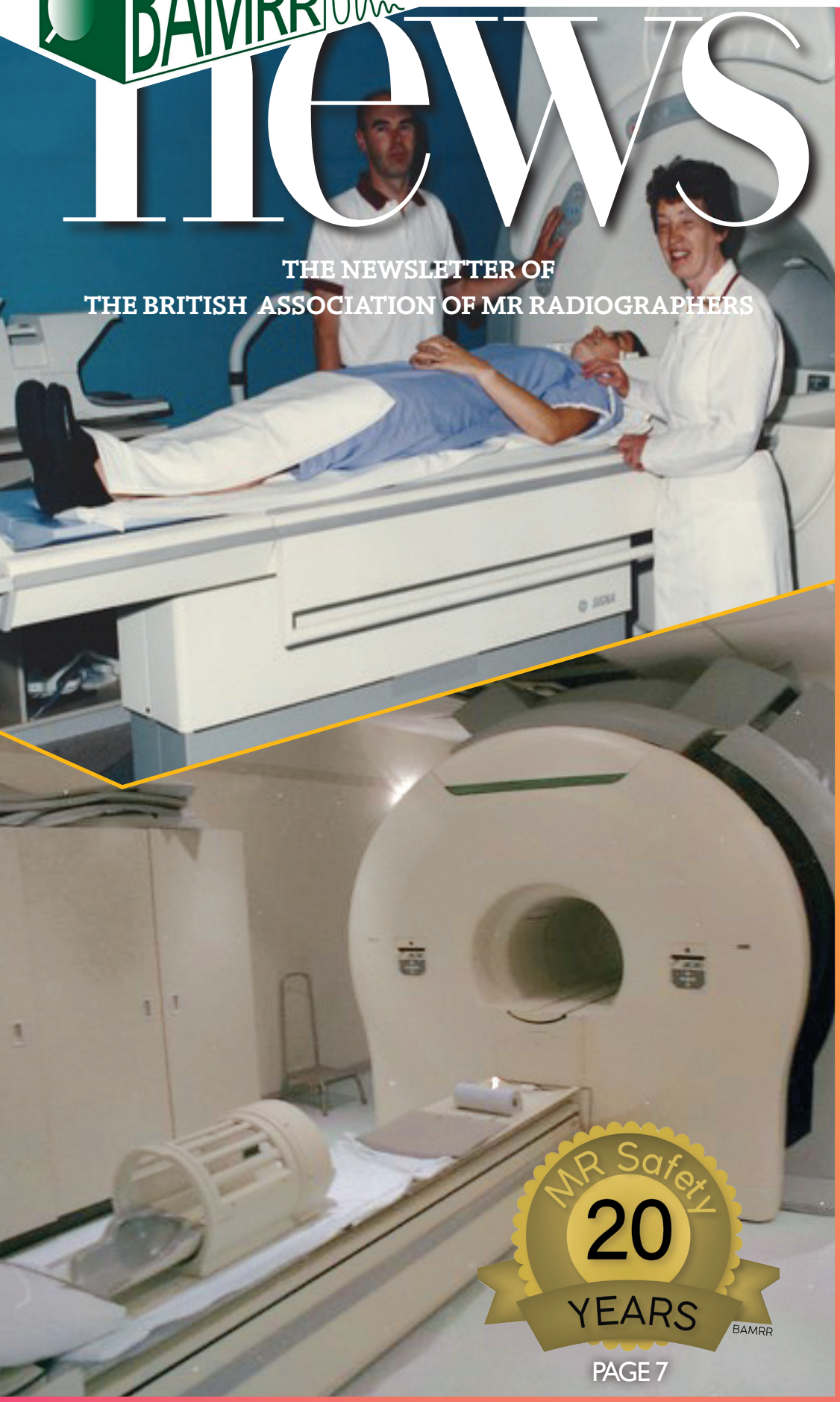
ISSUE 56
SPRING 2021

BAMRR News

THE NEWSLETTER OF
THE BRITISH ASSOCIATION OF MR RADIOGRAPHERS



IN THIS ISSUE:

WITH OUR SOLUTIONS

YOU GET OUR COMMITMENT

COMMUNITY

Together we can do more. **We pledge to assist our partners** wherever we can, however we can, to achieve our mutual goal.

EXCELLENCE

We promise to continue **to strive for excellence.** We will not be satisfied with anything less than the highest quality, in order to deliver meaningful benefits to you and your patients.

INNOVATION

We re-affirm our ongoing commitment to conducting and supporting research that improves patients' lives and meets physicians' needs. **Ambitious and bold innovation** is in our DNA and we promise to keep it that way.

ETHICS

We promise that all our goods and services are designed to not only improve the lives of patients and physicians now, but also **to assure a better, more sustainable future** for generations to come.

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welcome

from your BAMRR PRESIDENT

Welcome to the Spring edition of the newsletter.

At the time of writing we are still submerged in the latest lockdown with increased pressures on all our services. Hopefully all our members will have had at least their first vaccine by now and hopefully many the 2nd and we will be seeing some light at the end of the tunnel.

Have a look at our interesting feature on metal in masks to ensure all patients remain safe. Also for those of you that are looking for a safe means of cleaning the scanner bores, the SWIFFER was our greatest purchase during the first lockdown, a fantastic way of cleaning the bores that is MRI Safe. Available from Amazon and other good outlets!

BAMRR'S main aim is education and about all aspects of MRI. Unfortunately we have had to postpone our face to face courses due to the pandemic but we hope that later this year our Intro course will go ahead. We ran a fantastic virtual conference last October which was a great success and although we missed seeing our members face to face it was a great way of getting lectures out there to members from the comfort of their sofas. We are doing that again this year so save the date Saturday 2nd October 2021. Details of these will be on the BAMRR website.

Some of the projects we are currently involved in are setting up guidelines for cauda equina scanning locally, supporting the set up of the MRSE course and working alongside other bodies such as the BIR and SOR on various projects including a new label for implants.

If anyone would like to apply to become a member of BAMRR we do have some spaces on the board. All it takes is to be working in some aspect of MRI, to have an interest in sharing knowledge of MRI, to attend Policy board meetings three times a year, support the courses we provide and generally support the BAMRR team on the running of the group. In return you would become part of a great team and become part of a great network of MRI personnel. If anyone is interested in joining please email your CV and a covering letter to the contact details on the website.

Keep safe and keep scanning!

Liz McBain

BAMRR President

from your EDITOR

Well it has been a pretty uneventful six months in the world since the last BAMRR News. No one has been on holiday. No one has eaten a meal out. No one has gone to the pub. No one has seen their extended families. No one has met up with their friends. And then there's the likes of us…

We have ploughed on. Gone to work every day. Been really busy. Had a lot of changes to deal with. Some of it has been very stressful.

To begin, I was quite jealous of my next door neighbour, who is furloughed and at home every day whilst still being paid. But as time has passed and I can see how despondent and bored he has become, I have actually started to realise that I am actually lucky. I get to do something very worthwhile and important every day, and, I get to see friends and colleagues who I can chat with about work stuff and non-work related drivel. I actually think that he would swap if he could right now. Yes, I am really keen for it all to end, and I am sure you all are too. We have been tremendously busy and have awkward waiting lists to catch up with. But in some respects I think we have had some advantages and should feel good about them and about ourselves.

May there be a light at the end of your tunnel!

Matthew Benbow

BAMRR Editor

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WELCOME

from our sponsor GUERBET

Guerbet wishes you a warm welcome to the Spring edition of BAMRR News.

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We continue our committment to supporting continuous professional development for MR Radiographers. Throughout the year, in partnership with Radiologists/Radiographers who are passionate about sharing their knowledge, we organise and support teaching courses which are informative and relevant. Please visit our website www.guerbet.co.uk to find out more about the events we hold or sponsor.

Do not hesitate to get in touch on 0121 733 8542 or uk.info@guerbet-group.com if there is something you would like to tell us. As always, we welcome your comments and suggestions as we are here because of you.

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Contrast for Life

Safety News

MHRA Safety Guidelines for Magnetic Resonance Imaging Equipment in Clinical Use, latest update February 2021.

