

MRI provision for cauda equina syndrome

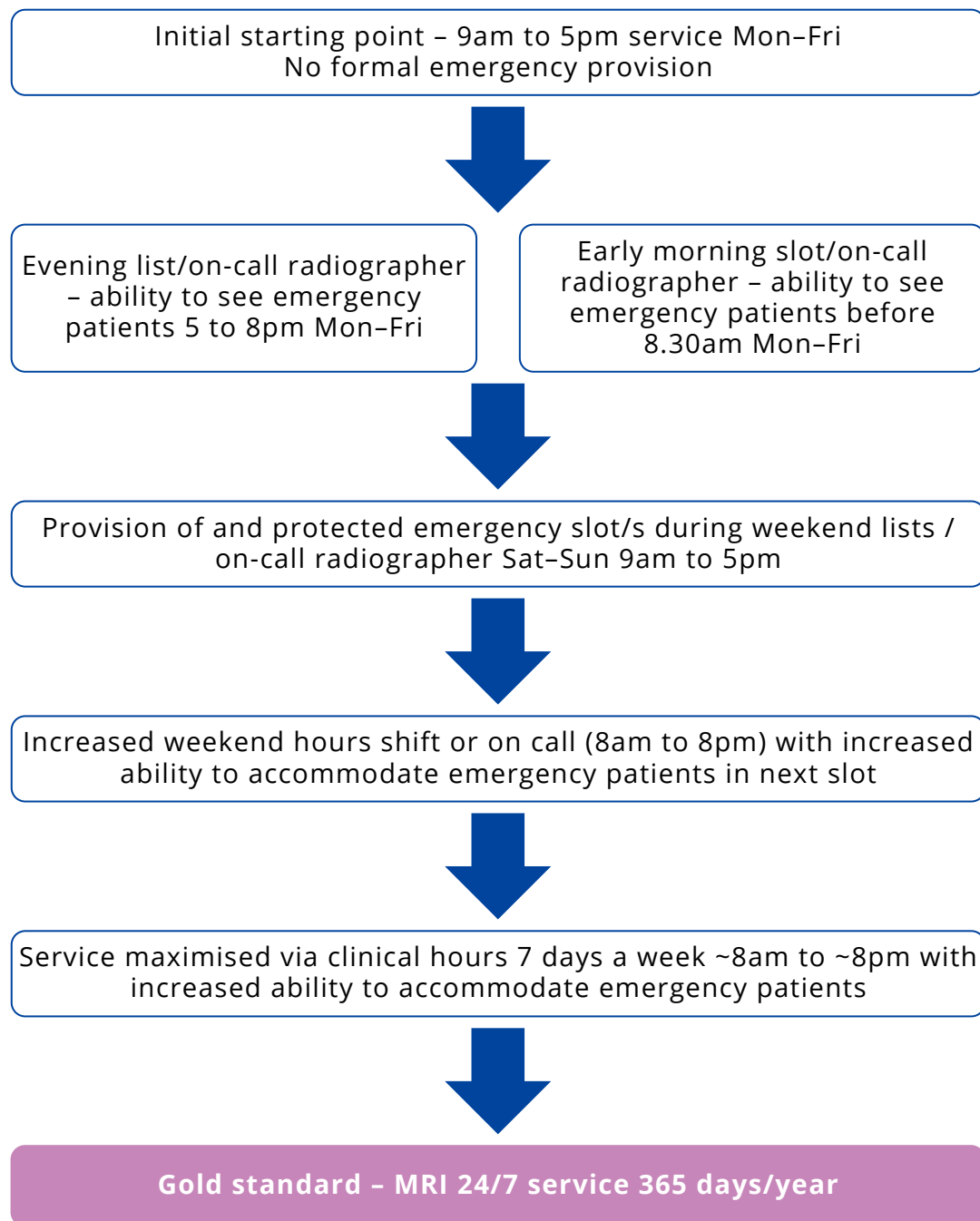
Contents

Service standards	3
MRI 24/7 service development planner	4
Introduction	5
1 Timing of imaging	6
2 Referral criteria	6
3 MRI referral	7
4 24/7 MRI access	8
5 Staffing	8
6 Radiographer training	9
7 Image transfer and reporting	9
8 MRI protocol	10
MRI protocol flow chart	10
9 Audit	11
Glossary	11
References	12
Members of the working party	14

