

INDEPENDENT EXPERT REPORT ON NEUROSURGERY FOR THE ELJAMEL INQUIRY

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Private and Confidential

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STATEMENT OF FACT

As a result of our neurosurgical training, participation in Continuous Professional Development (CPD), regional, national and international roles we have prior knowledge and acquaintance with Mr Sam Eljamel. None of the expert witnesses consider that this raises a conflict of interest which undermines the independence of our review in connection with the work of the Inquiry. None of us have any relevant connection with or interest connected to NHS Tayside, the Scottish Executive or Government, Mr Eljamel, Fernbrae Hospital, Dundee, Circle Healthcare or any other body named in the Inquiry's Terms of Reference.

In this report we have added some explanatory comments within [...] parentheses and footnotes.

BACKGROUND

Our overriding duty is to assist the Inquiry and provide an unbiased opinion as independent experts in relation to those matters that are within our expertise.

We have been instructed to focus upon the time between the period leading up to Mr Eljamel's appointment as an employee of NHS Tayside on 9 October 1995 and the date of his voluntary erasure from the General Medical Council's medical register in 2015 ("the relevant period") subject to the nature of the questions being posed possibly relating to other periods of time. We have been asked to include matters that fall outside of the relevant period if they are relevant to matters raised in our instructions and relevant to the Inquiry's Terms of Reference.

We have been instructed to identify, explain and describe any principles or practices which have changed significantly over time, including from today's perspective, in order to assist the Inquiry's forward-looking function.

- a) We confirm that we provide our report as independent experts, that we understand that duty and that we comply with that duty in the compilation of the report;
- b) We understand and comply with our overriding duty to assist the Chair on matters within our expertise;
- c) We have set out the substance of all facts, materials and instructions which are material to the opinions expressed. We have made clear which of the facts stated are within our knowledge, which are not and to the extent that such facts are within our knowledge, we certify them to be true;
- d) We give details of any literature or other material upon which we have relied in the compilation of our report in footnotes;
- e) Where there is a range of opinion in the professional community on any matter dealt with in the report we (a) summarise the range of those opinions and (b) give reasons for the opinion or opinion reached by us;
- f) We provide a summary of our conclusions;
- g) Where we are not able to give an opinion without qualification, we state the qualification to any opinion or conclusion provided;
- h) We confirm that the opinions we have expressed represent our true and complete professional opinions on the matters to which they refer; and
- i) We confirm that the details of our report are confidential and that they have not been shared with, nor any advice or guidance sought, from individuals beyond the membership of the group who have not first been approved by

the Inquiry.

Summary

The report is divided into 5 sections. All authors have reviewed and contributed to all sections.

Section A describes the experience of the authors and appends precis CVs. Our approach to writing the report is described.

Section B describes the emergence of neurosurgery as a specialty and the development of areas of subspecialisation within neurosurgery. The interface of neurosurgery with other specialities is outlined. Specific information is provided on a large range of spinal and cranial conditions and the surgical procedures used to treat these pathological conditions in the elective and emergency setting.

Section C describes the pathways for qualification as a neurosurgeon. The consultant appointment process is reviewed. The place of induction to neurosurgical appointments, and the responsibilities of the consultant with respect to training and allocation of work to trainees are discussed. The responsibilities of a consultant neurosurgeon regarding continuous professional development and professionalism are reviewed. Expected interactions between a neurosurgical service and governmental, collegiate and educational bodies are discussed. Consideration is given to the circumstances and logistics of a consultant being placed under clinical supervision or suspended from practice.

Section D considers multiple aspects of neurosurgical practice including roles, responsibilities, working patterns and workload. The many facets of professional responsibilities covering the four domains defined by the General Medical Council (GMC) are described: (i) knowledge, skills and development; (ii) patients, partnership and communication; (iii) colleagues, culture and safety; and (iv) trust and professionalism.¹ [ELJ0001-00052]

Section E considers limitations in preparing this report and considers other matters that may be relevant to the Inquiry.

¹ GMC Publication: Good Medical Practice 2024. The GMC has an archive of editions of Good Medical Practice that were operative during the relevant period. These are referred to in this report.

Part A – your qualifications and background and approach to the report.

1. Please set out details of your qualifications, including your professional and/or academic experience. Please exhibit professional CVs with your report.

1.1. Précis CVs are provided in Appendix 1.

2. Please set out in the report how you have gone about compiling it, including which sections have been allocated to each of the members of the expert group (if applicable) and why.

2.1. The Experts met and discussed their approach to the report. Given the timeframes, we considered that each expert would be nominated as lead author for several individually numbered sections of the report and should compile the initial draft for the allocated sections. The Experts shared drafts providing opportunities for experts to review and where relevant amend or add to the content. Consensus meetings were held to finalise content that all three experts agree upon and approve.

2.2. Allocations were based on individual expert experience. None of the experts specialise in “functional” surgery although all have general knowledge of this subject area. Patients with “functional” neurosurgical conditions can present as emergency or urgent on-call referrals: all experts have participated in the delivery of emergency and on-call services.

2.3. Mr Redfern was a Consultant at the time of Mr Eljamel’s appointment in 1995 and led on sections 3 to 7, 21 to 28 and 31 to 33. His practice was a wide-ranging general practice.

2.4. Mr Wigfield, who mainly has a spinal based practice, led on sections 8 to 12, 30, 36 to 39, and 42.

2.5. Professor Whitfield, who commenced as a consultant with a general cranial and spinal practice and now has a mainly cranial based practice, led on sections 2, 13 to 20, 29, 34, 35, 40, 41, 43 and 44.

2.6. Sections 1, 18-20 and 45-48 were compiled by all experts.

Part B – General

Neurosurgical practice

3. Please provide a brief history of the emergence of neurosurgery as a medical discipline in the period leading up to the relevant period.

3.1. During the 1980s neurosurgical subspecialisation was burgeoning. Thus, particularly in larger departments - in Scotland these would have been in Glasgow and in Edinburgh - neurosurgeons were developing subspecialty expertise, in addition to their general caseload. This would include such surgical activity as neuro-vascular, skull base, paediatric, and functional neurosurgery. Additionally, whilst various spinal conditions already fell largely within the province of neurosurgery, there was an increasing tendency for acute spinal conditions to be 'taken over' by neurosurgery. For example, lumbar CES (cauda equina syndrome) became regarded as being a condition to be managed by neurosurgery or by a specialist spinal orthopaedic service, and no longer by orthopaedic surgeons without specific spinal expertise. Likewise, the management of spinal infections and spinal tumours now fell exclusively within the province of neurosurgery or fellowship-trained spinal surgeons with expertise in spinal reconstruction and stabilisation.

3.2. This trend continued into the 1990s but consultants in smaller units would have continued to undertake the broad range of neurosurgical procedures.

3.3. Over the same period (ie from the 1990s) there were significant advances in neuroradiology, with CT becoming more sophisticated, and with most units now having their own MRI scanner on site. Additionally, myelography was being replaced by CT myelography and, subsequently, by MRI. Myelography is an invasive technique which involves the subarachnoid injection of a water-soluble*, radio-opaque contrast medium (such as Iohexol (Omnipaque)) which would provide an outline of the spinal cord and spinal nerves, interpretation of which facilitated diagnosis. MRI scanning, on the other hand, provides a more direct and anatomically-sensitive depiction of these neural structures thus enabling a much more sophisticated anatomical / pathological diagnosis to be established. MRI also

has the additional advantage of being non-invasive so that it can be much more readily utilised, although caution has to be taken in the presence of ferro-magnetic implants (which has led to the transition to the use of titanium rather than stainless steel for this purpose) and with cardiac pacemakers. [*Historically contrast agents (most notably Myodil) were oil-based and thus some remained permanently within the CSF pathways, even when the neuro-radiologist had attempted to aspirate the agent from the dependent part of the CSF pathway following the investigation. This could lead, in some cases, to chronic inflammation and scarring of the arachnoid membrane ('arachnoiditis') with significant adverse sequelae. In the late 1980s the use of oil-based agents was finally abandoned and thereafter water-soluble agents were employed exclusively. However, many patients who had been harmed following the use of Myodil in the transition period (between recognition of the adverse effects and its ultimate withdrawal from use) successfully sued for negligence]. The benefits of the newer radiological techniques were predominantly reduction in side effects for patients and a much greater speed and accuracy of diagnosis for clinicians. This resulted in significant improvement in outcomes both in terms of efficacy of treatments with known benefits (by better anatomical localisation of surgical procedures) and in the avoidance of futile surgical exploration in those cases in which, hitherto, diagnostic uncertainty would have been present pre-operatively.