The main change in this version is the addition of the term 'MR Unlabelled' in the defined terms. A more comprehensive update is expected later this year.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/958486/MRI_guidance_2021-4-03c.pdf

Safety Guidelines for Magnetic Resonance Imaging Equipment in Clinical Use - GOV.UK

Safety Guidelines for Magnetic Resonance Imaging Equipment in Clinical Use 5/86 1 Introduction 1.1 Background This is the 4th edition of the safety guidelines and aims to provide relevant safety information for users of magnetic resonance imaging (MRI) equipment in clinical use but will have some relevance in academic
assets.publishing.service.gov.uk

BAMRR

SAVE the DATE
Conference
Saturday 2nd October 2021

Registration will open soon: Bamrr.org

BAMRR Policy Board Members, Spring 2021

The co-ordination of the Associations activities is overseen and undertaken by an elected Policy Board. The board currently consists of the following who are members of BAMRR and working in different regions of the UK.

The Policy Board is composed of:

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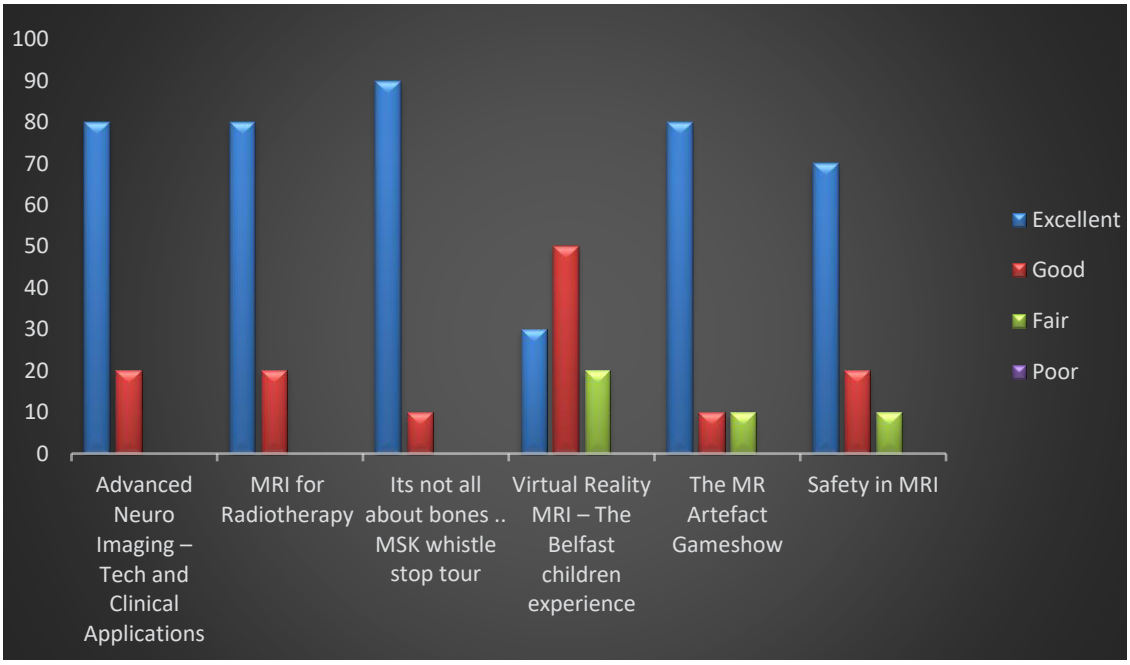
BAMRR 2019 Conference Evaluation

10 Reposnses



	Excellent 5*	Good 4*	Fair 3*	Poor 2*
Advanced Neuro Imaging – Tech and Clinical Applications	8 (80%)	2 (20%)	0 (0%)	0 (0%)
MRI for Radiotherapy	8 (80%)	2 (20%)	0 (0%)	0 (0%)
Its not all about bones .. MSK whistle stop tour	9 (90%)	1 (10%)	0 (0%)	0 (0%)
Virtual Reality MRI – The Belfast children experience	3 (30%)	5 (50%)	2 (20%)	0 (0%)
The MR Artefact Gameshow	8 (80%)	1 (10%)	1 (10%)	0 (0%)
Safety in MRI	7 (70%)	2 (20%)	1 (10%)	0 (0%)

Any other comments or suggestions?

- Great CPD. As much as it's nice to have a day out and a social, being able to dial in from the comfort of my own home was convenient and way! Thank you to all involved.
- Worked really well online, apart from the technical hitches with Cormac McGraw presentation. Excellent speakers, good range of topics.
- Excellent conference - well done.
- Great to have this on a virtual platform. Not been able to attend due to work and family commitments so this has made it accessible for me. Thank you.
- Thanks for organizing a virtual conference. It was so lovely to have that connection. Missing so many things this year. Martin was fantastic, great choice of moderator.
- Well done BAMRR for putting on this conference at such a difficult time.
- A few technical glitches – like no images during the quiz. A good conference overall. Would love to have this on other years alongside the usual conference – extends the number of people who could 'attend'.

How Did you hear of the BAMRR conference?

BAMRR Email ***7 (70%)***

Colleague ***1 (10%)***

Social Media ***1 (10%)***

BAMRR Website ***1 (10%)***

This year it will be 20 years since the tragic accident that killed 6year old Michael Colombini during his MRI when a magnetic oxygen cylinder was accidentally taken into the scan room. As a result of this accident there have been many changes in MR safety that have affected working practices and procedures, the roles of people who work in MRI, and the technology used.

Every year on the anniversary of the accident those who work in MRI engage in talking about all aspects of MR safety, and in recent years this has developed into a week-long event called MR Safety Week. Many organisations in the international MR community mark this event by publishing information daily during the week to encourage everyone to focus on MR safety. The goal is to raise awareness, refresh MR safety education, improve working practices, highlight issues that we all face, and ultimately to prevent further safety incidents.

BAMRR will be publishing daily releases during safety week in July.

Recommended Resources

metrasens

The Metrasens website has a range of videos, webinars and podcasts on the subject of MR safety in the resource section.

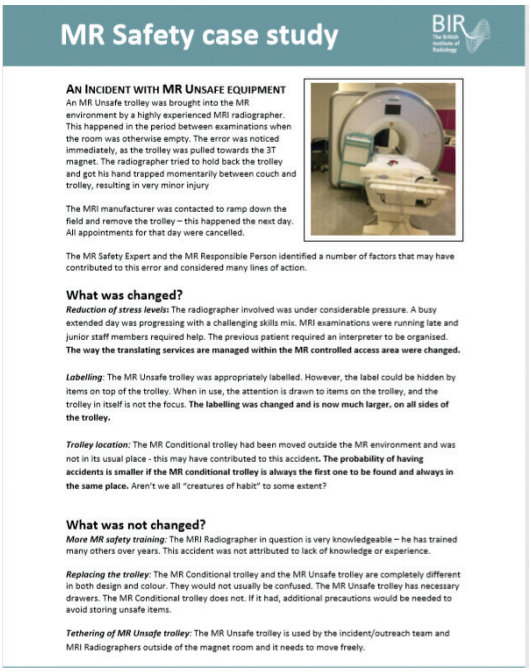
One to watch is '20 years of MR Safety: Lessons on the journey to 2021 and beyond' by Tobias Gilk. This webinar details what happened in the Michael Columbini accident. It identifies the increased risk factors for MR incidents in MRI scanners 20 years after the accident, such as stronger clinical magnets and the fact that more patients have implants and devices, and also identifies external factors such as increased throughput pressures and reduced staffing levels. Recognition is given to professional bodies, legislation, and accredited courses as contributors to improve MR safety, and the speaker concludes by stating that 'the MR professional community makes MRI safer'.

Use this as an opportunity to review your department safety signage and layout. The IPEM website has a range of free MRI safety notices available for download. Safety signage within the controlled area plays a key role in alerting individuals to the hazards in the MR environment. The MHRA Safety Guidelines for Magnetic Resonance Imaging Equipment in Clinical Use (Feb 2021) has guidance on signage in section 5.4.7.

Symbol	Term	Definition
	MRI safe	an item that poses no known hazards in all MRI environments. "MR safe" items include non-conducting, non-metallic, non-magnetic items.
	MRI conditional	an item that has been demonstrated to pose no known hazards in a specified MRI environment with specified conditions of use. Field conditions that define the MRI environment include static magnetic field strength, spatial gradient, dB/dt (time varying magnetic fields), RF fields, and specific absorption rate (SAR).
	MRI unsafe	an item that is known to pose hazards in all MRI environments.

Use this as an opportunity to review equipment that is taken into the MR Environment. The MHRA recommends that all equipment that may be taken into the MR Environment is clearly labelled using ASTM markings (Safety Guidelines for Magnetic Resonance Imaging Equipment in Clinical Use, Feb 2021, section 4.9.3).