Service standards

1. Cauda equina syndrome (CES) is a time-dependent clinical emergency and all acute imaging services supporting type 1 emergency departments (EDs) should have policies in place for managing these patients.
 2. Every acute imaging service should provide access to a 24/7 MRI imaging service for acute CES.
 3. Imaging should be undertaken urgently within four hours of request.
 4. Where an MRI service cannot be provided locally, the acute service should have a networked service agreement with other local or regional providers.
 5. However, all acute services should aim to have on-site 24/7 MRI by June 2024.
 6. Where a transfer of patients is necessary there should be protocols in place documenting the patient pathway including the decision to transfer, process for referral, agreed responsible clinical teams at both sites, protocols for imaging, communication of the final report, treatment and repatriation.
 7. The MRI scans should be undertaken by staff who are appropriately trained in MRI imaging including MRI safety.
 8. The final report should be issued by an appropriately trained professional within one hour of the MRI scan.
-

MRI 24/7 service development planner



Introduction

CES is a rare diagnostic and surgical emergency, caused by sudden narrowing of the lumbar spinal canal, usually as a result of an acutely prolapsed intervertebral disc, and requires urgent specialist decompression.

It is a very uncommon cause of pain in the patient presenting in the ED, with an estimated population incidence of 1–1.9 per 100,000.¹

If this condition is not managed in a timely and efficient manner it can lead to severe and permanent disability including irreversible paralysis and loss of bladder, bowel and sexual function. The difficulty is in accurately making the diagnosis. The recognised features of CES include bilateral sciatica, progressive neurological deficit, difficulty in initiating micturition or impaired sensation of urinary retention with overflow, a sensation of rectal fullness, faecal incontinence, anaesthesia of the anal sphincter and loss of sexual function. CES may present with any or many of these symptoms. There is no single feature that is reliable to aid or confirm diagnosis of CES as these symptoms have limited specificity. The correlation of clinical findings with MRI is poor,² but MRI is the gold standard diagnostic study to help rapidly exclude the diagnosis. The Healthcare Safety Investigation Branch (HSIB) has recently identified CES as a major patient safety issue and made recommendations to improve safety including access to urgent MRI.³ It is also worth considering the implications of CES due to malignant causes as symptoms of malignant spinal cord compression (MSCC) can be similar, and there is established guidance on imaging and treatment for MSCC.⁴

It is difficult to exclude CES on clinical symptoms alone. The recent guidance published by Getting It Right First Time (GIRFT)⁵ on spinal disease and CES indicated that there should be availability of MR scanning for these patients on a 24/7 basis. This is also recommended in the GIRFT specialty report on emergency medicine.⁶ This is supported by the work of the Society of British Neurological Surgeons and the British Association of Spinal Surgeons,⁷ which recognises the role that MRI has in the diagnosis of CES and states that it should be available 24/7 in referring hospitals. The decision to undertake an MRI scan in a patient suspected of having CES has also been indicated as not requiring discussion with a spinal surgeon.⁷ This presents major logistical issues.

Currently, there are around 170 major (type 1) EDs in England, which are located within around 130 acute trusts, with some NHS trusts being responsible for two or more EDs. (A type 1 ED is defined as 'a consultant-led 24-hour service with full resuscitation facilities'.⁶)

We know from the recent GIRFT report that not all of these trusts have the ability to perform 24/7 MRI scanning.⁵ This has often resulted in patients being treated and transferred between organisations, often late at night for an urgent diagnostic study. This has implications such as the cost and inconvenience of moving patients, additional burden on centres that are offering a 24/7 MRI service, possible delays to patient pathways and additional complications if the patient has an implant as the scanning hospital will not have access to previous notes and imaging. Emergency MRI should be available on-site in all acute hospitals dealing with these patients by a target date of June 2024. Where a local service is unable to provide this service then there should be an agreed networked service with local providers and clear protocols should be in place, bearing in mind the pressures on the ambulance service. These should detail the journey from diagnosis, procedures for referral, safe transfer including pain relief, issuing of the urgent report, treatment and repatriation of the patient.

