.12.030
7. Wiebe J. Is your patient claustrophobic? *Can J Med Radiat Technol*. 2004;35(2):25-30. doi:10.1109/t-aiee.1949.5060014
8. Thorpe S, Salkovskis PM, Dittner A. Claustrophobia in MRI: the role of cognitions.



- Magn Reson Imaging*. 2008;26(8):1081-1088. doi:10.1016/j.mri.2008.01.022
9. Munn Z, Moola S, Lisy K, Riitano D, Murphy F. Claustrophobia in magnetic resonance imaging: A systematic review and meta-analysis. *Radiography*. 2014;21(2):e59-e63. doi:10.1016/j.radi.2014.12.004
  10. Funk E, Thunberg P, Anderzen-Carlsson A. Patients' experiences in magnetic resonance imaging (MRI) and their experiences of breath holding techniques. *J Adv Nurs*. 2014;70(8):1880-1890. doi:10.1111/jan.12351
  11. Carlsson S, Carlsson E. "The situation and the uncertainty about the coming result scared me but interaction with the radiographers helped me through": A qualitative study on patients' experiences of magnetic resonance imaging examinations. *J Clin Nurs*. 2013;22(21-22):3225-3234. doi:10.1111/jocn.12416
  12. Törnqvist E, Månsson Å, Larsson EM, Hallström I. It's like being in another world - Patients' lived experience of magnetic resonance imaging. *J Clin Nurs*. 2006;15(8):954-961. doi:10.1111/j.1365-2702.2006.01499.x
  13. Tischler V, Calton T, Williams M, Cheetham A. Patient anxiety in magnetic resonance imaging centres: Is further intervention needed? *Radiography*. 2008;14(3):265-266. doi:10.1016/j.radi.2007.09.007
  14. Norbash A, Yucel K, Yuh W, et al. Effect of team training on improving MRI study completion rates and no-show rates. *J Magn Reson Imaging*. 2016;44(4):1040-1047. doi:10.1002/jmri.25219
  15. Dewey M, Schink T, Dewey CF. Claustrophobia during magnetic resonance imaging: Cohort study in over 55,000 patients. *J Magn Reson Imaging*. 2007;26(5):1322-1327. doi:10.1002/jmri.21147
  16. Andre JB, Bresnahan BW, Mossa-Basha M, et al. Toward quantifying the prevalence, severity, and cost associated with patient motion during clinical MR examinations. *J Am Coll Radiol*. 2015;12(7):689-695. doi:10.1016/j.jacr.2015.03.007
  17. Lloyd L. A Tale of Two MRIs. *J Med Imaging Radiat Sci*. 2020;51(4):S9-S10. doi:10.1016/j.jmir.2020.05.010
  18. Brunnquell CL, Hoff MN, Balu N, Nguyen X V., Oztek MA, Haynor DR. Making Magnets More Attractive: Physics and Engineering Contributions to Patient Comfort in MRI. *Top Magn Reson Imaging*. 2020;29(4):167-174. doi:10.1097/RMR.0000000000000246
  19. Sadigh G, Applegate KE, Saindane AM. Prevalence of Unanticipated Events Associated With MRI Examinations: A Benchmark for MRI Quality, Safety, and

- Patient Experience. *J Am Coll Radiol*. 2017;14(6):765-772.  
doi:10.1016/j.jacr.2017.01.043
20. Asante S, Acheampong F. Patients' knowledge, perception, and experience during magnetic resonance imaging in Ghana: A single centre study. *Radiography*. 2020;(xxxx). doi:10.1016/j.radi.2020.11.020
  21. Berg WA, Blume JD, Adams AM, et al. Reasons women at elevated risk of breast cancer refuse breast MR imaging screening: ACRIN 6666. *Radiology*. 2010;254(1):79-87. doi:10.1148/radiol.2541090953
  22. Wardenaar K, Lim C, Al-Hamzawi A, et al. The Cross-National epidemiology of specific phobia in the World Mental Health Surveys. *Psychol Med*. 2017;47(10):1744-1760. doi:10.1017/S0033291717000174.The
  23. Salari N, Hosseinian-Far A, Jalali R, et al. Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: a systematic review and meta-analysis. *Global Health*. 2020;16(1):1-11.
  24. Jia R, Ayling K, Chalder T, et al. Mental health in the UK during the COVID-19 pandemic: cross-sectional analyses from a community cohort study. *BMJ Open*. 2020;10(9):e040620. doi:10.1136/bmjopen-2020-040620
  25. Wong LE, Hawkins JE, Langness S, Murrell KL, Iris P, Sammann A. Where Are All the Patients? Addressing Covid-19 Fear to Encourage Sick Patients to Seek Emergency Care The Human-Centered Design Method. *NEJM Catal Innov Care Deliv*. 2021;(Figure 1):1-12. doi:10.1056/CAT.20.0193
  26. Powell R, Ahmad M, Gilbert FJ, Brian D, Johnston M. Improving magnetic resonance imaging (MRI) examinations: Development and evaluation of an intervention to reduce movement in scanners and facilitate scan completion. *Br J Health Psychol*. 2015;20(3):449-465. doi:10.1111/bjhp.12132
  27. Ahlander BM, Engvall J, Maret E, Ericsson E. Positive effect on patient experience of video information given prior to cardiovascular magnetic resonance imaging: A clinical trial. *J Clin Nurs*. 2018;27(5-6):1250-1261. doi:10.1111/jocn.14172
  28. Hyde LL, J Mackenzie L, Boyes AW, Symonds M, Brown S, Sanson-Fisher R. Medical Imaging Outpatients' Experiences With Receiving Information Required for Informed Consent and Preparation: A Cross-Sectional Study. *J Patient Exp*. 2018;5(4):296-302. doi:10.1177/2374373518765794
  29. McGlashan HL, Dineen RA, Szeszak S, et al. Evaluation of an internet-based animated preparatory video for children undergoing non-sedated MRI. *Br J Radiol*.