The British Institute of Radiology raised awareness of safety in 2020 by focusing on the learning that can be gained from real life incidents. The published data sheets from last year can be accessed via their website.



MR Safety case study

BIR

An Incident with MR Unsafe Equipment

An MR Unsafe trolley was brought into the MR environment by a highly experienced MRI radiographer. This happened in the period between examinations when the room was otherwise empty. The error was noticed immediately, as the trolley was pulled towards the 3T magnet. The radiographer tried to hold back the trolley and got his hand trapped momentarily between couch and trolley, resulting in very minor injury

The MRI manufacturer was contacted to ramp down the field and remove the trolley – this happened the next day. All appointments for that day were cancelled.

The MR Safety Expert and the MR Responsible Person identified a number of factors that may have contributed to this error and considered many lines of action.

What was changed?

Reduction of stress levels: The radiographer involved was under considerable pressure. A busy extended day was progressing with a challenging skills mix. MRI examinations were running late and junior staff members required help. The previous patient required an interpreter to be organised. **The way the translating services are managed within the MR controlled access area were changed.**

Labelling: The MR Unsafe trolley was appropriately labelled. However, the label could be hidden by items on top of the trolley. When in use, the attention is drawn to items on the trolley, and the trolley in itself is not the focus. **The labelling was changed and is now much larger, on all sides of the trolley.**

Trolley location: The MR Conditional trolley had been moved outside the MR environment and was not in its usual place - this may have contributed to this accident. **The probability of having accidents is smaller if the MR conditional trolley is always the first one to be found and always in the same place.** Aren't we all "creatures of habit" to some extent?

What was not changed?

More MR safety training: The MRI Radiographer in question is very knowledgeable – he has trained many others over years. This accident was not attributed to lack of knowledge or experience.

Replacing the trolley: The MR Conditional trolley and the MR Unsafe trolley are completely different in both design and colour. They would not usually be confused. The MR Unsafe trolley has necessary drawers. The MR Conditional trolley does not. If it had, additional precautions would be needed to avoid storing unsafe items.

Tethering of MR Unsafe trolley: The MR Unsafe trolley is used by the incident/outreach team and MRI Radiographers outside of the magnet room and it needs to move freely.

Goodbye to Past President

◆ **Aileen Wilson**

At the end of December we said goodbye to one of our board members Aileen Wilson as she stepped down from the board. Aileen has been on the policy board for 6 years and was our outgoing President. During her time on the board the biggest project Aileen was involved in was setting up the new BAMRR Website. This took a mammoth effort and the resulting website I'm sure you'll agree is fantastic. We have all been really grateful for the commitment of Aileen and the hours she has spent dedicated to the board. She is a font of knowledge and experience that we have all benefited from but with a fabulous mix of professionalism and fun!

Good luck Aileen in your new adventures.

Liz McBain

BAMRR President

New BAMRR Board member

◆ **Chris Watson**

Prior to joining Philips at the start of 2020, I was working as an Advanced Clinical Specialist Radiographer at Southampton General Hospital. In this role I worked closely with Southampton University as a research coordinator/facilitator within the MRI department as well as being actively involved in education and protocol optimisation."

Clinical Application Specialist

Philips Electronics UK Limited

BSc hons: Radiography (Diagnostic Imaging) - City University London

PGC: Magnetic Resonance Imaging - Anglia Ruskin University

BAMRR

Join us for the

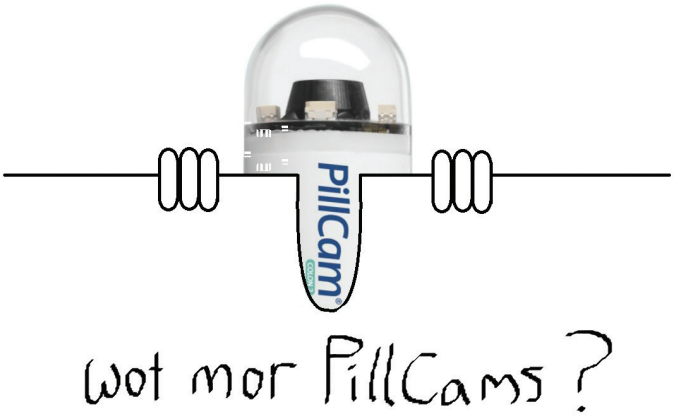
BAMRR Session at UKIO

7th- 25th June 2021

Exact date and time of our BAMRR On-Line session To Be Confirmed....

Please see UKIO website or more information https://www.ukio.org.uk/

Hope to see you there....



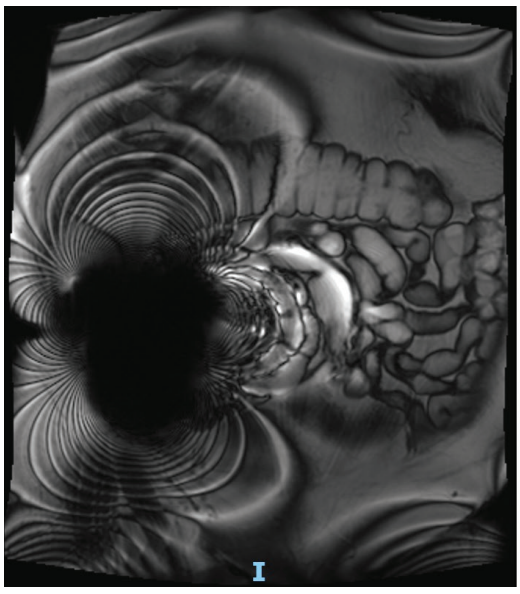
Matthew Benbow, *Superintendent Radiographer CT & MRI Royal Bournemouth Hospital*

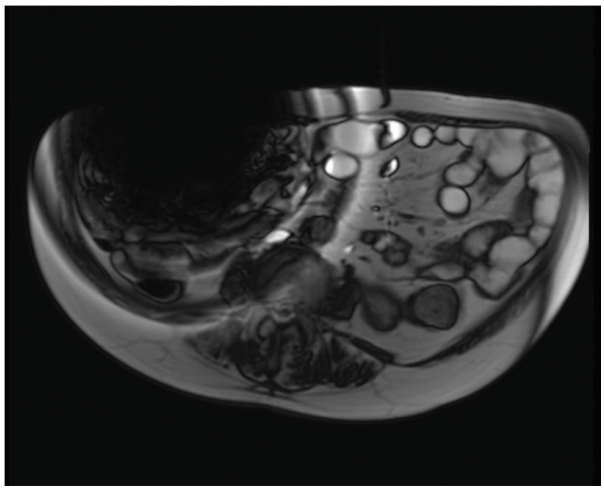
A news article in March reported suggested that post Covid, an increased number of patients might be investigated with a PillCam to help catch up with the cancer care investigations backlog. It was interesting that to me it was being promoted as if it was new technology, which of course we in the world of MRI know that it is not. In fact, it was at a 2015 SMUG meeting in Poole that I was first involved in MR safety discussions and how we all might like to add it to our list of safety questions asked.

Looking today at the company website, it still confirms that after ingesting a PillCam capsule, and until it is excreted, patients should not be near any source of powerful electromagnetic fields, such as one created near an MRI device. So it comes down to firstly being able to ascertain that a patient has actually taken one (and they are not confusing what you are asking with having an endoscopy, which seems common from my experience), and secondly, that if they have, then how do you know it has passed and not become lodged. Some patients see them pass, but not all. The GI report may perhaps visualise the footage of it passing (yes, sorry, I know) but should we need to look this information up before we go ahead with a scan? Or should we get abdominal x-rays on all these patients? In the end this would need to come down to a local decision on the best method to get the facts.

So, can they lodge? Surely they just transit in a day or two and if we wait this long then we can assume patient safety? Well I do have a personal interesting story from my own unit…

In late September 2017 a patient was booked for a small bowel MRI study. She had been investigated with a PillCam in July, but quite clearly on the safety questionnaire she has written that she saw it 'pass through', plus, this was over 2 months prior so the radiographer was quite understandably assured that it was long gone. On commencing the localisers, this is what the radiographer saw:





She naturally abandoned the scan immediately and moved the patient out. The patient had appeared to suffer no ill effects, discomfort or heating. The radiographer asked her again about it, and made the following note on RIS - "Patient insisted that she had passed the pill camera but large artifact on the planning scan so abandoned and patient was sent home. Can the patient please be referred back to the consultant as the camera has been in her since July."