3.4. In the operating theatre stereotactic neurosurgery was being increasingly utilised. This is a minimally-invasive type of neurosurgery which uses 3D imaging via MRI or CT scanning to help guide the surgeon towards deep areas of the brain. Functional neurosurgery had relied upon stereotactic techniques (utilising ventriculography) since the 1950s but CT scanning now facilitated the use of external apparatus (such as the Leksell or CRW frames) for image-guided targeting for biopsy, tumour resection and other procedures, using Cartesian coordinates. In the late 1990s frameless stereotaxy brought about another dramatic change in neurosurgical practice. This was particularly relevant in tumour practice but when applied in functional neurosurgery still required *physiological* as well as *anatomical* targeting. Frameless stereotaxy (neuronavigation) is, in essence, a computer-assisted, image-guided surgical technology that acts as a "GPS" for the central nervous system. Unlike the earlier stereotactic systems which it replaced it obviates the need for a cumbersome frame to be attached to the patient, relying instead upon tracking a surgeon's instruments in real-time and

overlaying their exact position onto the patient's pre-operative MRI or CT scans on a monitor. This significant change in practice would enable techniques that were previously undertaken free-hand and often based on empirical external landmarks to be undertaken with much greater accuracy and thus reduced risk of a 'target' being missed. So, for example, the historical practice of placement of a rigid cannula within the third ventricle by estimation of the position of the entry point 2.0 to 2.5 cm lateral to the midline and 1.0 cm anterior to the coronal suture to achieve a steep, blind vertical trajectory into the third ventricle at a depth of approximately 9.0 cm. This could now be achieved with a much greater degree of accuracy and safety using a neuronavigation technique. There would be for all surgeons, and also for the theatre staff, a learning curve to be negotiated with the application of this technique. However, once established it would then become routine practice and could be applied generically to many neuro-surgical procedures. The significant clinical benefits—specifically regarding patient safety, diagnostic yield in biopsy collection, and navigational precision when accessing deep brain structures—are self-evident.

4. What are the main categories of neurosurgical practice in which a neurosurgeon might practice or specialise?

4.1. At the time in question the main areas of subspecialisation would have been neuro-vascular, neuro-oncology, skull base (and pituitary surgery), paediatric neurosurgery, spinal neuro-surgery, and functional / pain. Several of these specialities would have involved close working relationships with other disciplines.

4.1.1. **Neurovascular surgery** involves management of conditions predominantly involving blood vessels such as (a) aneurysms (pathological balloon-like abnormalities of cerebral arteries which may rupture and bleed); (b) AVMs (arterio-venous malformations – abnormal collections of blood vessels in which high-pressure arterial blood enters veins with risk of bleeding or, in the 'shunt phenomenon', blood is diverted away from other areas of the brain with adverse neurological consequences); and (c) strokes, the result either from intracerebral haemorrhage or from cerebral ischaemia (reduction of cerebral blood flow resulting from, for example, disease of the carotid or vertebral arteries).

- 4.1.2. **Neuro-oncology** involves the management of benign or malignant tumours of the nervous system, often involving a multi-disciplinary approach with neuro-oncologists (cancer specialists with expertise in disorders of the nervous system) and radiotherapists.
- 4.1.3. **Skull base** surgery involves management of tumours and other conditions in and around the base of the skull which can present particular technical challenges because of complex anatomical relationships and may thus also involve collaboration with other specialties such as ENT, maxillo-facial or plastic and reconstructive surgeons.
- 4.1.4. **Pituitary surgery** is concerned specifically with pathology affecting the pituitary gland which is located at the base of the skull behind the eyes and at the roof of the nose. The conditions involved are predominantly tumours but occasionally also inflammatory disease may be encountered. Because of the hormonal function of the pituitary gland, and the close proximity of tumours in this region to the optic chiasm, this sub-specialty is routinely managed from a combined clinic with an endocrinologist, supported by ophthalmological assessment (especially for monitoring of visual fields and acuity).
- 4.1.5. **Paediatric neurosurgery** involves the management of all those conditions which can affect children as well as adults, but also many complex congenital abnormalities (congenital means present from birth) including spinal and cranial developmental defects (e.g. spina bifida, cranial synostosis (abnormalities of the cranial vault development), hydrocephalus, and some rare tumours which present early in life). These surgeons may thus also work in collaboration with other specialties, for example with maxillo-facial surgeons (in the management of synostosis). They will also require particular communication skills for handling the emotional consequences for the relatives of children suffering from serious illness. In addition, they work in close collaboration with paediatric-trained anaesthetists because of the particular complexity of the management of the airway, circulation, metabolism, and temperature in small, vulnerable children.

4.1.6. **Spinal neurosurgery** involves management of common degenerative conditions (cervical and lumbar disc disease) and also reconstruction of the spine (for trauma, tumour, and deformity) with a wide variety of implants. They may, at times work in collaboration with orthopaedic spinal experts and may rely upon neurophysiology expertise for spinal cord monitoring during correction of deformity or when removing of tumours from within the spinal cord, at both of which times the cord is particularly vulnerable to irreversible damage.

4.1.7. Neurosurgeons who specialise in **pain and functional surgery** provide services for patients with conditions such as movements disorders (e.g. Parkinsonism, chorea and athetosis) and those suffering from chronic pain. Such pain may be *nociceptive* (arising from damage to the musculo-skeletal system) or *neuropathic* (arising from damage to the nervous system, and may include damage to peripheral nerves, or be in the form of phantom limb pain, the intractable pain which may develop after loss of a limb or following damage to the thalamus, a deep part of the brain). Surgical techniques may include DBS (deep brain stimulation, in which specific locations within the brain can be stimulated electrically by a device implanted into the brain and which can be controlled externally); SCS (spinal cord stimulation) in which electrodes are placed upon the dorsal part of the spinal cord so that sensory pathways can be stimulated to modify chronic pain, again by means of an externally-located control system; DDS (drug delivery system) in which a refillable chamber, with an incorporated adjustable pump mechanism, is implanted into the abdominal wall and then connected by a catheter to the lumbar subarachnoid space, allowing delivery of drugs into the CSF and thus in high concentration to the spinal cord (baclofen for spasticity, e.g. in multiple sclerosis; or morphine in selected patients with intractable chronic pain). The rate of administration of the drug can be titrated before refilling the pump chamber and then further adjusted by means of controlling the speed at which the pump is set; and by vagal nerve stimulation (an implanted device in the chest with electrodes placed directly onto the vagus nerve in the left side of the neck) used in the management of drug-resistant epilepsy.

5. To what extent and for what reasons might a neurosurgeon specialise in or focus on one or more of these areas?

5.1. Particularly in smaller units there was - and remains - a continuing need for each surgeon to maintain general neurosurgical skills. This requirement was a historical consequence of how individual departments evolved. An aspiring neurosurgeon surgeon in the 1950s might have wished to develop neurosurgical services within a district general hospital. Initially, they would have absorbed traditional workloads, such as head trauma and spinal cases, from their general surgery colleagues. These new colleagues brought additional skills, further disseminating specialised knowledge. Consequently, the unit would receive neurosurgical referrals not just internally, but from other hospitals across the region, cementing the era of the neurosurgical 'generalist'. However, as larger centres became increasingly specialised, some highly complex cases began to be referred onward. Simultaneously, a critical need for local expertise persisted, driving individual subspecialisation within every unit. This evolution was - and is - propelled by the superior clinical outcomes and expertise that arise from managing larger volumes of a specific condition. Thus, even within a small unit of three to five consultants, individual surgeons would subspecialise in fields such as skull base, vascular, or paediatric neurosurgery. Concentrating a specific case mix during a trainee's attachment to that surgeon enables the effective transfer of this expertise to the next generation. This balance of departmental expertise developed partly through serendipity and necessity - such as encountering a dense cluster of specific cases over a short timeframe - but more commonly through the strategic appointment of new consultant colleagues whose skill sets complement the existing staff. For example, one or more neurosurgeons in a department might develop a subspecialist interest in pituitary surgery to preserve that service locally. This volume allows them to maintain clinical proficiency, avoid de-skilling, and secure a sufficient caseload to effectively teach trainees. In this pituitary example, development would also involve establishing a combined clinic with an endocrinologist. Such collaboration increases the efficiency of clinical assessments and decision-making, enhances the pathophysiological and radiological understanding of both clinicians, and streamlines the patient pathway. Similar principles apply to other subspecialty interests. Ultimately, the responsibility for driving these developments lies with the clinical lead and hospital

management, often supported by guidance from specialist bodies such as the SBNS.

6. In what circumstances would neurosurgeons normally work with or alongside other clinical specialities, such as the following? How are the responsibilities between or amongst these clinical areas defined and maintained?

6.1

(a) **Anaesthesia** – Routinely in the operating theatre (in both elective and emergency procedures) and also, in some instances, in the radiology department for certain neuroradiological investigations such as cerebral angiography (the radiological assessment and interpretation of the blood supply to the brain). Generally, a neurosurgeon will work with the same anaesthetist for their regular operating session. This familiarity with each other's ways makes for good long-term collaborative understanding between the two colleagues. The anaesthetist will also frequently be involved in post-operative care or, if dually trained as an intensivist, in the management of unconscious patients on ITU. There are thus frequent collaborations between the two specialties in the delivery of patient care.