- 2018;91(1087). doi:10.1259/bjr.20170719
30. Bolejko A, Hagell P. Effects of an information booklet on patient anxiety and satisfaction with information in magnetic resonance imaging: A randomized, single-blind, placebo-controlled trial. *Radiography*. 2020;27(1):162-167. doi:10.1016/j.radi.2020.07.011
  31. Tugwell JR, Goulden N, Mullins P. Alleviating anxiety in patients prior to MRI: A pilot single-centre single-blinded randomised controlled trial to compare video demonstration or telephone conversation with a radiographer versus routine intervention. *Radiography*. 2018;24(2):122-129. doi:10.1016/j.radi.2017.10.001
  32. Tazegul G, Etcioğlu E, Yildiz F, Yildiz R, Tuney D. Can MRI related patient anxiety be prevented? *Magn Reson Imaging*. 2015;33(1):180-183. doi:10.1016/j.mri.2014.08.024
  33. Munn Z, Pearson A, Jordan Z, Murphy F, Pilkington D, Anderson A. Addressing the Patient Experience in a Magnetic Resonance Imaging Department: Final Results from an Action Research Study. *J Med Imaging Radiat Sci*. 2016;47(4):329-336. doi:10.1016/j.jmir.2016.04.007
  34. Santarém Semedo C, Moreira Diniz A, Herédia V. Training health professionals in patient-centered communication during magnetic resonance imaging to reduce patients' perceived anxiety. *Patient Educ Couns*. 2020;103(1):152-158. doi:10.1016/j.pec.2019.08.003
  35. Munn Z, Jordan Z. Interventions to reduce anxiety, distress and the need for sedation in adult patients undergoing magnetic resonance imaging: A systematic review. *Int J Evid Based Healthc*. 2013;11(4):265-274. doi:10.1111/1744-1609.12045
  36. Munn Z, Jordan Z, Pearson A, Murphy F, Pilkington D. "On their side": Focus group findings regarding the role of MRI radiographers and patient care. *Radiography*. 2014;20(3):246-250. doi:10.1016/j.radi.2014.03.011
  37. NHS. Claustrophobia. <https://www.nhs.uk/mental-health/conditions/claustrophobia/>. Published 2019. Accessed June 4, 2021.
  38. Enders J, Zimmermann E, Rief M, et al. Reduction of claustrophobia with short-bore versus open magnetic resonance imaging: A randomized controlled trial. *PLoS One*. 2011;6(8):1-10. doi:10.1371/journal.pone.0023494
  39. van Minde D, Klaming L, Weda H. Pinpointing moments of high anxiety during an MRI examination. *Int J Behav Med*. 2014;21(3):487-495. doi:10.1007/s12529-013-9339-5