A month later the patient was x-rayed and this now showed no evidence of the PillCam, so the MRI study was repeated and the artefact had gone.

The news article went on to suggest that the NHS may be offering a PillCam to 11,000 patients. By my rough calculation, with there being around somewhere over 200 NHS Trusts in the UK, we might just need to keep our eyes (and safety questionnaires) peeled for around 50 each!

https://www.theguardian.com/society/2021/mar/11/bowel-cancer-screening-capsules-the-latest-in-at-home-care-trend

Space…the Final Frontier

Matthew Benbow, *Superintendent Radiographer CT & MRI Royal Bournemouth Hospital*

How many ears does Captain Kirk have?

Answer…three – his left ear, his right ear and his final front ear.

And according to the Starship Enterprise, SPACE is the final frontier….but is it for MRI?

MRI has a problem. This is that the better you want to see something, the more it is going to cost you. By *'see better'* I am referring to either higher resolution or improved signal, and by *'cost more'* and am meaning an increase in scan time, and possibly an unacceptably high Specific Absorption Rate (SAR).

When anatomical structures under scrutiny are small or narrow, we need to scan with higher resolution, both in-plane and through-plane (thin slices) in order to distinguish them. To make things more challenging still, some small structures can lie in tricky-to-image planes, rather that in nice convenient orthogonal orientations. They might lie obliquely, e.g. the anterior cruciate ligament, or perhaps even lie in a curving, twisting orientation that is inconsistent between patients, such as the common bile or pancreatic duct. A good solution is to acquire near-isotropic 3D 'slabs' of scan data, giving the opportunity to retrospectively reconstruct optimal planes or perhaps to create volumetric images such as maximum intensity projections (MIPs), but to facilitate this the voxel resolution must be appropriately small, ideally sub-millimetre.

However, scanning with very thin slices gives us two problems:

1. This slices return less signal, and so images can be excessively noisy.
2. This slices will result in reduced overall anatomical coverage unless we significantly increase the number of them and therefore phase encodings scanned. But a consequence of doing this is that the scan time goes up and the increase may not be acceptable, either due to a raised likelihood of patient movement, or simply that we cannot afford to spend this amount of time per patient when running a high demand service.

So we need a solution, and one option is the 3D fast spin echo sequence known as SPACE (Siemens), CUBE (GE), VISTA (Phillips) or 3D MVOX (Canon). But how does this sequence achieve a high number of slice locations in high detail and a reasonable scan time, without resulting in too much patient heating?

Achieving a higher number of thin slice locations

2D Fast Spin Echo (2D FSE)

A long established way of minimising scan time whilst keeping the number of slice locations high is to use fast spin echo. Here several lines of k space are filled during each TR by using multiple 180o refocusing RF pulses. There is a limit to this technique however as each of these refocusing pulses takes a finite time period, and as such there is only so many that can fit into the required TR/TE period. Even for weightings where a longer TE time is acceptable and there is no upper limit to the TR time, e.g. T2 weighting, the Free Induction Decay (FID) (which is dependant on the T2 decay times of tissue) fades too quickly over time such that later echos ultimately become too weak to be unusable, resulting in reduced SNR and CNR. So there is a limit to how long a fast spin echo train can be, usually around 30 echos. For us to be able to sample more echos in each TR, we need to either reduce the time taken to acquire each one, or extend the time that we can utilise a usable FID.

Reducing Inter-Echo Time

Standard 2D FSE uses slice selective RF pulses, i.e. a gradient is applied to coincide with each RF pulse, and this takes time. In fact each 180o refocusing input takes several milliseconds. But, with 3D imaging slice selection is performed by a second phase encoding step and so there is no requirement to add a slice select gradient. Therefore refocusing can be performed for each echo in under half the time. The result is that for the same time period, many more echos can be sampled.

Extending the FID and Echo Train

In clinical MRI scanners, the FID of tissue is proportional to the remaining transverse magnetisation, i.e. governed by T2 relaxation, and as such will generally decay in around 100 milliseconds. So when an attempt is made with 2D FSE to excessively increase the echo train, the result is that the later echos return poor signal, plus an undesirable increase in image blur where these echos fill the outer, spatial portion of k-space. If we could somehow 'slow down' the decay of the FID, we could extend it's use and fit more measurements in, i.e. enjoy a longer echo train.

Th 3DFSE solution is to reduce the refocusing RF input from 180o to perhaps around 30o to 120o, i.e. flip some of the magnetisation temporarily and partially into the longitudinal plane. This might sound counterproductive but actually has a big benefit – the decay time of longitudinal magnetisation is based on the T1 time of tissue which is in the order of 1000+ milliseconds, and as a result the FID will last MUCH longer. In essence we will be partially 'storing' transverse magnetisation in the longitudinal plane to slow down its decay.

Author's unnecessary Star Trek analogy of benefits of 3D FSE:

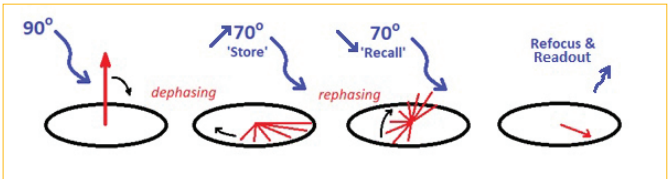
Kirk, Spock and Bones have retired to their quarters for a session with a couple of bottles of Saurian Brandy, a tipple that surely must be consumed 'on the rocks' to be more palatable and thereby reduce the time between drinks. They each grab a bag of ice from Deck 8 galley and get started. Bones and Spock cunningly 'store' their ice in the fridge where it will last a longer, so extending their afternoon on the hard stuff as they can 'recall' ice over a longer period and keep drinking longer. Kirk on the other hand didn't bother, so is going to find his afternoon is going to melt away much more quickly.

Making the drink more palatable to shorten the gap between rounds = reducing the inter-echo spacing

Storing ice in the fridge so it lasts longer = extending the FID

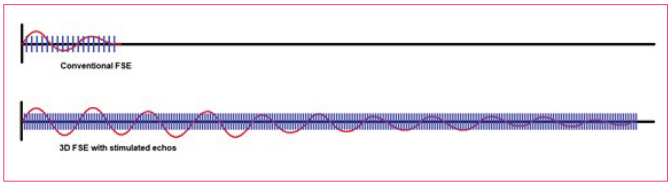
Thereby lengthening their afternoon session = extending the echo train

Before readout, a third RF input is then made to 'recall' the magnetisation back into the transverse plane where it can be sampled, producing what are known as 'Stimulated Echos'. The result is that a FID in the order of 10 times longer than 2D FSE is available for acquiring signal. So when these two techniques are combined it is easily possible to achieve echo trains of 200 or more which in practice are usually combined with parallel imaging and partial k space filling techniques to ensure that overall sequence scan times are very acceptable.



◆ After the initial 90o RF pulse, a follow up RF input of less than 180o (in this case 70o) is employed which will 'store' a proportion of the magnetisation in the longitudinal plane where it will decay more slowly and thereby extend the FID. Later it is 'recalled' back into the transverse plane for readout.

It could be expected that using a refocusing RF of under 180o might result in less signal being produced, but in practice this is not the case. This is because signal will originate from both stimulated and spin echos.



◆ Compared with conventional spin echo, 3D FSE with stimulated echos has two tricks - shorten the gap between echos, and, extend the FID to allow a much longer echo train. Combining these two allow good anatomical coverage with thin slices in a reasonable scan time.

In reality the flip angles used are not fixed, but are adjusted throughout the acquisition which enable signal amplitudes to be maximised along the FID. In fact, cunning methods have been devised that result in some parts of the echo train, for example the central part, giving back a significantly higher signal amplitude than a fixed 180o refocus would achieve. Additionally, as the variation in flip angle introduces a controllable amount of longitudinal versus transverse magnetisation, careful placement of the proportion of each into the contrast area of k-space can allow either T1 or T2 weighted imaging, so is very flexible. The key word here is weighting, i.e. all images will contain a proportion of both contrasts, depending on the combinations of effective TE and flip angles utilised throughout the echo train. Echos that have spent time partially decaying in the longitudinal plane (the stimulated echos) will not behave in a way that is familiar to us. Our usual knowledge of how to adjust TE times in Spin Echo imaging will not be applicable to Stimulated Echos as the magnetisation will not be decaying so quickly.