(b) **Radiology** – Frequently. Good clinical practice would involve regular (almost daily) interaction with neuro-radiologists for discussion of imaging in its clinical context. All neurosurgical units will have one (and in large units, possibly several) neuro-radiologist(s), a radiologist who has undertaken special training in the interpretation of the radiology of the nervous system – and who will thus also work with neurologists, in addition to their neurosurgical responsibilities. In addition to their diagnostic work and attending neuroradiology MDTs (in collaboration with neurosurgeons) they may also have an interventional role within the unit. In this latter capacity they may take on the role of 'operator', undertaking tasks such as the treatment of cerebral aneurysms by the introduction of coils within the aneurysmal sac, the coils being positioned utilising radiological guidance, or in the management of acute stroke by thrombectomy (removing clots from within arteries using coils inserted through a superficial blood vessel (artery) at the groin or in the upper limb).

(c) **Oncology** – Regularly, either at fixed neuropathology sessions and / or as a part of consultant ward rounds. This latter approach would also serve as a useful teaching opportunity for trainees. The work of an oncologist is primarily concerned

with the treatment of patients with 'cancers' (malignant growths) but as part of the selection for treatment they will also attend planning sessions (often in the form of an MDT meeting) with relevant specialties. For neuro-oncologists (cancer experts specialising in tumours of the nervous system) that will be neurosurgeons. At such an MDT it is likely that in addition to a neurosurgeon, a neuro-radiologist will also be in attendance so as to optimise understanding of the nature and extent of the disease as part of the treatment planning process.

(d) **Neurology** – Regularly, during the relevant period, as part of regular department postgraduate teaching sessions and, clinically, in joint discussion of patients admitted to the neuroscience unit. Consultant referrals (from neurology to neurosurgery, and vice versa) would form a significant part of the investigation of complex neurological disease. Regular joint meetings with neurology services also facilitates the cross-fertilisation of ideas between specialties - including their respective trainees – and a greater understanding amongst both specialties of their areas of clinical overlap. For example, motor neurone disease (MND) and cervical myelopathy (due to spinal cord damage in the neck) may both present with symptoms of upper limb weakness, poor grip strength, clumsiness when walking, and lower limb spasticity (stiffness) so that discussion about and familiarity with both conditions is essential for both specialties. Joint meetings are thus an important means of training and of maintaining expertise for both specialties.

(e) **Orthopaedic surgery** – Frequently in the management of acute trauma and, additionally, in the shared care of some complex spinal cases. There may also be collaboration between the two specialties in some units in the management of scoliosis (spinal deformity) and with spina bifida in order to protect the nervous system if corrective surgery on the spine is indicated.

(f) **Pain management** – Either in collaboration with a regular combined pain management service (in which neurosurgical interventions would form an integral part of the available treatment options) or sporadically in individual cases requiring specialist pain services. The former might include such procedures as SCS (spinal cord stimulation), DBS (deep brain stimulation), surgical interventions for TGN (trigeminal neuralgia) such as injection, or RF (radiofrequency) coagulation of the trigeminal ganglion, spinal cord DREZ (dorsal root entry zone) lesions, and implantation of drug delivery systems for chronic pain &/or spasticity.

(g) **Paediatrics** – In addition to collaborative management of childhood CNS (central nervous system) trauma, tumours and infections, and disorders of CSF

dynamics, interactions with paediatrics may also involve a collaborative approach to managing the developing CNS, in particular congenital conditions including spina bifida. Such management will now almost invariably involve an MDT approach (with key participants in care likely to include paediatrics, neurology, oncology and specialist nurses) but, in the early 1990s, may still have been undertaken on an *ad hoc* basis. (In those circumstances an individual neurosurgeon may have taken on responsibility for the complex management of a child with spina bifida without input from other colleagues. They would thus have been working entirely in isolation, relying strictly on their own clinical judgment and without a structured, formal network of other specialists). Paediatric operations have increasingly necessitated the expertise of trained paediatric anaesthetists. Such practice would now be considered mandatory but even as recently as the early 1990s paediatric-trained anaesthetists may not always have been available.

(h) **Infectious diseases** - There are frequent occasions in neurosurgical practice when the input of a microbiologist is needed, particularly in the management of post-operative infections, of infected implants, of CNS infections (such as cerebral abscess or subdural empyema), and in nosocomial infections (infections acquired in a healthcare setting, and thus likely to be resistant to standard treatment). In all these cases early discussion with a microbiologist will be helpful in selecting the most appropriate chemotherapeutic agent, either alone or in combination.

(i) **Psychiatry** – Neurosurgical interactions with acute psychiatric services are relatively infrequent. In some patients with frontal lobe syndromes – resulting from tumour or trauma, for example – or in acute confusional states or delirium - disruptive behaviour may warrant acute psychiatric referral but, in general, such clinical scenarios can be managed 'in house' (within the neurosurgical unit itself).

There are some patients with very severe, treatment-resistant depression or OCD (obsessive compulsive disorder) that may respond to functional psycho-neurosurgery. Such surgical treatment is only available in a small number of highly specialised units with assessment being made by an MDT (multidisciplinary team - which, as a minimum, will typically include a neurosurgeon and a psychiatrist, both of whom will have developed special expertise in this process, and probably also a clinical psychologist), with a second opinion by two independent doctors, and with strict adherence to regulations contained within Section 57 of the Mental Health Act 1983 [ELJ0001-00076].

(j) **Other relevant clinical specialities:**

- **Neuro-rehabilitation** - The interaction between neurosurgery and rehabilitation medicine will generally involve an MDT approach involving a neuro-rehabilitation consultant, a neuropsychologist, specialist brain injury rehabilitation staff (nursing, OT (occupational therapy), physiotherapy, and SALT (speech and language therapy)) focused on maximising functional recovery, improving quality of life, and facilitating the return to daily activities for patients with severe brain, spinal cord, and peripheral nerve injuries. This collaboration integrates acute surgical intervention with long-term, restorative care.
- **Neurophysiology** - In the 1990s, before intraoperative SCM (spinal cord monitoring) became more readily available, complex spinal operations (e.g. for intramedullary tumours (tumours arising within the spinal cord) or for scoliosis procedures (correction of severe spinal curvature) might also have involved collaboration with a neurophysiologist who would have been present in the operating theatre during the procedure. Similarly, in certain functional procedures (such as cortical resection for epilepsy) the presence of a neurophysiologist may have been required for intra-operative cortical mapping (in which at some point during the procedure prior to resection, the patient would have been 'woken' from the general anaesthetic and the electrical and functional response to cortical stimulation would have been evaluated).
- **General practitioners** - GPs (a primary care service) may refer patients directly to neurosurgery (a tertiary service) when imaging or severe symptoms confirm an urgent, structural surgical target, such as a brain tumour or spinal cord compression, and (less urgently) lumbar disc lesions causing sciatica. For suspected cauda equina syndrome (see section 8h, below) urgent direct referral to the local acute spinal service (which likely involves neurosurgery) is indicated. Under most circumstances, however, GPs refer patients with a suspected neurosurgical condition through other specialties (neurology or orthopaedics). This preliminary triage is necessary because of the finite limitation of neurosurgical resources. Those specialties in turn can then refer relevant cases to neurosurgery. Pre-operatively, neurosurgeons rely on GPs to optimise chronic conditions (e.g. diabetes and hypertension) and safely manage complex medications (anticoagulants). Post-operatively, the GP reassumes primary care,

monitoring surgical wounds, tapering medications like steroids or painkillers, and acting as a local safety net to catch early red flags or disease recurrence while coordinating long-term community rehabilitation.

(k) **Charitable institutions** - Neurosurgeons, through their individual or specialist interest in particular disorders of the nervous system, are likely to be involved to some degree with one or more of the many disease-related patient groups. Contact with such groups might be in one or more of various roles including advisory, educational, supportive, administrative or fund-raising. These many condition-specific groups are not limited to but include the following:

- Brain tumours: The Brain Tumour Charity;
- Cavernous angiomas (clusters of thin, dilated blood vessels in the brain or spinal cord): The Cavernoma Society;
- Epilepsy: The Epilepsy Society, Epilepsy Action;
- General neurosurgical conditions: The Brain and Spine Foundation;
- Head injury: Headway UK;
- Hydrocephalus and spina bifida: Shine (formerly known as ASBAH);
- Neurofibromatosis (genetic disorders which cause tumours to grow on nerve tissue throughout the nervous system) (NF-1, NF-2, Schwannomatosis): LINK (Let's Increase Neurofibromatosis Knowledge) which ultimately became Nerve Tumours UK (since 2018), and (in Scotland) Tumour Support Scotland;
- Pituitary disorders: The Pituitary Foundation;
- Spinal cord injury: Aspire, Spinal Injuries Association, Spinal Injuries Scotland; and
- Syringomyelia (a neurological disorder in which a fluid-filled cyst forms in the spinal cord): The Ann Conroy Trust.

7. What role would normally be expected to be played by:

(a) multi-disciplinary meetings;

(b) mortality and morbidity meetings; and

(c) other regular or normal collaborations between or amongst clinical professionals involved with the field of neurosurgery?