Given the urgency to make the diagnosis, and the potential life-changing consequences of missing the diagnosis, these guidelines are designed to support and encourage all trusts that may see patients with cauda equina (CE) compression, particularly those with a type 1 ED to support that department with the provision of MRI scanning, aiming towards a 24/7 delivery of an urgent MRI service. This would allow rapid decision-making and appropriate treatments and minimise bed blocking.

This work has been undertaken for the Clinical Imaging Board by The Royal College of Radiologists (RCR), Society and College of Radiographers (SCoR), Institute of Physics and Engineering in Medicine (IPEM), British Society of Skeletal Radiologists (BSSR) and British Society of Neuroradiologists (BSNR) and represents a pragmatic approach to the delivery of an MRI service, trying to avoid the necessity of moving patients between adjacent trusts.

This guidance looks at the provision of a safe MR scanning service, aiming towards local delivery of a 24/7 urgent MRI service. It offers methods to try to maximise the service that can be provided within the restrictions on radiographic staffing numbers and suggestions on the sequences that should be performed to minimise the time within the scanner.

This work is reminiscent of the introduction of CT scanning 30 years ago and forms the basis of the delivery of a 24/7 emergency MR scanning service to support EDs within the UK and improve patient care. All trusts should aim to have on-site 24/7 MRI by June 2024.

1 Timing of imaging

The timing of imaging examinations in CES is still contentious. Emergency out-of-hours imaging requests should only occur if there is a plan for immediate surgery. In light of the urgency of diagnosis, following receipt of the request, imaging should be undertaken as soon as is practicable in the next MRI slot within four hours of request. This will be aided by having daily dedicated emergency MRI imaging slots. From animal studies it is clear that after six hours complete neural ischaemia is irreversible. However, it is recognised that this timeframe is difficult to achieve in patient care.⁸

For a significant minority of patients there is irreversible neurological deficit at presentation, but it is not easy to identify this subset.⁹ For the typical CE-related problems such as incontinence there is controversy over whether the outcome is better for patients operated on within 24 or 48 hours.^{9,10} There is agreement that the outcome is poorer after 48 hours⁹ and surgery should be undertaken quickly after diagnosis.

Persistent pain seems to be more prevalent and severe with growing time to surgery.¹¹ There is also correlation of delayed surgery with delayed discharge and death; however, confounding factors were not excluded, and this could be due to underlying health issues causing delay in surgery in the first place.⁹ The position statement of the Royal College of Emergency Medicine¹ highlights the need for local policies and access to urgent 24/7 MR imaging.

2 Referral criteria

It is recommended that each MRI service has a standard operating procedure (SOP) to ensure that the full process for an on-call/out-of-hours service is documented, agreed and shared widely with referrers, wards and EDs as well as the relevant staff in the radiology department. It is recommended that the SOP includes the following.

- Agreement on which examinations can be referred for on-call MRI – is it limited to CES spines?
- Strict referral criteria set out in accordance with the GIRFT national pathway,¹² including who can refer (including seniority and specialty), who can accept/justify and protocol and accepted clinical indications including the need for bladder assessment in the emergency department prior to MRI.
- Process for patients who are unable to have their scan due to safety queries or who are contraindicated.

3 MRI referral

To ensure there are no delays in the MRI scan, the patient should arrive at the MRI department with all necessary information to ensure radiology staff can satisfy themselves that the patient is safe to be scanned. They must also have the appropriate pain relief and escort in place. To enable this, the following must be completed.

MRI safety checks

The patient should arrive in the MRI department with all necessary information to allow a final MR safety check to take place. The MRI department should be informed about all previous surgeries, implants and metallic foreign bodies that the patient has at the earliest opportunity so that the safety of these can be established.¹³ Sites may have local policies for scanning urgent and emergency patients, and the referring team should be made aware of these and ensure they are followed.

The MRI department should have a procedure in place to establish patient safety when the patient is unable to complete their own safety questionnaire.¹³

The MRI radiographers must have sufficient training and expertise in MRI safety to allow them to investigate implants and establish whether they are MR safe, MR unsafe or MR conditional to scan. The radiographer should be competent in adapting scan parameters to meet the conditions of any MR conditional implants. This is particularly important when on call or out of hours, where there may not be physicists or other senior radiographers to consult about implant safety. Where there is any doubt about patient safety (for example, when scanning a patient with MR unlabelled implants or off-label scanning) the radiographer should follow the local SOP for scanning patients with implants where MRI may be contraindicated. As per MHRA guidelines¹³ this might involve a discussion with the relevant consultant radiologist and/or MRI safety expert. It may be necessary to delay a scan until the relevant expertise is available for more complex safety requirements, and this process must be documented in the local SOP. Established local safety protocols for evaluating and scanning implants, which can be followed when expertise is not available, would facilitate access to MRI out of hours and 24/7 scanning.