For example, consider these 3 brain images.

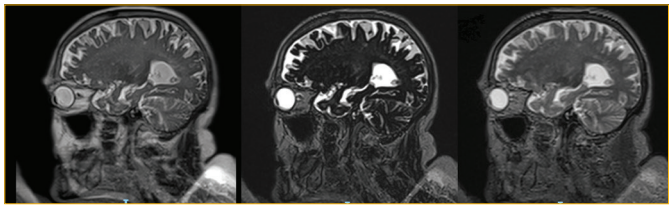


Image 1 Image 2 Image 3

Image 1 uses a standard fixed 180o refocusing pulse, i.e. is from a standard fast spin echo acquisition. The TR is 2500 and the TE is 120 and so the image contrast achieved is of typical T2 appearances.

Image 2 also uses a fixed 180o, in fact the only change is that the TE has been increased to 500. This makes the image very heavily T2 weighted, in fact too much for this clinical application.

Image 3 however shows what happens when we utilise the same long TE of 500, but this time allow variable flip angles optimised to seek T2 weighting. The contrast achieved is now the same as image 1, i.e. as if we had utilised TE 120 and 180° refocusing.

Fortunately the expected weighting for any TE chosen can be calculated, and therefore manufacturers can create sequences for us that will give us the image contrasts we clinically require.

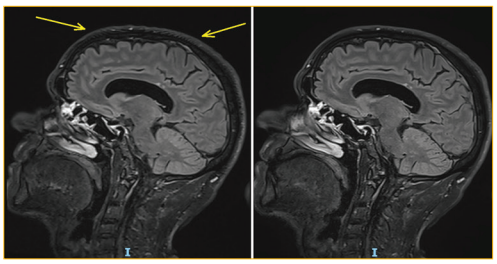
Patient Heating Benefits (SAR)

Using a larger amount of RF energy in MRI will result in higher Specific Absorption Rates (SAR), i.e. more patient heating. SAR varies as a square of the flip angle – the higher the flip angle...the much higher the SAR. Fast Spin Echo uses multiple 180o RF inputs throughout the echo train and is therefore SAR intensive and radiographers will more likely be faced with scanner warnings regarding sequences not being achievable at Normal Scan Mode.

Due to this square relationship, even small reductions in flip angle will reduce SAR significantly and so the variable flip angle approach of 3D FSE described above comes with the benefit of significant reductions in SAR. This can be particularly useful with higher field strength scanners where enforced limitations are more common.

FID Artifacts

Now this is complicated...and I don't pretend to understand it well, but there is an artifact to contend with. It comes as a result of the interference of the FID signal and the Echo signal, because in 3D imaging both are phase (spatially) encoded. The FID signal will 'creep in' and add to the periphery of k space where spatial data is stored and this signal will be strongest for tissues with a short T1 time, e.g. fat. A high signal of rapidly changing intensity will be seen in the image, but only in areas perpendicular to the readout gradient orientation. A good example is at the top of the head where narrow bands of varying intensity can be seen near the vertex.



◆ Left image - 128 x 0.6mm slices scanned in 4 mins 17 secs using 1 signal average and parallel imaging factor of 2. FID artefact can be seen at the vertex. Right image – the same sequence repeated in 4 mins 7 secs using 2 signal averages and parallel imaging factor of 4. The artefact has been eliminated.

One solution is to double the signal averages, but then to 'buy back' the increase in scan time by also doubling your parallel imaging factor (so long as the coil arrangement allows this). This artefact is likely to be more prominent at 3T than 1.5T.

3D FSE Sequence Summary

Non selective refocusing RF pulses

Short inter-echo spacing of 3-4 ms

Very long echo trains, perhaps over 200

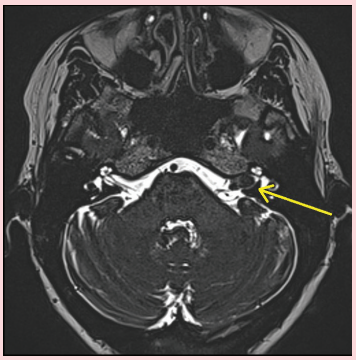
Reduced, variable flip angles, perhaps 30-120o to lengthen the FID, optimise signal and reduce SAR

Combined with parallel imagining and partial k space filling to shorten scan times

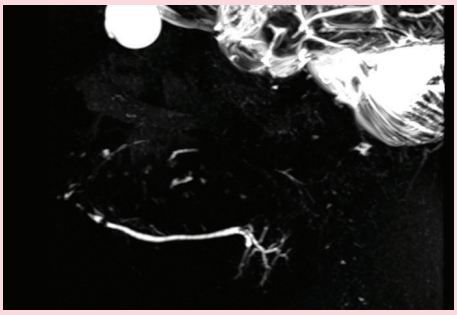
Cont'd...Page 12

Cont'd...from Page 11

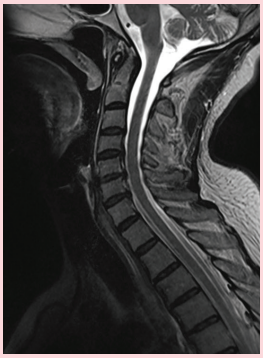
Clinical Examples

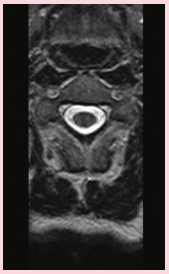


- Axial 3DFSE of the IAMs showing a left acoustic neuroma.

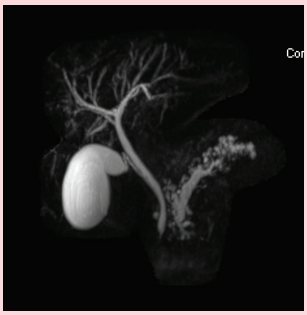


- Heavily T2-weighted 3DFSE MIP of the submandibular salivary duct.

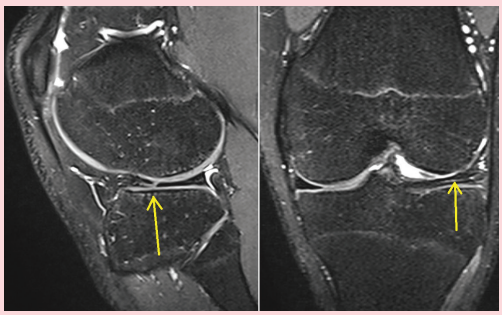




- Sagittal 0.6mm isotropic 3DFSE Cervical Spine, plus axial reformat of the same data set.



- MIP of a 3DFSE MRCP showing chronic pancreatitis.



- Whilst scanned sagitally, multiplane reconstructions are possible of this 3D FSE knee due to the use of isotropic 0.6mm voxels.

  The images nicely demonstrate a complex tear involving the body and anterior third of the lateral meniscus, with a horizontal component.

Conclusion

Captain's log...star date Spring 2021…

3D FSE is a versatile sequence that allows good anatomical coverage of small voxels in very acceptable scan times, whilst avoiding problematic SAR restrictions.

It allows scanning of 100+ slice locations in around 3 to 5 minutes.

This in turn permits retrospective multiplanar reconstructions of oblique and curved structures.

Multiple image weightings are supported – T1,T2 and Proton Density.

It can be used in combination with Inversion Recovery (STIR and FLAIR) and Fat Saturation.

It suppresses flow artefacts due to it being a volume acquisition and hence selective refocusing pulse, i.e. we re-focus the entire volume, so even when blood/CSF moves it will receive both pulses.

Reasonable imaging times (5-10 min, or significantly less when combined with parallel imaging and partial k space filling)

It can boldly go where no 3D sequence has gone before.

Scan long...and prosper.

Further Reading

https://onlinelibrary.wiley.com/doi/10.1002/jmri.24542 http://mriquestions.com/spacecubevista.htm https://www.ajronline.org/doi/10.2214/AJR.06.0556

The below article was published in Radiography in December 2020, the full article can be accessed via https://www.radiographyonline.com/article/S1078-8174(20)30246-7/fulltext or DOI:https://doi.org/10.1016/j.radi.2020.11.017

MRI reporting radiographers - A survey assessment of number and areas of practice within the United Kingdom

The aim of this study was to obtain a picture of the number of MRI reporting radiographers trained and in practice currently in the UK and to identify the scope of their practice.