How has the role of these meetings and / or other collaborations changed, if at all, over the period in which the Inquiry is interested?

7.1. The Calman-Hine Report (1995) [ELJ0001-00047] brought about a radical change in the delivery of specialist services in the UK, including neurosurgery. It

advocated a change from a generalist model (e.g., care given by general surgeons and physicians) that was supported by specialists to a fully specialist service. One of the main recommendations of the report was the creation of MDTs (multidisciplinary teams) with diverse expertise (e.g. surgeons, oncologists, nurses) to manage cancer patients. Whilst the report had come about in response to poor outcomes in cancer treatments, the principles which were recommended were applied to other specialist services, including neurosurgery.

7.2. Although there had been some MDT activity prior to 1995, it was not until the late 1990s that such activity became more widespread. With the increasing tendency to specialisation, the numbers of surgeons dealing with particular conditions fell but, commensurate with that change, the operative numbers (and thus experience of the particular condition) of these surgeons increased.

7.3. Activity and outcomes were now also monitored by the introduction of regular departmental (and, often, interdepartmental) **audit meetings**. Time would have had to be made available for this additional activity and so the traditional departmental **M&M (morbidity and mortality) meeting** – which was historically a confidential, peer-reviewed forum for clinical staff to examine adverse outcomes, unexpected complications, or patient deaths - tended to disappear. For many years these meetings had remained entirely autonomous, devolved strictly to individual clinical units, and with no external oversight. Knowledge from them was rarely formally documented, remaining largely contained within the immediate surgical department, and was seldom a driver for what is now termed clinical governance (a systematic framework through which healthcare organisations are held accountable for continuously improving the quality of their services and safeguarding high standards of care). In addition to providing a regular forum for interesting cases / complications to be reviewed, M&M meetings had also been an important educational activity for trainees who would have to read up on particular topics and then hone their presentation skills amidst the relative security of departmental colleagues. By way of contrast, the primary purpose of **clinical audit meetings** was to systematically measure current clinical practice against explicit, evidence-based criteria. Whilst audit meetings were becoming widely practised it was not until the Health Act (1999) that such activity became mandatory since it

became a legal responsibility for NHS bodies to monitor and improve healthcare quality.

7.4. There has been another important change which has resulted from the transition from the somewhat *ad hoc* format of M&M meetings to the far more structured MDT meetings and regular audit sessions. Whereas the former (M&M) were particularly susceptible to bias – with complications frequently being presented by the operating surgical teams themselves – the switch to audit was accompanied by an increasing tendency for other surgical groups to scrutinise outcomes. The potential for partiality remained but was lessened considerably by the newer, and more formal, approach to review of surgical practice. Whilst the practice of more structured audit meetings replacing M&M meetings had occurred from about 1989 onwards uptake was not universal. However, the repercussions of the high-profile Bristol Royal Infirmary cardiac surgery scandal (Kennedy Inquiry 1998) and the Health Act (1999) led to an immediate mandatory requirement for regular structured audit meetings. Thereafter audit was no longer an option but became an obligation.

7.5. It is thus the case, therefore, that at the outset of the period in which the Inquiry is interested there was a less formal approach to review of the activity of surgical colleagues within a department. As the changes described above were more widely introduced, however, then more opportunities would have arisen for trends in complications to be revealed. Initially, audit topics were selected locally by clinical leads focusing on high-volume, high-risk, or high-cost procedures, alongside targeted responses to specific departmental complications or near-misses. Following the 1999 clinical governance mandate, this autonomous selection shifted heavily toward externally imposed, national priorities. Departments were increasingly required to audit against evidence-based national guidelines and participate in large-scale national registries. This evolution ensured that local audit topics directly aligned with standardised national benchmarks rather than individual surgeon preferences.

7.6. By way of balance to the foregoing potential concerns, however, it should be stated that in many units (not just in neurosurgery in particular, or surgery in general, but across the spectrum of medical practice) there was a growing

tendency for complex cases to be discussed with colleagues both in house and elsewhere². Furthermore, once audit became a mandatory component of hospital practice - aligned with evidence-based guidelines from bodies like NICE and the British Association of Spinal Surgeons (BASS) - surgical practice shifted significantly toward standardisation. While specific operative techniques remain highly individualised, the clinical indications for and selection of surgical procedures are increasingly regulated by robust evidence and contemporary peer review via the Multidisciplinary Team (MDT) process. This shift inevitably generated hostility from an earlier generation of surgeons—the ‘old guard’—who viewed the changes as an infringement on clinical autonomy. However, the relentless combination of peer pressure and statutory mandates eventually forced compliance, a transition ultimately justified by improved patient outcomes. Today, a new generation of consultants and trainees have known no other system; they fully appreciate its benefits, despite the inevitable reduction in monthly clinical activity caused by mandatory attendance. Crucially, audit is systemic, not isolated to surgery. Even if an individual surgeon attempted to undertake an elective list during a scheduled audit session, they would find it logistically impossible, as the necessary anaesthetic and theatre staff would simultaneously be engaged in their own mandatory departmental audits.

Neurosurgical Procedures

Spinal Surgery

8. Please explain the following spinal issues with which patients may present to a neurosurgeon.

8.1. There are many terms and descriptions used in spinal surgery and neurosurgery that have considerable overlap in meaning and variation in interpretation. The focus of spinal surgery is often considered to be the bones and connective tissue of the spinal (vertebral) column. Neurosurgery is a broad term relating to surgery of the brain and spinal cord (the central nervous system) as well as peripheral nerves that contribute to the peripheral nervous system. Spinal surgery is regarded as a subspecialist area of both neurosurgery and orthopaedic

² One of the authors of this report would regularly contact one of his former trainers in another neurosurgical unit to discuss particularly complex cases during the first few years after his appointment to a substantive consultant post.

surgery where there is an overlap of surgical techniques and skills. This can give rise to confusion, misinterpretation and uncertainty when the terms are being used interchangeably even by medical professionals. Hence, it may be helpful to provide broad definitions and descriptions of the conditions with an accompanying glossary of the terms with both lay and medical professional interpretations.³ A broad context of the work neurosurgeons do in relation to these conditions can aid the general understanding of the principles of the work and surgery involved in treating a range of spinal conditions

8.2. In essence, spinal surgeons and neurosurgeons operate upon the spine with the goals of preventing or limiting neurological dysfunction that can result in pain, disability, death or deformity. This may involve treating conditions that are

³ Glossary of Terms

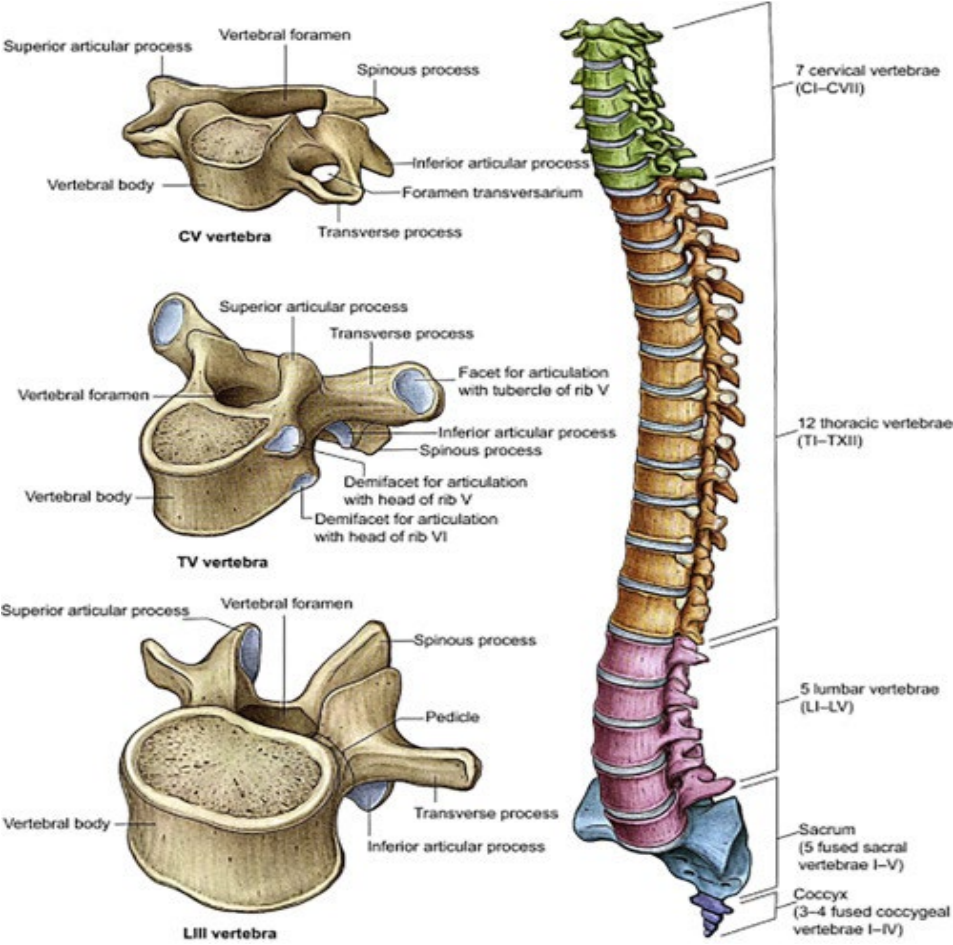
- **Vertebra (plural: vertebrae)** – Individual bones that make up the spine
- **Disc** – A type of fibrocartilaginous joint (a symphysis) connecting vertebrae that permits a degree of movement between vertebrae while providing stability.
- **Spinal cord** – Bundle of nerves that carries signals between the brain and body through the spinal column.
- **Spinal canal** – the cavity within the centre of the vertebrae through which the spinal cord passes.
- **Facet Joint** – one of a pair of bilateral and symmetrical joints that are part of a vertebra. They allow vertebrae to move in relation to each other in a constrained way while limiting excessive movement.
- **Nerve root** – The initial part of a nerve as it exits the spinal cord
- **Compression** – Pressure on nerves or the spinal cord
- **Inflammation** – Irritation of tissues characterised by pain, swelling, loss of function.
- **Sciatica** – Pain radiating down the leg due to nerve root irritation
- **Benign** – Non-cancerous
- **Malignant** – Cancerous
- **Paralysis** – Loss of muscle movement
- **Bowel and bladder control** – Ability to control urination and defecation

