| Item | Guidance | Things to consider |
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| **How to use** | **Please use this protocol in conversation with your Magnetic Resonance Safety Expert (MRSE).**<br>**Please contact your MRSE.** | **If you are the MRSE, you may find this protocol a useful prompt or to facilitate a methodical process.**<br>**An MRSE can administer this guidance themselves if they wish.** |
| **Background** | Protocols can aim to do many things, e.g. (1) SOP from radiology on how to do MRI or (2) how to manage the request including handling audiology and ENT, including audit.<br>Does your site need 1 or 2 or both? | What needs to go into the protocol will vary with site. Each site will have different relationships with other members of the multidisciplinary team.<br>This document aims to talk you through the process of writing the protocol you need. |
| **Aims** | This guidance has been compiled by sites with the highest throughput of CI patients and therefore the most experience scanning patients with CIs (e.g., MRI departments affiliated to national CI centres with paediatrics too).<br>This document aims to filter this experience down to sites with less (but still some) experience (e.g., MRI departments affiliated to CI centres).<br>**These MRI departments don't have the capacity to support all scanning of CI patients.**<br>Further aim to support other local MRI departments to scan their own CI patients. | This is not itself a protocol – no information should need updating.<br>Each site will need to make their protocol site-specific.<br>Consider the document length of your protocol. If it's too long people won't have time to read it (properly or at all).<br>Does your protocol need to cover CIs only, or CIs and ABIs?<br>This document aims to ensure that everyone is getting the key points into their documentation and give non implant centres a starting point.<br>**This document is guidance produced by the British Cochlear Implant Group MRI working group.** |
| **Referral process** | Describe the paperwork/request cards. Paperwork should include model and manufacturer OR CI centre patient is under so that this information can be verified.<br>Who completes this (radiologist? specialist in requesting area?)?<br>Electronic or paper. | Is it enough to tick a "CI" box or do you need/want more info/engagement from the requester?<br>Do you request any additional info on patient needs/surgical notes? Who is responsible for getting these (radiologist/specialist in requesting area?)? |
| **Overview of scanning decisions** | Outline the categories (but not aim to list MR conditional devices as this gets out of date) in terms of bandaging/not-bandaging, rotating magnets.<br>https://advancedbionics.com/gb/en/home/professionals/mri-safety-information.html<br>https://www.cochlear.com/us/en/professionals/resources-and-training/mri-guidelines<br>https://www.medel.com/en-gb/important-safety-information<br>https://www.oticonmedical.com/uk/for-professionals/cochlear-implant/mri-information-and-guidelines | Try to stick to facts and not generalise. Make sure it is accurate and sustainable.<br>There is no need to delay scanning patients with rotating magnets – does this expertise exist? Consider adding contact details of this expertise for staff who have not scanned a rotating magnet yet.<br>Consider listing manufacturer websites or otherwise emphasise getting the most up to date info. |