A survey was sent out via multiple pathways to try and capture as many radiographers as possible, a brief summary of the results are below.

Responses were received from 46 trusts, 40 English, 4 Scottish and 2 Welsh. 31 radiographers from 21 trusts were in training to report MRI scans and 80 radiographers from 38 trusts had completed training, 57 of these were currently in practice. The main reasons given for any gap in practice or for no longer practicing were a lack of radiologist support and a lack of staffing or backfill.

The majority of radiographers were reporting T/L spine and knee but there were other areas of practice including brain and c spine, breast, foot/ankle, pelvis and wrist.

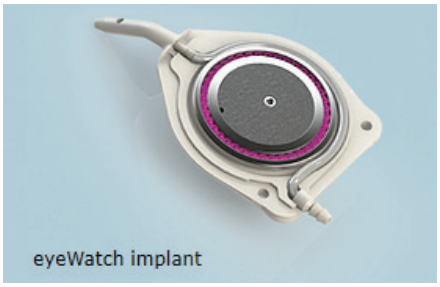
The results demonstrated that there is a huge variation in training, sign off and the governance processes for reporting radiographers within MRI. The results also demonstrated the importance of ensuring that the many components required to set up a reporting radiographer service in MRI are agreed prior to commencement, this includes the selection of the trainees, appropriate financial support and backfill, mentor support and post qualification governance.

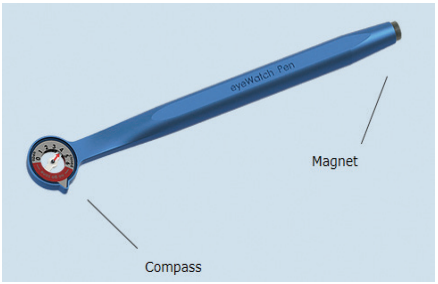
Reporting radiographers in MRI is still a relatively new concept and although courses have been available since 2003, the number in practice is still relatively low.

Implant News

RHEON MEDICAL

The eyewatch implant is a new type of implant used to treat glaucoma. This was flagged to us at BAMRR by one of our members and has been featured on TV. The implant itself is inserted through the front of the eye and connected to a drainage tube that filters excess fluid out of the eye so that it can be reabsorbed. In glaucoma patients this prevents the build-up of pressure in the eye that can lead to damage to the optic nerve and permanent loss of sight. The innovative element in this implant is a built in magnetically controlled flow mechanism that allows the surgeon to open and close the device using a special magnetic pen. The manufacturer says that it is MR Safe up to 3 Tesla, but stipulates that after MRI the patient should see a trained ophthalmologist for adjustment of the magnet position as it may have changed during their scan.





News Articles

'Three patients at Manchester Royal Eye Hospital are the first in the UK to test a new fully adjustable surgical implant to drain excess eye fluid caused by glaucoma'
https://mft.nhs.uk/2018/07/27/manchester-patients-are-first-in-the-uk-to-trial-new-glaucoma-treatment/

The eyewatch technology also featured on BBC's programme 'Trust me I'm a Doctor'
https://www.bbc.co.uk/programmes/articles/3dZ3HTVk7RJ4ZDS3ZZYkfhK/saving-sight-a-new-treatment-for-glaucoma

Safety News

At the BAMRR conference 2020 International MR Safety expert Dr Emanuel Kanal spoke about the importance of checking patient clothing prior to scan, his recommendation is to change them wherever possible to minimise the risk of hidden metallic fibres in clothing causing RF burns during their scan. This news article about how sports clothing may cause burns in MRI emphasizes his point.

'Doctors are warning people not to wear sports like clothing during MRIs'

https://www.businessinsider.com/lululemon-athleisure-burn-during-mri-doctors-warn-2018-5?r=US&IR=T

The MHRA recommends that prior to examination the patient should complete a screening consent/checklist form. This form should include identification of the presence of metal objects:

- in the body such as bullets, pellets, shrapnel, or other types of metallic fragments
- attached to the body such as body piercing
- on the body such as hairpins, jewellery, brassieres, hearing aids, spectacles, dentures with metal components, make-up, tattoos, transdermal patches etc.
- clothing with metallic / conductive content

(*MHRA Safety Guidelines for Magnetic Resonance Imaging Equipment in Clinical Use,* Feb 2021, section 4.12.5, Screening prior to examination).

Safety Alert

MHRA Regulating Medicines and Medical Devices

MHRA alert issued December 2020

Device: All brands and models of gastric bands

The MHRA has become aware that there is potential for harm when patients implanted with gastric bands containing metallic components undergo MRI. Some models of gastric bands may contain a metallic component as part of their device design.

Actions:

- Check if the patient has an implanted gastric band.
- Please refer to the latest version of the relevant manufacturer's Instructions for Use (IFU) for any MRI restrictions before scanning any patients with implanted gastric bands.
- Please make sure relevant staff within your department are aware of this information.

Infection control considerations: the need to change a patient's face mask prior to their MRI scan and ventilating the scan room

The evidence for appropriate ventilation and mask wearing to prevent hospital acquired Covid-19 disease is no longer disputed. The virus is known to be transmitted through the air and in droplets. The eyes, nose and mouth are known transmission routes. Exhaling, speaking, coughing, singing and sneezing are processes known to cause the virus particles to travel far and wide. The risk of catching the virus is thought to be greater in enclosed settings as the virus becomes contained, lingering for longer in a confined space. Ensuring appropriate source control in the form of facemasks and good ventilation to clear the air of contaminants is recommended.

In the previous article, Infection control considerations for MRI units, BAMRR Autumn Newsletter - 2020 , some of the collaborative ideas proposed by the MR community to reduce the risks of nosocomial infection were described. Establishing MR safe respiratory devices for both staff and patients were considered a priority. To that end I collated and provisionally classified some preliminary tested respiratory equipment, as per MR safety conditional labelling. The table detailed surgical masks, respirators and a powered hood which were all tested in the scan room by MR Safety Experts (MRSE) and an MR Safety Officer (MRSO). From feedback, these resources have proven useful. At that time though there was no MR safe patient IIR mask which 'ticked all the boxes' in terms of MRI safety, infection control or image quality. There were none that were easily identifiable as metal free. In the pursuit of this goal, I discussed the idea of labelling medical devices with two companies who provided facemasks to MRI units. The aim was to get their boxes of IIR, CE marked face masks labelled as metal free. This was achieved and the facemask specifically designed for MRI patients was also developed.

Personal protective equipment is essential because maintaining physical distancing from patients is not possible for radiographers

A core infection prevention strategy from the government has been to promote people to physically distance from each other. Radiographers are unable to comply with this recommendation when preparing their patients for a scan and have no choice but to work in proximity with colleagues. Radiographers must therefore have adequate personal protective equipment for themselves and their patients.

Development of MR safe, *metal free* labelled face masks for MRI patient use

The 2020 investigation into what metal free labelled IIR surgical masks were available for MRI patient use revealed that there were not any. Finding the correct mask for MRI patients could therefore be time consuming. From social media discussions it appeared that radiographers sometimes had to cut through the first mask in a box to check if the nose clip was plastic or metal as this was often the quickest, and only way, to confirm the constituent parts. This is inherently problematic though as some seemingly plastic nose clips can have very thin metal wires at their upper and lower edges. These thin wires cannot be easily seen, even when sliced apart. Some units were only provided with masks for patients which contained metal nose clips. Staff then had to cut away each metal strip by hand. This uses up valuable clinical time but more significantly could potentially cause cross contamination of the patient's mask in the process.

Liaising with a medical devices' supplier based in Dublin (Hospital Services Limited), we identified masks with a wholly plastic nose clip that were already being distributed to MRI units. The distributor agreed to label the boxes of these masks as metal free but could only print the text in black ink, not the conventional green and white text which denotes MR safety conditions. Their support for the project was very welcome though and resulted in what is believed to be the first boxes of face masks being identified for MR patient use. However, it became a concern that due to the susceptibility effect of the dense plastic clip in the scan field, some units may have to remove even the plastic clip by hand when scanning the head or neck region in case it created an image artifact in some sequences (DWI). The solution to this problem, it seemed to me, was to be able to find a face mask which would remain over the patient's nose and mouth with no nose clip, be metal free and labelled as such and be IIR CE marked. In discussions with a manufacturer of medical devices based in Glasgow (Sharon Services), they agreed to design such a mask in their Belgian factory and to label the boxes as metal free in the more familiar green and white text. These new patient masks are shown to contain no metal particles and have been tested in the bore at 3 T. Although the technical specifications of the mask stated that there is no metal in the material used, and therefore does not strictly require any MRI Safety testing, for due diligence, they underwent testing. An MRSE volunteered his time to test the mask (report available upon request) and confirmed the MR safety of the mask. The compromise, from an infection control point of view though, is that there is no clip for a tight seal against the patient's face. This potential shortcoming must be balanced against the advantages of ensuring that the patient's mask will not be cross-contaminated, if having to remove any nose clip, or heat up, move or cause image artifact if the nose clip is not removed. As always, a risk assessment by, for example, the local infection control team, MRI staff, manager and local MRSE must be made before choosing the appropriate PPE for patients to wear in the scan room.