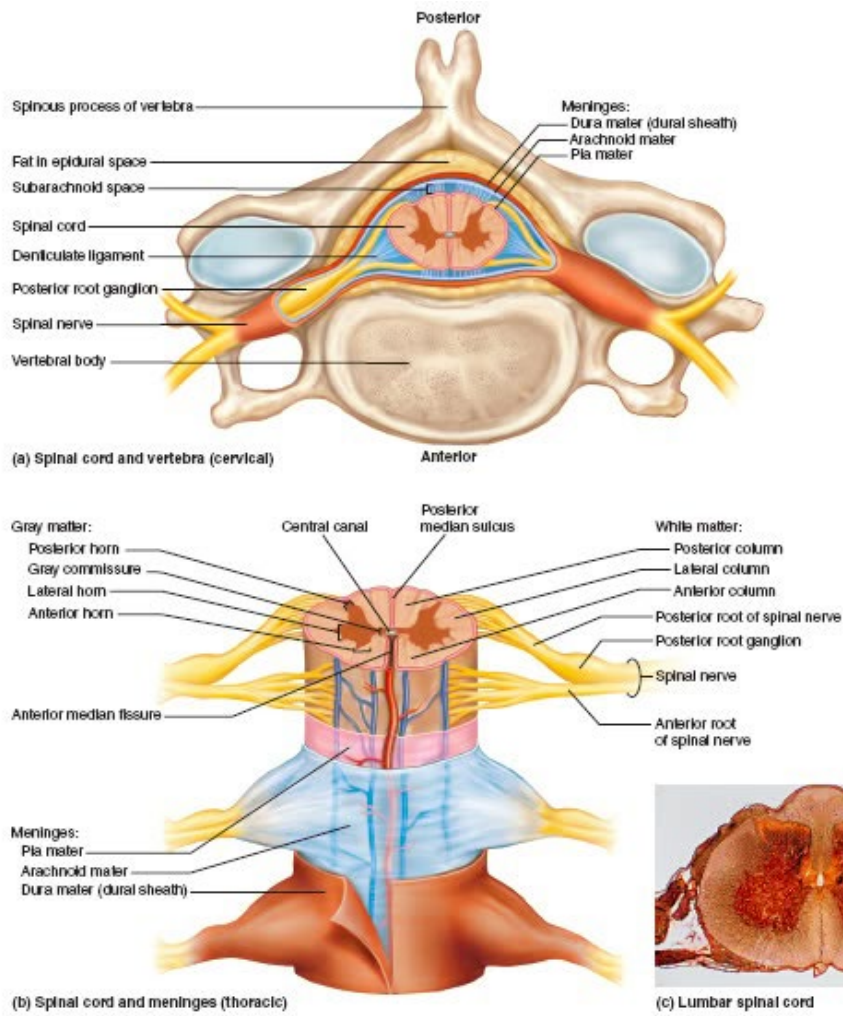
life-limiting, life-altering or that carry poor prognosis if left untreated without surgical intervention. This does not mean that surgery is the only treatment option available to spinal surgeons and non-operative options and interventions are also considered. When it comes to surgery, spinal surgeons can remove tissue, provide an environment for spinal stability, correct or prevent deformity, undertake interventions that modulate neurological function or undertake combinations of these procedures. Conditions may be encountered in both emergency and elective settings with differing challenges, constraints and urgencies depending on the context and information available to the surgeon taking into account patients hopes, fears, expectations in the setting of resources, expertise, the underlying pathology and realities of delivering clinical care where resources are not unlimited and there may be competing priorities.

8.3. It may be helpful, by way of example, to present a description of how a multitude of terms may be used in the context of one patient's presentation to a neurosurgeon. Qualifiers and explainers are in parenthesis: A 70-year-old female patient with *degenerative disc disease* (age-appropriate wear and tear in a disc that may not really be considered a disease), presents with leg pain and some symptoms suggestive of *cauda equina syndrome* (defined below, which may or may not have compressive causes suitable for surgical intervention). The imaging (a combination of possibly MRI scans, CT scans, plain x-rays) reveals a *herniated disc* (a disc bulge), combined with a *spondylolisthesis* (a slip of one vertebra in relation to another) resulting in *spinal stenosis* (narrowing in the spinal canal), associated *nerve root compression* and an old *osteoporosis* related fracture that results in a *degenerative scoliosis*.

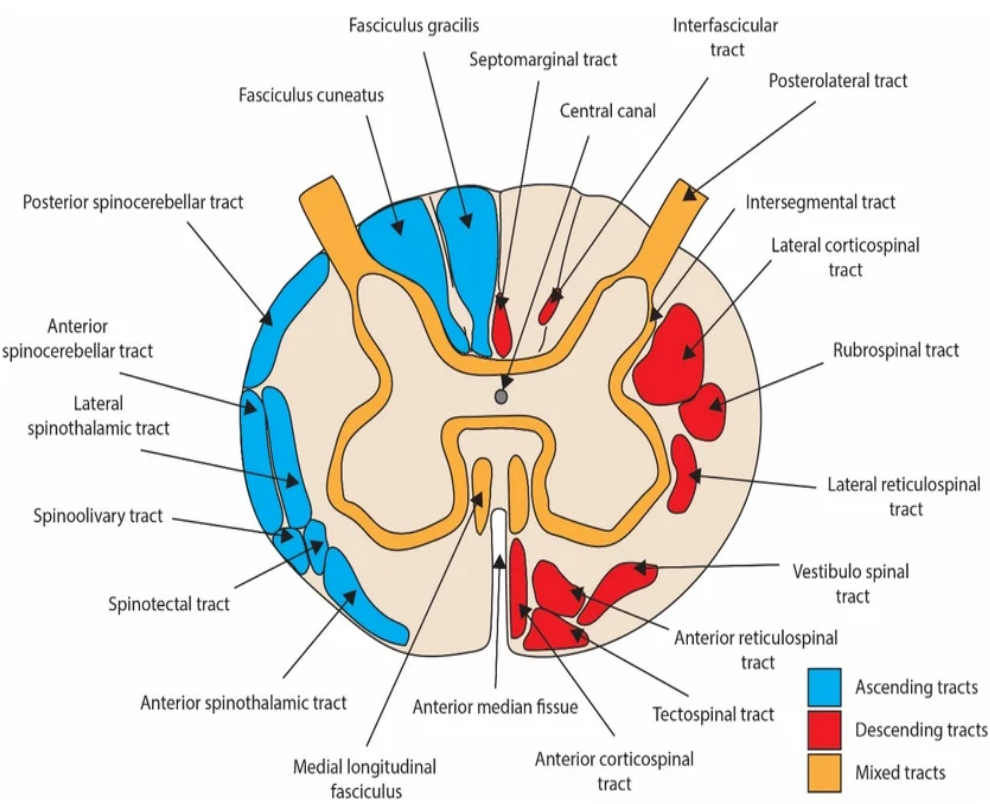
8.4. The paragraph above includes several terms in italics that may or may not be contributory factors to the patient's presentation in isolation but may be of significance in combination. The following explanation of common medical terms can provide wider understanding. The illustrations show: 1) the spinal column, 2) the relation of the spinal cord and exiting nerves to the surrounding bony vertebra, 3) a cross section of the spinal cord outlining the main pathways of nerves ascending or descending within the spinal cord and 4) the general vascular anatomy of the spinal cord and spinal column.

1.