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| **Written information to patient** | Refer to a specific information sheet for patients with CIs having an MRI scan in addition to the general MRI patient information sheet. | BCIG has an information sheet: Safety and MRI \| British Cochlear Implant Group (bcig.org.uk)<br>There is also a BSL version online: https://youtu.be/cmGFdr3pmBQ?si=_JXKNxm0sqWS0NJr |
| **Consider other imaging modalities** | Has the referrer been contacted, and have they considered other imaging modalities?<br>Consider if an alternative imaging modality would be more appropriate than MRI. If no, then proceed.<br>Consider the individual patient's risk-to-benefit ratio. E.g., rotating magnet or static magnet, e.g., scan of head, lumbar spine, foot. | Consider that sometimes the referrer doesn't even know that the patient has a CI.<br>This should be worded in a way to ensure that it doesn't overly discourage MRI for patients who would benefit from it while questioning the assumption.<br>This is likely to be an assessment done on each individual patient. |
| **Outline communication routes within the MRI department** | Is there one named radiographer who scans all CI patients? Or one named person who triages?<br>Provide their contact details.<br>What is done in an emergency/out of hours?<br>Some triage will still need to be done by the out-of-hours radiographer.<br>Patients with rotating magnets can be safely scanned. | What if the key people are away? Avoid needing to contact people who are away/ill.<br>Is this system sustainable?<br>What if an urgent scan comes in?<br>Does the out-of-hours radiographer have enough information to decide which patients can be scanned immediately (e.g. rotating magnets)? |
| **Outline communication routes with other departments including the patient's CI centre** | Consider and describe the entire route from requesting clinician (in whatever department that is) to radiology to radiographer and back again.<br>Consider/describe how ENT/audiology or CI centre (as appropriate locally) is contacted.<br>Consider/describe how you contact the CI centre if they are at a different hospital.<br>Do you provide a named contact in ENT/audiology/CI centre?<br>Provide generic contact details too if available.<br>Provide emergency/out of hours contact details too. | Radiology departments need to act as the patient advocates – this might mean giving the patient the info they need to withdraw consent.<br>Remind your CI centre/referrer (as appropriate) that **no implant is MRI compatible: always conditional with conditions**.<br>Always keep diagnostic and risk-to-benefit ratio value in mind.<br>Who is responsible for ordering splint/MRI kit/antenna coil cover? Do they contact manufacturer directly or go through CI centre? To be decided by the MRI department (in consultation with the CI centre if appropriate).<br>Does a CI consultant need to be present for the scan?<br>Who does the bandaging?<br>Who does the post-scan checks?<br>Are the communication routes sustainable? |
| **Outline communication routes with CI manufacturers** | The implanting site will have contacts with the manufacturer.<br>Do you contact the manufacturer directly or go through the CI centre?<br>Provide links or contact details. Provide named individuals if appropriate but also generic contact details to increase sustainability. | Does your site have a CI centre? Does the MRI department with a CI centre liaise with the local site? Sometimes the CI manufacturer prefers individual MRI departments to liaise with the CI centre.<br>Implanting sites do not necessarily have the capacity to handle every MRI request.<br>What should happen if the patient was implanted at another site entirely (i.e., not your local CI site)? Who is responsible for contacting the patient's CI centre?<br>Who is responsible for obtaining the splint/MRI kit/antenna coil cover? |

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| **Patient screening** | Stipulate the minimum time since surgery (i.e., at least 6 weeks or 6 months): check for the implant manufacturer and model.<br>Stipulate whether (or not) to scan an unconscious patient, or one under general anaesthetic (e.g., paediatrics).<br><br>Take extra care with (sequential) bilateral CIs, and with other implants. | Do you need a separate protocol for children (under a certain age, e.g., 6 years)?<br>There is no need to delay scanning patients with rotating magnets – does this expertise exist?<br>Has the patient been offered a BSL interpreter? Who determines this and who books them?<br>Do staff have Deaf awareness training?<br>Has the patient only remembered or told you about the most recent implant? Do older implants need bandaging/attention? |
| **Site-specific decisions and information** | Which field strengths do you use?<br>Which specific scanners?<br>Photographs: what does the field line look like? What do the static spatial gradient lines look like? | Can you scan rotating magnets at 3 T?<br>Are some scanners better arranged for undocking bed/controlling static spatial gradient lines passed through? |
| **Patient arrival in MRI department** | How long before the scan is the patient asked to arrive? | What are you going to do with this time?<br>Is it necessary/useful? |
| **Briefing of patient** | Detail how to inform and take consent before removing processor.<br>This part of the protocol may need to be as complete as all subsequent sections describing procedure.<br>Warn about pain, discomfort, strange physical sensations, auditory sensations, inflammation at magnet site and consequences of this, warn that the bandaging itself is uncomfortable, explain the alarm buzzer, and explain the need to take them out of the scanner slowly even once they have pressed the buzzer.<br>Tell the patient the total duration they will be wearing the bandage.<br>Tell the patient the duration of scan.<br>Tell the patient if you will ask them to wait before replacing processor (i.e., if any checks are needed). | Does it make sense to tell the patient that their processor may not work for several hours (i.e., potentially cause undue concern)?<br>It is necessary to convey the understanding that patient experience will vary but decide to what degree to outline the “worst-case” possibilities.<br>Does the patient get sent home if their implant isn’t working properly (even just through inflammation which is expected to go down)?<br><br>Ask the patient about their communication needs during scanning. They are unlikely to be able to hear and respond over the intercom. Do they want visual/tactile communication? |
| **Preparation of patient** | Refer to manufacturer guidance as this can change – most up-to-date guidance should be checked on a per-patient basis.<br>Explicitly and unambiguously state where the procedure should deviate from manufacturer guidance, e.g., magnetic splint or hearing aid putty, “black badges” etc., tension markers on bandage, two separate bandages to achieve a whole-head bandage, surgical tape. | Who should be able to follow this procedure?<br>If someone hasn’t done it before, should they be doing it unsupervised?<br>Can people watch a video or practice it on a colleague or watch a colleague scan?<br>Who does it? Is this a named person or role? Is this sustainable? |