Why each individual mask could not be labelled as metal free

The first iteration of these masks were blue and designed to have metal free text on each one. However, finding a suitable vegetable dye which adhered appropriately to the material proved unrealistic. The masks were instead kept plain white to try to stand out clearly from other types of mask that a unit may have. With each box also labelled,

identifying a patient's safe mask may be made more easily and save staff time in the process. Having metal free clearly visible on the boxes may also prevent masks destined for MRI patients being sent to non-MRI units by mistake.

Should we be changing a patient's face mask prior to their MRI scan?

Insisting that patients be given a fresh, MR safe mask before they are scanned may potentially reduce the risk of contamination if a patient's own mask is unhygienic. If the patient's mask has inadequate filtering layers it could also be unfit for the purpose of source control. Their mask must be MR safe, containing no metal nose clip to ensure the patient's safety if exposed to transmitted radiofrequency (RF) energies. The patient may not know what their mask is made of however and if it has an antimicrobial/ ionic covering this could be another potential cause of the mask to heat up and burn a patient's face, as per a recent warning given by the FDA.

Best practice for MR radiographers may be to change the patient's mask every time to a fresh MR safe one. Both myself and Danish radiographer, Dr Anne Dorte Blankholm, emphasised the need for patients to wear a safe patient mask in our recent presentations at the European Congress of Radiology in March. Now that MR safe alternatives are available, how can we justify allowing the patient to wear their own mask for an MRI scan?

Reasons why we should consider changing a patient's mask prior to their MRI scan:

1. The patient's mask may be unhygienic and no longer fit for the purpose of source control.
2. The mask may contain a ferrous nose clip which could move due to the static magnetic field effects, exposing the patient's nose or mouth. This could potentially allow airborne pathogens to be circulated around both the scanner bore and the scan room. The feeling of any mask
movement can also be disconcerting for the patient.
3. The nose clip may be metallic but non-ferrous and so could still be moved by the opposing Lenz effects of the static magnetic field.
4. If the nose clip is made of any metal (ferrous non-ferrous), it could potentially heat up because of exposure to the transmitted RF if within the region being scanned. The length of a typical metallic nose clip is 9 cm, but it could be longer, which could make a resonant length when exposed to the appropriate RF wavelength. At 3T, a length of 10-15 cm could make the occurrence of resonant heating effects more likely.
5. Staff must remove any metallic nose clip by hand, incurring a cross-contamination risk.
6. Some masks may have antimicrobial/ionic coatings which contain metallic particles. One effect of such coatings, when exposed to the transmitted RF, could be to cause the mask to heat up on the patient's face.
7. The patient may have no idea if their mask contains a metal nose clip or metallic coating or if it is hygienic.
8. Where the nose clip is made from any metal, magnetic or otherwise, there could be a susceptibility artifact/signal void in the images if the mask is within the region being scanned, rendering images potentially undiagnostic.
9. Even if the nose clip is plastic, rendering it MR Safe, it may still cause a susceptibility artefact if scanning in that region, degrading image quality. The extent of this artifact will be greater at higher field strengths. Consequently, some MRI units may also choose to remove any plastic nose clip by hand, potentially creating another cross contamination risk.
10. Most MR safe patient masks are not marked as metal free so finding the correct mask for MRI patients can take up valuable clinical time. Having boxes labelled as metal free might make it easier to identify and choose a safe mask.

Please note at the time of this publication UK professional bodies are considering making a statement to promote the need to change a patient's mask prior to their MRI scan.

For more information on MR safe masks please contact sales@omnitex-uk.com. Thanks to http://www.pearl-technology.com/ for promoting the need for MR safe patient masks to their European and global partners and to sales@sharonservices.co.uk for developing their Omnitex brand for this patient safety initiative. Thanks also to www.hsl.ie for labelling their face mask boxes as metal free too.

Considerations when ventilating the scan room

MRI units can be places with few or no windows, preventing easy access to fresh air and ventilation. The MRI scan room, control room, changing rooms, staff rooms, toilet and any other communally used areas create a risk that virus particles may be present. It is vital, when scanning Covid-19 patients or any other patient with a contagious disease, to be able to know how long scan room 'downtime' should be to allow for appropriate ventilation. This is to ensure that the room has been fully changed of air before anyone re-enters. The time to ventilate needs to be quantified so that no one puts themselves at risk by re-entering too soon. Hospital ventilation systems are generally of the highest standards, however, assessing the efficacy of some air filtration or ventilation systems can be difficult. Access to the scan room ventilation can be restricted and the instructions or information on older ventilation systems may have been lost. It is important that any air system does not just recirculate air rather than extract it from the scan room. Standard MRI scan rooms were never designed to be like a theatre or ITU treatment room, where air clearance and pressure systems for infection control purposes are built in. Unless verification that the ventilation is of suitable standard, no 'best guess' approach as to the 'down time' should be suggested.

For MRI safety reasons, scan rooms need to be within Controlled Access Areas (CAA). Any ventilation inadequacies may be accentuated in the CAA by an often-labyrinthine-like series of rooms designed to prevent free access to the scan room. This pandemic highlighted the need for adequate infection control policies for MRI units, especially how we can ensure scan rooms are extracted of any infective airborne particles. For mobile and static units, with full normal ventilation on, maintaining an open door while positioning the presumed 'non-contagious' patient, can be a sensible approach to allow some air changes to take place. The process of air extraction must be more measured for dealing with known cases of Covid-19 or any other transmittable disease though. An established 'down time' must be calculated, with the scan room door kept shut during the process to avoid air being sucked in from other areas. No one should be present in the scan room until air extraction is complete.

For mobile scanning units, it may be easier to ventilate the scan room as fresh air can be regularly brought into the scan room by the process of opening the control room door to the outside or raising the shutter while the scan room door is open. This does not guarantee, however, that the scan room or control room are fully ventilated, and staff cannot routinely vacate these areas between patients. For mobile units, this is one of the reasons to avoid booking positive cases.

The decision over how long to leave a scan room to ventilate can only be made after proper assessment of the ventilation system. Where this is unclear, perhaps an alternative process, of using the scan room's emergency air extract system can be considered. MRI scan rooms normally have their own gas extraction system installed which is designed to remove helium gas during a quench. In many systems this process may be initiated manually by pressing, an override button. As the purpose of this system is to extract helium gas during a quench, routine use for infection control purposes is not an intended use. Consequently, use of this method for room air extraction can only be made with the full agreement of all relevant parties: scanner manufacturer; estates team; MR Safety Expert; MR Responsible Person; infection control team and any other relevant managers.

At the height of the pandemic, some units took a pragmatic approach to ventilating the scan room by pressing the override button and ensuring sufficient 'down time' after every patient. This was intended to mitigate the risks of disease from both positive and asymptomatic cases. If scanning contagious patients, the employer/delegated manager must ensure appropriate measures are taken to try to secure a safe working environment for all. For this example, ensuring a workplace that has uncontaminated air would be part of any risk assessment to secure a safe environment. The decisions over when, how, and for how long, to ventilate scan rooms must be made. Associated standard operating procedures must also be written to ensure that everyone who works in the unit understands the processes to follow. This can help to control the risks and ensure best practices are followed.

For any comments or questions regarding this article please contact
mrisafetymatters@btinternet.com

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* Herborn CU, et al. Clinical Safety and Diagnostic Value of the Gadolinium Chelate Gadoterate Meglumine (Gd-DOTA). Invest Radiol 2007; 42:58-62.