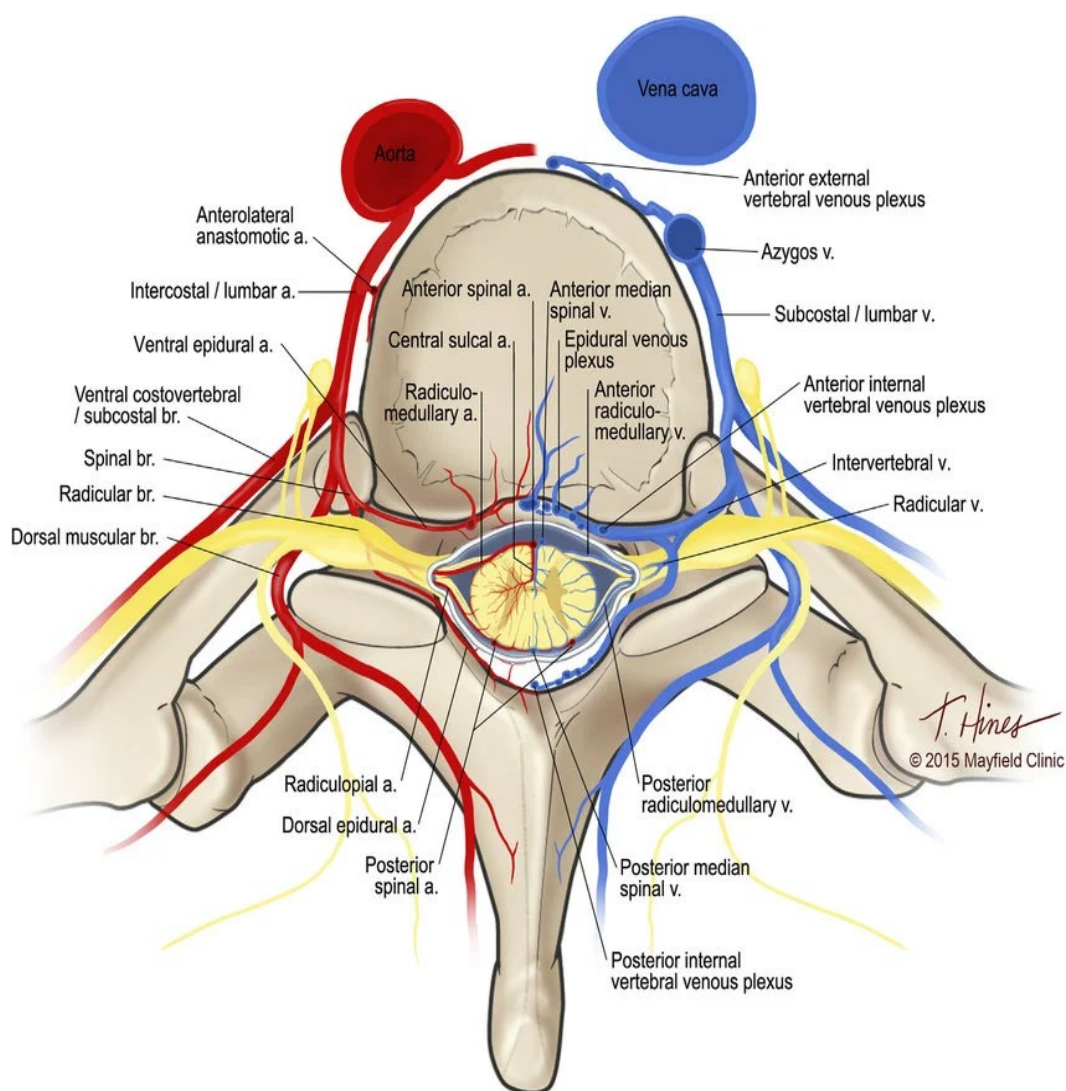




2.



3.



4.

8.5 A high level overview of nerves and the central and peripheral nervous system may be helpful. Nerves are bundles of neuronal tissue arranged in long fibre-like structures that transmit electrical signals between the brain and organs and tissues of the body. The Central Nervous System (CNS) consists of the brain and spinal cord and is largely protected within the bony confines of the skull and the spinal column made up of vertebrae. The Peripheral Nervous System (PNS) comprises the nerves branching out to the rest of the body. For most of their length these lack any bony protection. The majority of neurosurgeons operate on conditions that can affect the CNS or PNS, including structures adjacent to the nerves even if not operating on the nerves directly. Presently, neurosurgeons may specialise more in cranial or spinal CNS conditions and a minority might specialise in PNS conditions. During the period relevant to the Inquiry, neurosurgeons had a

more generalist practice and might undertake surgery on brain, spine, CNS and PNS conditions.

8.6 Herniated Disc

Between each spinal bone (vertebra) is a disc, a special type of fibrocartilaginous joint known as a symphysis that links the vertebra together allowing movement of vertebra combined with stability. The consistency of intervertebral discs changes with the aging process. Initially with a soft and gelatinous material – the *nucleus pulposus* surrounded by a tougher fibrous layer the *annulus fibrosus*. Herniated discs are common in the lower back and neck. A herniated disc occurs when the inner part of the disc pushes out through a crack in the tougher outer layer, or it can be interpreted as the whole disc becoming somewhat saggy and bulging back into the spinal canal. (Imagine a car tyre with some air let out of it, it bulges outwards but nothing has given way). This bulge can press on nearby nerves, causing:

- Back or neck pain
- Pain radiating down an arm or leg
- Numbness or tingling
- Muscle weakness

8.7 Ruptured Disc

A ruptured disc is essentially a more severe form of a herniated disc. In this case, the outer layer of the disc tears completely, allowing more disc material to protrude into the spinal canal. (Consider this to be like a burst car tyre). The clinical severity of a disc herniation or rupture is governed by the anatomical structures which the protruding disc compresses rather than whether the pathology is due to a disc herniation or rupture.

8.8 Spinal Stenosis

Spinal stenosis means narrowing of the spaces within the spine. This narrowing can result in pressure on the spinal cord or nerves, or restriction of flow in blood vessels associated with neural structures. A patient may be born with, or predestined to have, a narrow spinal canal – congenital spinal stenosis, or it may be acquired gradually over time. This is usually due to aging where osteoarthritis, or thickened ligaments can cause the following symptoms:

- Back or neck pain
- Leg pain or cramping when walking
- Numbness or weakness
- Balance problems
- Bladder, bowel or sexual dysfunction.

8.9 Spondylolisthesis

Spondylolisthesis occurs when one vertebra slips forward over the one below it. This slippage can compress nerves and may indicate instability. The lumbar spine is most commonly affected. There are five main types of spondylolisthesis: *Dysplastic* – a congenital defect in part of the facet joint formation that makes slipping likely; *Isthmic* – a defect in the pars interarticularis which may have several aetiologies in itself; *Degenerative* – commoner in older adults associated with osteoarthritis and degeneration in the discs; *Traumatic* – caused by a sudden injury or fracture; and *Pathologic* – due to bone weakness secondary to a pathological process such as infection, tumour or metabolic bone disease. However, a spondylolisthesis is not always symptomatic. When it is, common symptoms include:

- Lower back pain
- Leg pain or numbness
- Tight hamstrings
- Difficulty standing or walking for long periods.

8.10 Osteoporosis

Osteoporosis is a condition where bones become thin, weak, and brittle. In the spine, this can lead to compression fractures, where vertebrae collapse. Although osteoporosis itself is not a neurological condition, fractures can compress nerves or the spinal cord, requiring neurosurgical intervention. Symptoms may include:

- Sudden back pain
- Loss of height
- Stooped (kyphotic) posture
- Reduced mobility, potentially limited by pain.

8.11 Degenerative Disc Disease

Degenerative disc disease refers to age-related wear and tear of spinal discs. As discs gradually dehydrate with age and lose elasticity there may be less flexibility between vertebra, but at the same time there may be more movement between vertebra indicating less spinal stability. Despite the name, it is not a disease but a natural aging process. This can lead to:

- Chronic back or neck pain
- Disc herniation
- Spinal stenosis
- Nerve compression.

8.12 Nerve Root Compression

Nerve root compression occurs when a spinal nerve is squeezed by a disc, bone, soft tissue such as a ligament, a pathological process such as a tumour, or swelling such as a fluid filled cyst. There may be radiological appearances of compression in the absence of symptoms. Surgical treatment focuses on relieving pressure on the nerve. Other non-surgical interventions such as pain relief, physiotherapy or injection treatments are normally undertaken initially unless emergency surgery, e.g. for cauda equina syndrome, is required. Symptoms when they are present depend on the affected nerve and may include:

- Sharp or burning pain
- Pain traveling down an arm or leg often described as radiculopathy and in lay terms when the leg is involved as sciatica
- Numbness or tingling in the affected part of a limb
- Muscle weakness
- Bladder, bowel and sexual dysfunction.