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| | Insert earplugs before bandaging – you don't know what level of residual hearing they have; this should not be optional.<br>Outline what it's ok for the radiographer to do, e.g., use the patient's processor to find the implanted magnet, decide to use additional bandaging because the bandage is slipping over long hair.<br>Local anaesthetic: is it offered? Is it optional? Is it allowed? Who administers and who pays?<br>Who does all this? Named radiographer? ENT/CI centre staff?<br>Risk of needing to stop may be body-area specific. Lumbar spine one of the hardest, head-first vs. feet-first, brain might be tolerated better than spine. Long scans add risk. Protocol should address each body area by risk and procedure. Consider creating a flowchart. | Pros and cons of anaesthetic: would you prefer that patient is able to feel what's going on (pain=damage)?<br><br>How does the procedure differ from normal if contrast is needed (with significant cost per scan)? Would you consider not cannulating until patient has tolerated non-contrast scans? Long scans add risk of discomfort/needing to stop. |
| **Approaching scanner** | This is site-specific and scanner specific.<br>Describe each step of the process.<br>Describe how to un-dock the bed and wheel the patient in on undocked scanner bed.<br>The shielding on new scanners is much more efficient and new scanners will have passive and active shielding on the scanner itself. This results in higher/steeper gradients at the entrance to the bore.<br>Keep motion to an absolute minimum and as slow as possible. | Does anything else site-specific or MRI manufacturer/model-specific need to go in there?<br><br>You may find it useful to refer to the BCIG guidance on magnetic fields and heating |
| **Scanning** | How to reach each of the sequences for each clinical question and implant category and scanner.<br>Keep short.<br>Scanner manufacturer and software release-specific information and terminology such as first level, ScanWise Implant.<br>Stipulate a maximum duration for scanning - keep it short for risky scans (e.g., lumbar spine 8 min all in) vs. less risky (e.g., foot 20 min all in). Consider shortening long protocols (e.g., liver keep under 30 min all in).<br>Describe where to find CI-specific sequences for each clinical question if they exist. | Do you have CI-specific sequences for e.g., lumbar spine?<br>Do you have CI-specific sequences for scanning the brain?<br>Do you want to include information on how to manually tweak a few parameters to reduce SAR or reduce sequence?<br>What if you need to scan in first level? How can you be sure SAR is low enough?<br>Think about where SAR gets high (e.g., breath holds).<br>Does a senior radiographer/named radiographer have to do this?<br>Is this sustainable?<br>You may find it useful to refer to the BCIG guidance on magnetic fields and heating |

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| **Post-scan** | Does the patient undergo examination or audiology review immediately after their scan? Do they need an x-ray to confirm magnet location? Is this done as standard or only if there is a problem? Is there a different procedure if the problem is magnet-related or hearing-related? | What if the patient feels something is wrong? What if the implant doesn't work properly? Do you send them home? Do you refer immediately to audiology? What if the scan was performed out-of-hours? |
| **Audit and follow-up including incident reporting** | Describe the audit procedure.<br>Any incidents need reporting back to the implanting department.<br>**CI centres are likely to want to be informed of the scan as matter of routine, even if done in a different hospital. Incidents must be reported.**<br>Provide the relevant contact details. Is there a template report form? | Many implant centres will want to accrue information about successful scans as well as adverse events. Contact them when setting up the document to ask.<br>Manufacturers may also want to capture this, e.g., Cochlear: https://www.surveymonkey.com/r/mri-pmcf<br>You may find it useful to refer to the BCIG guidance on adverse events |
| **Training** | Describe any training that is needed to go alongside this protocol.<br>Are there instructional videos?<br>Do members of staff sign to say they have read the protocol?<br>Are they "signed off" as competent? | Think about creating training opportunities – can staff try out your new SOP in a low-risk scenario?<br>Your local protocol should be approved by the MRSE and/or MRI safety group in your MRI department.<br>This can be supported with asking an experienced radiographer from another site/someone from CI site/manufacturer coming in and train staff. |

***Approved by the Institute of Physics and Engineering in Medicine (IPEM)***