40. Flory N, Lang E V. Distress in the radiology waiting room. *Radiology*. 2011;260(1):166-173. doi:10.1148/radiol.11102211
41. Engels K, Schiffmann I, Weierstall R, et al. Emotions towards magnetic resonance imaging in people with multiple sclerosis. *Acta Neurol Scand*. 2019;139(6):497-504. doi:10.1111/ane.13082
42. Ladapo JA, Spritzer CE, Nguyen X V., Pool J, Lang E. Economics of MRI Operations After Implementation of Interpersonal Skills Training. *J Am Coll Radiol*. 2018;15(12):1775-1783. doi:10.1016/j.jacr.2018.01.017
43. Sozio SJ, Bian Y, Marshall SJ, et al. Determining the efficacy of low-dose oral benzodiazepine administration and use of wide-bore magnet in assisting claustrophobic patients to undergo MRI brain examination. *Clin Imaging*. 2021;79(February):289-295. doi:10.1016/j.clinimag.2021.06.013
44. Földes Z, Ala-Ruona E, Burger B, Orsi G. Anxiety reduction with music and tempo synchronization on magnetic resonance imaging patients. *Psychomusicology Music Mind, Brain*. 2017;27(4):343-349. doi:10.1037/pmu0000199
45. Stanley E, Cradock A, Bisset J, McEntee C, O'connell MJ. Impact of sensory design interventions on image quality, patient anxiety and overall patient experience at MRI. *Br J Radiol*. 2016;89(1067):1-6. doi:10.1259/bjr.20160389
46. Dabou EAA, AbdElazeem YFM, Elshenawie HAE. Effect of Lavender Essential Oil Inhalation on Anxiety Level for Patients Undergoing Closed Magnetic Resonance Imaging. *Evidence-Based Nurs Res*. 2020;2(3):9. doi:10.47104/ebnrojs3.v2i3.137
47. Napp AE, Diekhoff T, Stoiber O, et al. Audio-guided self-hypnosis for reduction of claustrophobia during MR imaging: results of an observational 2-group study. *Eur Radiol*. 2021. doi:10.1007/s00330-021-07887-w
48. Bigley J, Griffiths PD, Prydderch A, et al. Neurolinguistic programming used to reduce the need for anaesthesia in claustrophobic patients undergoing MRI. *Br J Radiol*. 2010;83(986):113-117. doi:10.1259/bjr/14421796
49. Rizzo S, Ferrera N, Pravatà E, Guggenberger R, Stern S, Del Grande F. Is hypnosis a valid alternative to spontaneous breathing general anesthesia for claustrophobic patients undergoing MR exams? A preliminary retrospective study. *Insights Imaging*. 2021;12(1):0-5. doi:10.1186/s13244-021-01020-7
50. Törnqvist E, Mnsson A, Larsson EM, Hallström I. Impact of extended written information on patient anxiety and image motion artifacts during magnetic resonance imaging. *Acta radiol*. 2006;47(5):474-480. doi:10.1080/02841850600690355

51. Munn Z, Pearson A, Jordan Z, Murphy F, Pilkington D, Anderson A. Patient anxiety and satisfaction in a magnetic resonance imaging department: Initial results from an action research study. *J Med Imaging Radiat Sci.* 2015;46(1):23-29.  
doi:10.1016/j.jmir.2014.07.006
52. Chapman HA, Bernier D, Rusak B. MRI-related anxiety levels change within and between repeated scanning sessions. *Psychiatry Res - Neuroimaging.* 2010;182(2):160-164. doi:10.1016/j.psychresns.2010.01.005
53. Munn Z, Jordan Z. The patient experience of high technology medical imaging: A systematic review of the qualitative evidence. *Radiography.* 2011;17(4):323-331.  
doi:10.1016/j.radi.2011.06.004
54. Murphy F. Act, scene, agency: The drama of medical imaging. *Radiography.* 2009;15(1):34-39. doi:10.1016/j.radi.2007.09.006
55. Harris LM, Menzies RG, Robinson J. Predictors of panic symptoms during magnetic resonance imaging scans. *Int J Behav Med.* 2001;8(1):80-87.  
doi:10.1207/S15327558IJBM0801\_06
56. Harris LM, Cumming SR, Menzies RG. Predicting anxiety in magnetic resonance imaging scans. *Int J Behav Med.* 2004;11(1):1-7. doi:10.1207/s15327558ijbm1101\_1
57. Booth L, Bell L. Screening for Claustrophobia in Mri – a Pilot Study. *Eur Sci J.* 2013;9(18):1857-7881.
58. Napp AE, Enders J, Roehle R, et al. Analysis and prediction of claustrophobia during MR imaging with the claustrophobia questionnaire: An observational prospective 18-month single-center study of 6500 patients. *Radiology.* 2017;283(1):148-157.  
doi:10.1148/radiol.2016160476
59. Ajam AA, Nguyen X V., Kelly RA, Ladapo JA, Lang E V. Effects of Interpersonal Skills Training on MRI Operations in a Saturated Market: A Randomized Trial. *J Am Coll Radiol.* 2017;14(7):963-970. doi:10.1016/j.jacr.2017.03.015
60. Hudson D. Scan Related Anxiety in Mri. *Imaging Ther Pract.* 2016;(September 2016):18-24.  
[https://manchester.idm.oclc.org/login?url=https://search.proquest.com/docview/1828147645?accountid=12253%0Ahttp://manfe.hosted.exlibrisgroup.com/openurl/44MAN/44MAN\\_services\\_page?genre=article&title=SCAN+RELATED+ANXIETY+IN+MRI&author=Hudson%2C+Darren&vo](https://manchester.idm.oclc.org/login?url=https://search.proquest.com/docview/1828147645?accountid=12253%0Ahttp://manfe.hosted.exlibrisgroup.com/openurl/44MAN/44MAN_services_page?genre=article&title=SCAN+RELATED+ANXIETY+IN+MRI&author=Hudson%2C+Darren&vo).
61. West MA, Dawson JF. *Employee Engagement and NHS Performance.*; 2012.
62. West M, Dawson JF, Admasachew L, Topakas A. *NHS Staff Management and Health*

*Service Quality*.; 2011. [http://e3idocs.fmhs.fastmail.net/dh\\_129656.pdf](http://e3idocs.fmhs.fastmail.net/dh_129656.pdf).