8.13 Cauda Equina Syndrome

Cauda equina syndrome is a rare but serious emergency. The *cauda equina* is a bundle of nerves at the lower end of the spinal cord. These nerves provide sensory innervation and motor (muscle) function to the bladder, perineum (saddle area), anus and lower limbs. Cauda equina syndrome is a constellation of symptoms that describe dysfunction in these nerves. Causes may be compressive or non-compressive. Non-compressive causes include inflammation around the lining of the nerves (arachnoiditis), ischaemic insults with reduced blood supply to the nerves, infections including viral infections such as herpes simplex virus, varicella-

zoster virus, cytomegalovirus, Epstein-Barr virus and HIV. *Elsberg syndrome* describes a specific form of acute cauda equina syndrome frequently triggered by herpes virus reactivation. Neurosurgical and spinal surgical involvement is focussed on treating the *compressive* causes of cauda equina syndrome for which the commonest cause is a large, herniated disc in the lumbar spine causing compression of the nerves passing through that region – namely, the *cauda equina*. Surgery is often required on an emergency or urgent basis to prevent permanent damage. Compression of these nerves can cause:

- Severe lower back pain
- Weakness or numbness in both legs
- Loss of bladder or bowel control
- Loss of genital sensation and sexual function
- Numbness in the groin or inner thighs (“saddle numbness”).

8.14 **Scoliosis**

Scoliosis is an abnormal sideways curvature of the spine. It may develop during very early childhood for example infantile scoliosis, or more commonly during adolescence, often referred to as Adolescent Idiopathic Scoliosis (A.I.S), but it can also occur in adults due to degeneration of discs and joints in the spine as well as being caused by other underlying pathological processes. Neurosurgeons *may* become involved if nerves or the spinal cord is affected. It is more common for scoliosis to be treated by orthopaedic spine surgeons who have specific expertise in managing this type of spinal deformity especially for infantile and adolescent scoliosis. Mild scoliosis may cause no symptoms, while more extreme cases can lead to:

- Back pain
- Uneven shoulders or hips and associated cosmetic distress
- Breathing problems (in severe curves)
- Nerve compression
- Secondary musculoskeletal problems in trying to compensate for the curve.

8.15 **Spondylitis**

Spondylitis refers to inflammation of the spinal joints. A type encountered by surgeons is ankylosing spondylitis, an inflammatory condition that can cause the

spine to become stiff and fused over time. There may be spinal surgical involvement due to trauma or deformity of the spine. Inflammation can also affect nerves. There can be other inflammatory conditions that may affect the spine. Spondylitis should not be confused with the similar sounding term of *spondylosis* which is a non-inflammatory description and is usually associated with more common age-related degenerative changes. Symptoms of spondylitis include:

- Chronic back pain and stiffness
- Pain worse in the morning
- Reduced spinal flexibility
- Spinal deformity especially a forward curvature of the spine or kyphosis.

8.16 Spinal Tumours

Spinal tumours are abnormal growths that can develop within the spinal cord, its coverings – the meninges, - or the surrounding bones. They may be benign (non-cancerous) or malignant (cancerous). Malignant tumours of the vertebrae may rarely be due to primary bone tumours and more commonly are representative of wider spread of metastatic deposits of tumours that have arisen elsewhere in the body. Neurosurgeons often manage these cases due to the risk of nerve or spinal cord damage with a risk of paralysis. Symptoms may include:

- Persistent back pain
- Pain worse at night
- Weakness or numbness
- Difficulty walking
- Bladder, bowel problems or sexual dysfunction.

8.17 Spinal Trauma

Spinal trauma refers to injuries caused by accidents such as falls, car crashes, sports injuries, or violence resulting in penetrating injuries. It can also result from minor or low energy insults that might occur in frail patients or those with underlying metabolic bone disease such as osteoporosis. Symptoms range from pain to paralysis as well as deformity. Occasionally patients may not recall a specific event that resulted in the trauma detected incidentally on imaging. Prompt neurosurgical evaluation is important in determining the extent of any deficit, the potential for future deficits, the assessment of spinal stability not just at the point

of immediate presentation to the surgeon but also in the context of longer-term slowly progressing spinal deformity. These injuries may involve:

- Fractures or dislocations of vertebrae
- Damage to discs or ligaments
- Spinal cord or nerve injury.

8.18 Any other common spinal conditions or injuries which a patient may present to a neurosurgeon.

Infections of the spine might present to neurosurgeons. An infection of the intervertebral disc and adjacent vertebrae often referred to as discitis or spondylodiscitis may be referred to neurosurgeons although treatment often remains with doctors specialising in managing infectious diseases. An infection in the space outside the lining of the spinal cord (the epidural space) may become infected resulting in an epidural abscess. A neurosurgeon may be required to decompress the spinal cord or to obtain tissue samples to assist in the microbiological identification of the infective organism and to guide antimicrobial treatment.

8.19 Medical Definitions of Common Spinal Conditions

8.19.1 Herniated Disc

Protrusion or extrusion of the nucleus pulposus of an intervertebral disc through a defect or weakening in the annulus fibrosus, potentially resulting in compression or irritation of adjacent spinal nerve roots or the spinal cord.

8.19.2 Ruptured Disc

A condition in which there is complete disruption of the annulus fibrosus of an intervertebral disc with escape of nuclear material into the spinal canal or neural foramina; often considered a severe form of disc herniation.

8.19.3 Spinal Stenosis

Abnormal narrowing of the spinal canal, lateral recesses, or intervertebral foramina, which may result in compression of the spinal cord, cauda equina, or spinal nerve roots.

8.19.4 Spondylolisthesis

Anterior, posterior, or lateral displacement of a vertebral body relative to the vertebra below it, most commonly occurring in the lumbar spine and often associated with degenerative changes or defects of the pars interarticularis.

8.19.5 Osteoporosis

A systemic skeletal disorder characterized by decreased bone mass and deterioration of bone microarchitecture, leading to increased bone fragility and susceptibility to fracture, particularly of the vertebrae, hip, and wrist.

8.19.6 Degenerative Disc Disease

A condition marked by progressive structural and functional deterioration of intervertebral discs, including disc dehydration, loss of disc height, and annular fissuring, commonly associated with aging and mechanical stress.

8.19.7 Nerve Root Compression

Mechanical pressure exerted on a spinal nerve root due to disc herniation, osteophyte formation, ligamentous hypertrophy, tumour, or other space-occupying lesions, resulting in radicular pain or neurological deficits.

8.19.8 Cauda Equina Syndrome

A neurological emergency caused by compression of the lumbosacral nerve roots within the spinal canal, characterised by lower extremity weakness, sensory disturbances in a saddle distribution, and dysfunction of bladder, bowel, or sexual function.

8.19.9 Scoliosis

A lateral curvature of the spine greater than 10 degrees as measured by the Cobb angle⁴ on radiographic examination, often accompanied by vertebral rotation and classified as idiopathic, congenital, or neuromuscular.

8.19.10 Spondylitis

Inflammation of one or more vertebrae or spinal joints, commonly referring to inflammatory disorders of the spine such as ankylosing spondylitis, which may result in pain, stiffness, and progressive spinal fusion.

⁴ Cobb Angle – a radiological measurement assessing the severity of scoliosis

8.19.11 Spinal Tumours

Neoplastic growths arising within or adjacent to the spinal column, including vertebral, intradural extramedullary, or intramedullary lesions, which may be benign or malignant and can cause neurological impairment by compression or invasion.

8.19.12 Spinal Trauma

Physical injury to the spinal column, spinal cord, or associated neural and soft tissue structures resulting from external forces such as blunt or penetrating trauma, potentially leading to instability, neurological deficit, or paralysis.

8.19.13 Spinal Infection

Spondylodiscitis is a combined infectious and inflammatory process affecting both the intervertebral disc and adjacent vertebral bodies. An epidural abscess is a localised collection of pus and infected tissue within the epidural space between the dura and the overlying bone and ligaments.

9 Broadly how might the requirements placed on a neurosurgeon in their spinal work be experienced in an emergency setting, as opposed to in more routine hospital settings?

9.1 Technically the requirements may be constant in principle for a neurosurgeon undertaking both emergency neurosurgery as well as planned routine neurosurgery that is often referred to as elective neurosurgery. However, there are notable differences in context that can be of influence in the delivery of the surgical work. Out of hours presentations requiring urgent or emergency management typically comprise cranial and spinal trauma, intracranial haemorrhage, acute hydrocephalus and space occupying lesions that cause symptomatic elevations of intracranial pressure (e.g. tumours, abscess). Some intervertebral disc prolapses may cause an emergency presentation due to compression of the spinal cord or cauda equina.

9.2 Emergency neurosurgery is provided 24 hours a day 365 days a year. Many resources including staff in a hospital work a predictable 40 hour week, often 37.5 hours a week although there may be opportunities for overtime working. This means that for 128 hours out of a 168-hour week, i.e. more than 2/3 of a week,

activity is delivered in an “out-of-hours” context with reduced resources and in a less predictable manner. The consultant neurosurgical workforce in a hospital must provide emergency cover for the whole week and in turn, the whole year. Different sized units will have different working patterns to accommodate this requirement for cover. In a small unit with 3 consultants this would be a 1:3 on-call rota⁵. Typically, colleagues will also cover each other for annual leave, professional leave or for personal family issues or provide sickness cover. This can result in a consultant providing on-call activity on a 1:2 basis and even occasionally on a 1:1 for a period of time. It is common for the weekend on-call activity to be consolidated into one block of consecutive days from a Friday until Sunday inclusive with an over spill of work into the Monday. A larger unit with more consultant staff can distribute the emergency workload to a greater extent.