Where an MRI department is not set up to scan particular implants (for example pacemakers, neurostimulators, infusion pumps) it is advisable that agreements are in place with another local site that is able to perform the scan. Departments that provide the services for these more complex implants may not be able to provide this service out of hours due to the availability of other departments such as a cardiology clinic. The Clinical Imaging Board has previously released a statement that 'patients with cardiac devices should no longer be disadvantaged and have the same access to MRI scanning in the NHS as everyone else'.¹⁴ Separate guidance on scanning active cardiac devices has been published.¹⁵

Where a patient has a contraindication to MRI (for example an MR unsafe implant) then the hospital should have a local policy for managing these patients without an MRI scan. Computed tomography (CT) or CT myelography if available should be considered as a contingency imaging strategy.^{16,17} However, compared with MRI this has poor soft-tissue contrast and might not reveal disc protrusions in older patients with degenerative spinal conditions and can make the images non-diagnostic.

MR procedures may be used for pregnant patients after critical risk–benefit analysis, following review of local policies and the safety advice contained in the MHRA guidelines to minimise the risk to the patient and the fetus.¹³

Pain relief

The patient must keep still for the duration of the MRI scan to enable diagnostic images to be obtained. Any pain relief that the patient requires to help them keep still during the scan must have been organised before the patient arrives at the MRI department and there must be a member of the clinical team present to administer this and monitor the patient.

Additional staffing

It is important to ensure that appropriate levels of staffing are available, particularly outside of normal MRI scanning hours. The referring or local responsible clinical team should identify patients who require additional support (for example log roll) at the point of referral to avoid delays to the scan. All staff who attend the MRI department to assist with patients should be at least verbally screened for implants before entering the MRI controlled access area, in line with the MRI local rules and the MHRA MRI guidelines.¹³ All supporting staff must be informed of the risks of entering the MR environment (scan room) and should not enter unless they have been cleared to do so by an authorised member of the MRI team and have completed the relevant MRI safety screening form.

4 24/7 MRI access

There is no guidance nationally on requirements for or experience in the setting up of an MRI on-call service.

A gap analysis should be undertaken that includes a plan to progress from whichever level of service the department is providing currently to the provision of a 24/7 service. In the first instance there should be protected daily slots to scan patients with suspected CES or other emergency scans. See the MRI 24/7 suggested service development planner on page 4.

5 Staffing

The minimum staffing required for the provision of an MRI on-call scan is a radiographer who is both an MRI authorised person (supervisor) and an MR operator (as per the definitions in the MHRA safety guidelines for MRI).¹³ This enables the radiographer to both supervise a non-authorised person in the MR environment and operate the MRI equipment. The radiographer must have enough experience to independently deal with complex cases, emergency situations and safety queries and perform MRI examinations of the spine. The radiographer should not be left on their own at any time with the patient. For the examination to start, a second person must be present. Who this is will need to be agreed locally, but possible options are:

- On-call radiologist
- Second radiographer – can be two on call for MRI or someone from a different modality
- Escort staff from the referring ward/department.

If contrast or other medication is required then the radiographer must follow local policy to check the medication details.¹⁸

If the second person is not MRI authorised then MRI safety training must be given. What this includes and how it is documented should be in the local department SOP. As a minimum requirement, this training should include the hazards associated with the magnet room, restrictions on access and what to do in an emergency situation (clinical and non-clinical).

Consider whether other radiographers who are working within the department who already provide an on-call or out-of-hours service can be trained to complete an MRI spine examination.¹⁹ If this occurs then provision for ensuring adequate training and maintaining competency must be documented. Their training and experience also need to include the ability to deal with emergency procedures and safety queries as well as scanning competencies as per section 6.