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UK-D-Ad-08-13

DOTAREM® 0.5 mmol/ml (Gadoteric acid) Solution for injection, vials and pre-filled syringe (PFS)
Please consult full Summary of Product Characteristics (SmPC) before using. The following is a summary:
ACTIVE INGREDIENT: Gadoteric acid, 279.32 mg/ml (equivalent to 0.5 mmol/ml). Osmolality: 1350 mOsm.kg-1. Viscosity at 20°C: 3.2 mPa.s (2.0 mPa.s at 37°C). pH: 6.5 to 8.0. **THERAPEUTIC INDICATIONS:** Dotarem should be used only when diagnostic information is essential and not available with unenhanced magnetic resonance imaging (MRI). *Adults and paediatric population (0-18years).* Contrast enhancement in Magnetic Resonance Imaging: ***Encephalic and spinal MRI:*** Detection of brain tumours, tumours of the spine and surrounding tissue, invertebral disc prolapse, infectious diseases; ***Whole Body MRI:*** Including renal, cardiac, uterine, ovarian, breast, abdominal and osteo-articular pathology; ***Angiography:*** Dotarem is not recommended for angiography in children under 18 years of age due to insufficient data on its efficacy and safety in this indication. **POSOLOGY AND METHOD OF ADMINISTRATION:** The lowest dose that provides sufficient enhancement for diagnostic purposes should be used. The dose should be calculated based on the patient's body weight, and should not exceed the recommended dose per kilogram of body weight detailed in this section. The product is intended for IV administration only. Intravascular administration of contrast media should, if possible, be done with the patient lying down. After the administration, the patient should be kept under observation for at least half an hour, since experience shows that the majority of undesirable effects occur within this time. **Adults including the elderly:** *Encephalic and spinal MRI:* The recommended dose is 0.1mmol.kg-1, i.e. 0.2ml.kg-1 to provide diagnostically adequate contrast. A further injection of 0.2mmol.kg-1, i.e. 0.4ml.kg-1 within 30 minutes, may improve tumour characterisation and facilitate therapeutic decision making. *Whole body MRI and angiography:* The administration of 0.1mmol. kg-1, i.e. 0.2ml.kg-1 is recommended to provide diagnostically adequate contrast. *Angiography:* In exceptional circumstances administration of a second consecutive injection of 0.1mmol.kg-1, i.e 0.2ml.kg–1 may be justified. However, if the use of 2 consecutive doses of DOTAREM® is anticipated prior to commencing angiography, the use of 0.05 mmol.kg-1 (i.e. 0.1ml. kg-1) for each dose may be of benefit, depending on the imaging equipment available. **Paediatric population (0-18 years):** *Brain and spinal MRI, whole body MRI:* the recommended and maximum dose of Dotarem is 0.1 mmol/kg body weight. More than one dose should not be used during a scan. Due to immature renal function in neonates up to 4 weeks of age and infants up to 1 year of age, Dotarem should only be used in these patients after careful consideration, at a dose not exceeding 0.1 mmol/kg body weight, *Angiography:* The efficacy and safety of DOTAREM® in children under 18 years has not been established. **Patients with renal impairment:** The adult dose applies to patients with mild to moderate renal impairment (GFR > 30ml/min/1.73m2). Nephrogenic systemic fibrosis (NSF) has been reported with gadolinium-containing contrast agents in patients with acute or chronic severe renal impairment (GFR < 30ml/min/1.73m2). As there is a possibility that NSF may occur with DOTAREM®, it should therefore only be used in this group after careful risk/benefit assessment and if the diagnostic information is essential and not available with non-contrast enhanced MRI. If it is necessary to use DOTAREM®, the dose should not exceed 0.1 mmol.kg-1. Because of the lack of information on repeated administration, DOTAREM® injections should not be repeated unless the interval between injections is at least 7 days. **Patients with hepatic impairment:** The adult dose applies to these patients. Caution is recommended especially in the perioperative liver transplantation period. **CONTRA-INDICATIONS:** Hypersensitivity to gadoteric acid, to meglumine or to any medicinal product containing gadolinium. **SPECIAL WARNINGS AND PRECAUTIONS OF USE:** Do not use by intrathecal route. Take care to maintain strictly intravenous injection: extravasation may result in local intolerance reactions, requiring the usual local care. The usual precaution measures for MRI examination should be taken, such as exclusion of patients with pacemakers, ferromagnetic vascular clips, infusion pumps, nerve stimulators, cochlear implants, or suspected intracorporal metallic foreign bodies, particularly in the eye. **Hypersensitivity:** Hypersensitivity reactions can be either immediate (< 60 minutes) or delayed (up to 7 days), allergic or non-allergic. Anaphylactic reactions occur immediately, can be fatal and are independent of dose. There is always a risk of hypersensitivity regardless of the dose injected. Patients with hypersensitivity or previous reaction to contrast media are at increased risk of severe reaction. In these patients DOTAREM® should only be administered after careful consideration of the risk/ benefit ratio. Hypersensitivity reactions may be aggravated in asthmatic patients or those taking beta-blockers. During the examination, supervision by a physician is necessary. If hypersensitivity occurs, administration of the contrast medium must be discontinued immediately and appropriate specific therapy instituted. **Impaired renal function:** Prior to administration of DOTAREM®, it is recommended that all patients especially those above 65 years are screened for renal dysfunction by obtaining laboratory tests. Due to the risk of NSF in patients with acute or chronic severe renal impairment, administration in this group should be considered and performed as above. Haemodialysis shortly after administration may be useful in removing DOTAREM® from the body. However, there is no evidence to support the initiation of haemodialysis for prevention or treatment of NSF in patients not already undergoing haemodialysis. **CNS disorders:** Special precaution is necessary in patients with a low threshold for seizures. All equipment and drugs necessary to counter any convulsions must be readily available. **INTERACTIONS:** No interactions with other medicinal products have been observed. Formal drug interactions studies have not been carried out. **PREGNANCY AND LACTATION: Pregnancy:** There is a lack of human data on the use of gadoteric acid in pregnancy. Animal studies do not indicate direct or indirect harmful effects. Administration during pregnancy should be avoided unless absolutely necessary. **Lactation:** Gadolinium containing contrast agents are excreted into breast milk in very small amounts (see section 5.3 of the SmPC). At clinical doses, no effects on the infant are anticipated due to the small amount excreted in milk and poor absorption from the gut. Continuing or discontinuing breast feeding for a period of 24 hours after administration of DOTAREM®, should be at the discretion of the doctor and lactating mother. **UNDESIRABLE EFFECTS:** Side effects associated with use of gadoteric acid are usually mild to moderate in intensity and transient in nature. Injection site reactions, nausea and headache are the most frequently observed reactions, as well as feeling cold, hypotension, somnolence, dizziness, feeling hot, burning sensation, rash, asthenia, dysgeusia and hypertension are also common. These reactions can be immediate (within 60 minutes after injection) or delayed (within 7 days after injection). Immediate reactions include one or more effects, appearing simultaneously or sequentially, and often cutaneous, respiratory, gastrointestinal, articular and/or cardiovascular reactions. Each sign may be warning of starting shock and go very rarely to death. Isolated cases of nephrogenic systemic fibrosis (NSF) have been reported with gadoteric acid most of which were in patients co-administered with other gadolinium-containing contrast agents. Children: Safety of paediatric patients was considered in clinical trials and post-marketing studies. As compared to adult, the safety profile of gadoteric acid did not show any specificity in children. Most of reactions are gastrointestinal symptoms or signs of hypersensitivity. Please consult the SmPC in relation to other side effects. **MARKETING AUTHORISATION HOLDER:** Guerbet B.P. 57400 F-95943 Roissy CdG Cedex France. **LEGAL CATEGORY:** POM. **MARKETING AUTHORISATION NUMBERS:** PL 12308/0016 (vials); PL 12308/0017 (PFS). **LIST PRICE:** 10 x 5ml vials £272.50, 10 x 10ml vials £440.20, 10x 15ml PFS £569.10, 10 x 20ml PFS £666.50. **DATE OF REVISION OF TEXT:** March 2018.

Adverse events should be reported. Reporting forms and information can be found at www.mhra.gov.uk/yellowcard.Adverse events should also be reported to
Guerbet Laboratories Ltd. Avon House, 435 Stratford Road, Shirley, Solihull, B90 4AA. Tel: 0121 733 8542 Fax: 0121 733 3120 Email: uk.info@guerbet-group.com

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BAMRR NEWS Issue 56 SPRING 2021 Published by BAMRR
Editor: Matthew Benbow Designed by Sarah Moss Designs (style@sarahmossdesigns.co.uk)
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