6 Radiographer training

All radiographers who undertake MRI scanning, whether in or out of hours, must complete a local training programme. This must include the use of equipment, the hazards associated with MRI and actions to take in a medical and non-medical emergency and must fulfil the training requirements for category A personnel (MR operators) as defined by the MHRA.¹³

If the second person present is not an MR authorised person with independent access to the MR environment (scan room) then their training requirements must be understood, completed and documented by the on-call MRI radiographer (see section 5).

Wider staff training

It is important to communicate with referrers and non-MRI staff who may be involved in out-of-hours services and ensure that they too have an understanding of MRI risk and hazards, as it is the responsibility of the referrer to identify those patients with implants and/or contraindications to MRI.

7 Image transfer and reporting

Images should be easily and rapidly accessible to the clinical teams across the network for review, decision-making and reporting. The reporting of these examinations needs to be clearly defined in the SOP, using on-call local radiologists, networks²⁰ or a reporting radiographer of an appropriate competence to sign off the examination; or where no local service is provided, clear local protocols with outsourcing reporting companies need to be established. This will allow a rapid 24/7 production of the report, which should be made available to the referring clinician within one hour.

8 MRI protocol

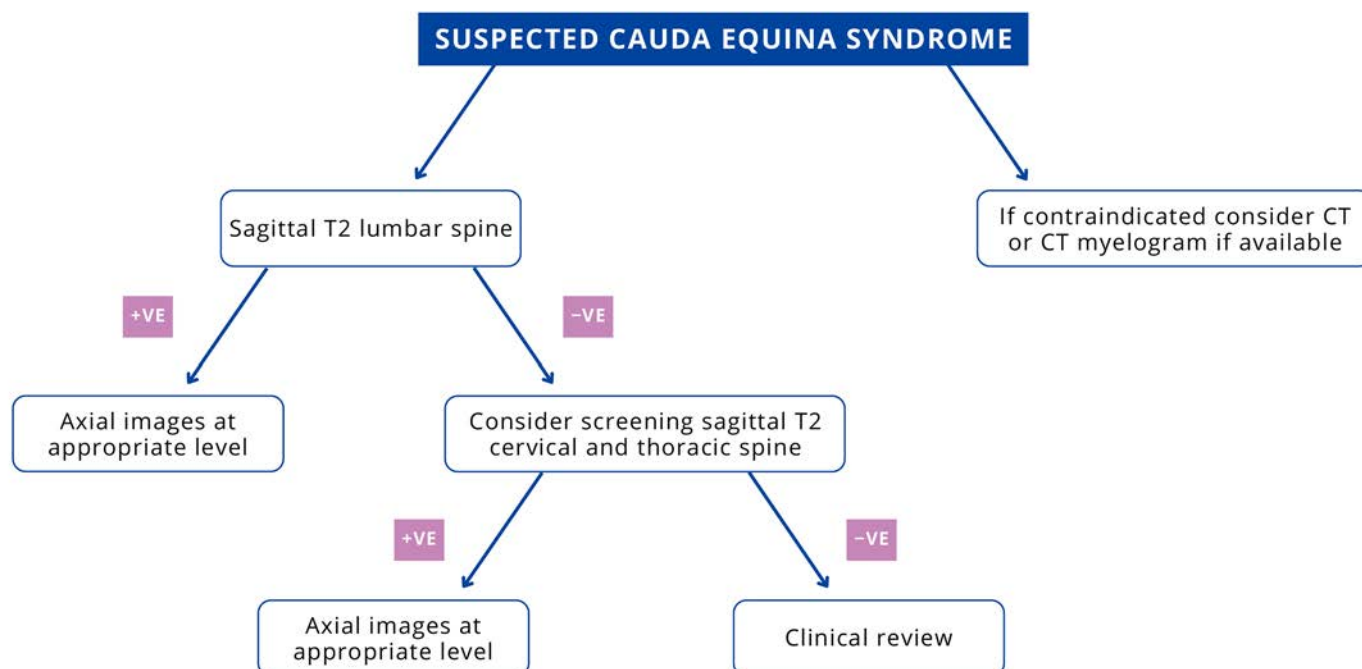
A sagittal T2 weighted sequence is the single MRI sequence needed to screen for and demonstrate CE compression,^{21,22} and therefore to make the decision to intervene surgically. The 24/7 CES MRI screening protocol should prioritise this sequence. This is typically a 2D turbo spin echo sequence.

There is indication in the literature that a limited emergency MRI protocol is effective for safely excluding compressive CES.²³ Further imaging within the scan session should not be required for screening purposes. However, when the presence of CE compression is identified, additional images are often required before surgery, for example axial T2 weighted and sagittal T1 weighted sequences. Centres should also consider covering the entire spine when the radiographers cannot identify CES on the T2 sagittal sequence. This may be in the form of a single T2 sagittal sequence covering the cervical and thoracic spine.

The scan duration should be kept to a minimum, as patients are in pain and might move considerably during acquisition. It is advisable to prioritise the T2 sagittal sequence and have a CES MRI protocol with shorter sequences stored for patients who are unable to tolerate lying still for the standard scan.

It is also advisable to have a low specific absorption rate (SAR) protocol set up to reduce SAR levels for those patients with MR conditional implants, and a metal artifact reduction protocol set up to reduce the artifact from any metal within the imaged area.

MRI protocol flow chart



9 Audit

An audit should be undertaken on provision of out-of-hours MRI looking at the current gap, challenges and progression towards a 24/7 service.

Glossary

MR conditional	An item with demonstrated safety in the MR environment within defined conditions. At a minimum, address the conditions of the static magnetic field, the switched gradient magnetic field and the radiofrequency fields. Additional conditions, including specific configurations of the item, may be required.
MR unsafe	An item that poses unacceptable risks to the patient, medical staff or other persons within the MR environment.
MR safe	An item that poses no known hazards from exposure to any MR environment.
MR unlabelled	An item without an MR safe, MR conditional or MR unsafe label.
MR environment	The 3D volume of space surrounding the MR magnet that contains both the Faraday shielded volume and the 0.5 mT field contour. This volume is the region in which an item might pose a hazard from exposure to the electromagnetic fields produced by the MR equipment and accessories.
SAR	Specific absorption rate. The rate at which radiofrequency energy is absorbed by the patient per kg.
T1 or T2 weighted images	Types of MRI images that result in different tissue contrast.

References

1. The Royal College of Emergency Medicine. Cauda equina syndrome position statement. 25 February 2020. https://rcem.ac.uk/wp-content/uploads/2021/10/Cauda_Equina_position_statement_Feb20.pdf
 2. Dionne N, Adefolarin A, Kunzelman D et al. What is the diagnostic accuracy of red flags related to cauda equine syndrome (CES) when compared to magnetic resonance imaging (MRI)? A systematic review. *Musculoskelet Sci Pract* 2019; **42**: 125–133.
 3. HSIB Cauda Equina investigation www.hsib.org.uk/investigations-and-reports/timely-detection-and-treatment-of-spinal-nerve-compression-cauda-equina-syndrome-in-patients-with-back-pain/
 4. West of Scotland Cancer Network. West of Scotland guidelines for malignant spinal cord compression. 2018. www.woscan.scot.nhs.uk/wp-content/uploads/2013/08/Final-Published-WoS-Guidelines-for-Malignant-Spinal-Cord-Compression-v2.0.pdf
 5. Hutton M. *Spinal services. GIRFT Programme national specialty report. Getting It Right First Time*, 2019. <https://gettingitrightfirsttime.co.uk/wp-content/uploads/2019/01/Spinal-Services-Report-Mar19-L1.pdf>
 6. Moulton C, Mann C. *Emergency Medicine. GIRFT Programme national specialty report. Getting It Right First Time*, 2021. www.gettingitrightfirsttime.co.uk/medical-specialties/emergency-medicine/
 7. Society of British Neurological Surgeons and British Association of Spine Surgeons. Standards of care for investigation and management of cauda equina syndrome. December 2018. www.sbns.org.uk/index.php/policies-and-publications/
 8. Gardner A, Gardner E, Morley T. Cauda equina syndrome: a review of the current clinical and medico-legal position. *Eur Spine J* 2011 May; **20**(5): 690–697.
 9. Hogan WB, Kuris EO, Durand WM, Eltorai AEM, Daniels AH. Timing of surgical decompression for cauda equina syndrome. *World Neurosurg* 2019; **132**: e732–e738.
 10. Heyes G, Jones M, Verzin E, McLorinan G, Darwish N, Eames N. Influence of timing of surgery on cauda equina syndrome: outcomes at a national spinal centre. *J Orthop* March 2018; **15**(1): 210–215.
 11. Shapiro S. Cauda equina syndrome secondary to lumbar disc herniation. *Neurosurgery* 1993; **8**: 317–322.
 12. GIRFT Suspected Cauda Equina Syndrome pathway 2023.
 13. MHRA. *Safety guidelines for magnetic resonance imaging equipment in clinical use*. February 2021. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/476931/MRI_guidance_2015_-_4-02d1.pdf
 14. MRI for patients with pacemakers and implantable cardioverter-defibrillators – MRI conditional and legacy devices. Joint letter from the British Cardiovascular Society and the Clinical Imaging Board. www.rcr.ac.uk/sites/default/files/2018_letter_rcr_bcs_mri_for_pacemaker_patients_corrected.pdf
-

15. Bhuva A, Charles-Edwards G, Ashmore J et al. Joint British Society consensus recommendations for magnetic resonance imaging for patients with cardiac implantable electronic devices. *Heart* 14 September 2022. Online ahead of print doi: 10.1136/heartjnl-2022-320810.
16. Cohen MS, Wall EJ, Kerber CW, Abitbol JJ, Garfin SR. The anatomy of the cauda equina on CT scans and MRI. *J Bone Joint Surg Br* 1991; **73**(3): 381–384.
17. Peacock JG, Timpone VM. Doing more with less: diagnostic accuracy of CT in suspected cauda equina syndrome. *AJNR Am J Neuroradiol* 2017; **38**(2): 391–397.
18. Royal Pharmaceutical Society. *Professional guidance on the administration of medicines in healthcare settings*. 2019. www.rpharms.com/Portals/0/RPS%20document%20library/Open%20access/Professional%20standards/SSHM%20and%20Admin/Admin%20of%20Meds%20prof%20guidance.pdf?ver=2019-01-23-145026-567
19. Hauptfleisch J, Meagher TM, King D, López de Heredia L, Hughes RJ. Out-of-hours MRI provision in the UK and models of service delivery. *Clin Radiol* 2013 May; **68**(5): e245–8.
20. The Royal College of Radiologists. *Radiology reporting networks: understanding the technical solution*. The Royal College of Radiologists, 2022.
21. Krishnam MS, Curtis J (eds). *Emergency radiology*. Cambridge University Press, 2009: 157–158.
22. McNamee J, Flynn P, O’Leary S, Love M, Kelly B. Imaging in cauda equina syndrome: a pictorial review. *Ulster Med J* 2013; **82**(2): 100–108.
23. Gnanasekaran R, Beresford-Cleary N, Aboelmagd T et al. Limited sequence MRI to improve standards of care for suspected cauda equina syndrome. *Bone Joint J* 2020; **102-B**(4): 501–505.

Members of the working party

British Society of Neuroradiologists (BSNR):	Dr David Summers
British Society of Skeletal Radiologists (BSSR):	Dr Bernhard Tins
Institute of Physics and Engineering in Medicine (IPEM):	Sarah Prescott Marco Borri
The Royal College of Radiologists (RCR):	Dr Raman Uberoi Professor Mark Callaway
Society of Radiographers (SoR):	Helen Estall Rachel Watt






The Royal College of Radiologists. *MRI provision for cauda equina syndrome*. London: The Royal College of Radiologists, 2023.

© The Royal College of Radiologists, February 2023.

The Royal College of Radiologists
63 Lincoln's Inn Fields
London WC2A 3JW

+44 (0)20 7405 1282
enquiries@rcr.ac.uk
www.rcr.ac.uk
 @RCRadiologists

The Royal College of Radiologists is a Charity registered with the Charity Commission No. 211540.

This material has been produced by The Royal College of Radiologists (RCR) for use internally within the specialties of clinical oncology and clinical radiology in the United Kingdom. It is provided for use by appropriately qualified professionals, and the making of any decision regarding the applicability and suitability of the material in any particular circumstance is subject to the user's professional judgement.

While every reasonable care has been taken to ensure the accuracy of the material, RCR cannot accept any responsibility for any action taken, or not taken, on the basis of it. As publisher, RCR shall not be liable to any person for any loss or damage, which may arise from the use of any of the material. The RCR does not exclude or limit liability for death or personal injury to the extent only that the same arises as a result of the negligence of RCR, its employees, Officers, members and Fellows, or any other person contributing to the formulation of the material.