9.3 Neurosurgery workload in general and including spinal workload can be categorised as emergency and elective. The emergency workload can be further categorised as requiring immediate intervention or urgent intervention, implying a bit more time to make preparations but still not the idealised circumstances of elective neurosurgery. Factors that need to be taken into consideration include: the urgency for decision making including urgency for surgery, time constraints that may include “windows of opportunity”, availability of resources, the condition of the patient and time that may have elapsed since the onset of their presenting circumstances, evaluation of likely outcome and risks associated with intervention or non-intervention, logistics such as transport links, intensive care bed availability, prioritisation of competing specialties and sometimes in the case of the multiply injured patient the sequence of interventional priorities.

9.4 The emergency neurosurgical activity is less controlled and predictable than routine elective surgery. The following points should be considered:

9.4.1 Often the neurosurgeon has incomplete information in an emergency situation compared to an elective setting. There may be limited knowledge

⁵ 1 in 3 rota means that 3 persons share responsibility for 24/7 care. A 1 in 5 rota means that 5 persons share responsibility for 24/7 care. Surgeons normally work up to 48 hours of normal office hours. This means that the remaining 120 hours during a week are divided equally adding an additional 40 hours per week “on-call” for a consultant on a 1:3 rota.

of past medical history, medications, allergies, patient wishes, co-morbidities (other coexisting illnesses the patient may suffer from) and limited corroborative information from relatives. In some emergency settings even the identity of the patient may initially be unknown and the surgeon has to decide to intervene in less than optimal circumstances.

- 9.4.2 In emergency settings the options available may be constrained to “the least bad option” at that moment without the luxury of time to make a more measured decision that would occur in a routine or elective setting. Intervention may have the aim of damage limitation more than a focus on the perfect outcome that may be achieved for conditions that present and are suitable for routine surgery.
- 9.4.3 During the relevant period an emergency patient with a neurosurgical condition would normally be assessed by an emergency medicine specialist within an Emergency Department, or by a medical or neurology “on-call” team in the Medical Assessment Unit. Only rarely would a direct referral from a GP be received. A clinical diagnosis would be made by the referring team. Usually investigations would be undertaken, often after consultation with the neurosurgical registrar who would, depending upon experience, seek senior input on the management plan and any arrangements for transfer of care to the neurosurgical unit.
- 9.4.4 In the emergency setting there are limitations on the time available for a full preparatory work up of the patient for surgery. There may be inaccessibility of all complimentary information, associated specialties e.g. neurophysiology, ophthalmology, ear, nose and throat (by way of example only and not specifically). There may be a lack of access to more complex radiological investigations. In the first decade of the relevant period access to MRI scans and cerebral angiography was often limited “out of hours”. Second opinions from colleagues and an absence of multi-disciplinary team meetings out of hours are less frequently available. This is all in the context of competing priorities that challenge triage (the selection and prioritisation of patients for emergency treatment), where dynamics are shifting with changing urgencies sometimes as a patient’s condition changes. Most clinical specialties have junior members of medical staff (e.g. registrar) available at short notice. Consultant supervision should be available 24/7 for acute specialties, although many cases do not require in-person attendance of the responsible consultant. The level of consultant

involvement in any individual clinical case is determined by the capabilities of the junior doctor and any unit protocols that may exist. The Consultant should ensure that the junior doctor is aware of any specific requests a consultant may have about being contacted.

- 9.4.5 Routine or elective neurosurgery may be displaced and deferred due to the arrival of emergency patients with little consequence other than inconvenience and the need to reschedule elective surgery. In contrast, delaying emergencies may have more significant consequences with the potential to impact survival or disability.
- 9.4.6 The surgical environment may be more challenging for emergency surgery. It is possible that the operating team is made of people who do not routinely or frequently work together so the workflow may be less smooth. Team members may be pulled from other settings at short notice to accommodate the needs of emergency presentations. The surgical team may only use some equipment infrequently and therefore be less familiar with the use of that equipment.
- 9.4.7 The patient's tissue that the surgeon has to operate upon may be less optimal than in an elective setting. For example, it may be more swollen, disrupted in a non-surgical manner making wound closure challenging, there may be extensive bloodstaining impairing the differentiation of anatomical and surgical access pathways, metabolically and physiologically the patient may be significantly compromised from the outset e.g. out of control diabetes, renal (kidney) impairment, challenges with blood pressure (by way of example and not an exhaustive list).
- 9.4.8 In the emergency setting there can be pressing ethical issues in part due to the limited time to make decisions. There may be concerns about consent for procedures especially if a patient cannot appreciate or weigh up issues such as risk and benefits themselves due to impaired consciousness and a reliance on relatives or third parties helping to inform decision making. Another ethical issue may be decisions that can influence life or death of an individual balanced against the availability and use of resources for a wider population given the context of potential futility of any potential intervention given the injury load of the patient. An example might

be transferring a patient and using the last Intensive Care Bed⁶ for a patient with unsurvivable injuries.

- 9.4.9 The behaviour of decision making in the emergency setting may be different from an elective routine surgical setting. There may be less room for decision by consensus, and the circumstances may require *leadership under urgency* characterised by directness, clarity and unambiguous decision making, which may be seen as *authoritarian leadership* – but may be an example of applied *situational leadership*.
- 9.4.10 In the emergency setting there is a higher emotional load for surgeons. For example, trauma patients may be younger than routine elective patients, their injuries may be ghastlier – to an extent they would never be shown on television, and there may be catastrophic associated injuries, for example traumatic amputation of limbs or spillage of abdominal contents from road traffic accidents. Such injuries would typically take priority over neurosurgical intervention. The pace of emergency referrals may leave little time for surgeon reflection, recovery or destressing between cases. The surgeon may be faced with multiple casualties or emergency referrals with limited resources. The outcomes associated with surgery in the emergency setting may be limited to survival, disability or death versus more refined outcomes that can be measured against best practice for elective procedures.

9.5 The summary of differences in requirements includes for emergency surgery: compressed time constraints, surgery delivered under uncertainty, a heightened moral and psychological burden when considering emergency and urgent surgery. Compared to routine surgery, which is undertaken in a more deliberate, optimised, shared information setting with resource buffering from the institution providing the elective treatment.

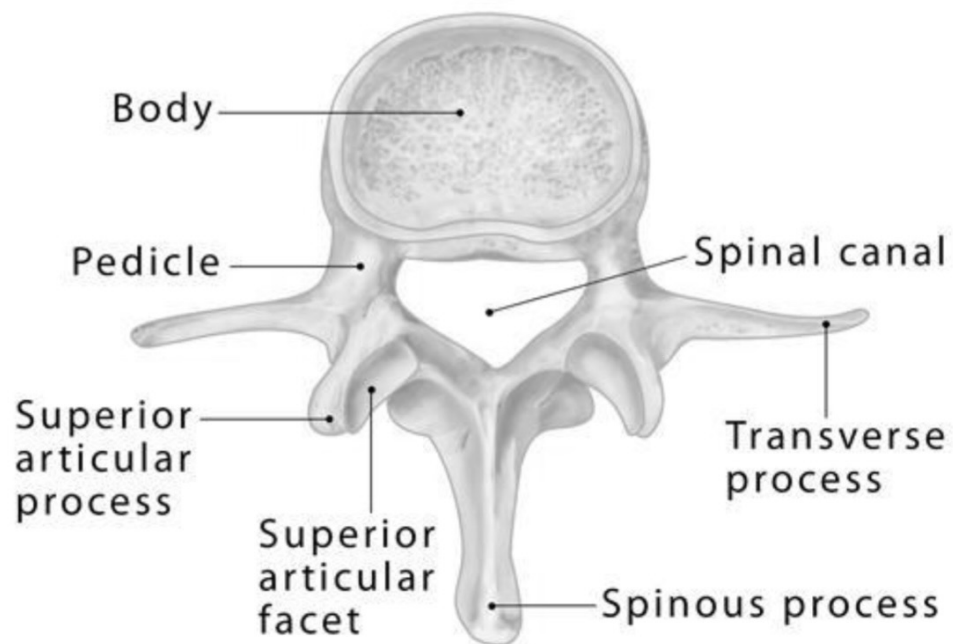
⁶ An intensive care bed is normally used for patients with a depressed level of consciousness due to major trauma or spontaneous intracranial haemorrhage (GCS 8 or less); post-operatively following major intracranial surgery, severe spinal cord injury, status epilepticus (ongoing treatment resistant seizures), those with blood pressure concerns or airway/ breathing concerns.

10 Please identify the patients who would be suitable to undergo and explain the purposes and objectives of, main contraindications for and the broad operative procedures involved in the following operations.

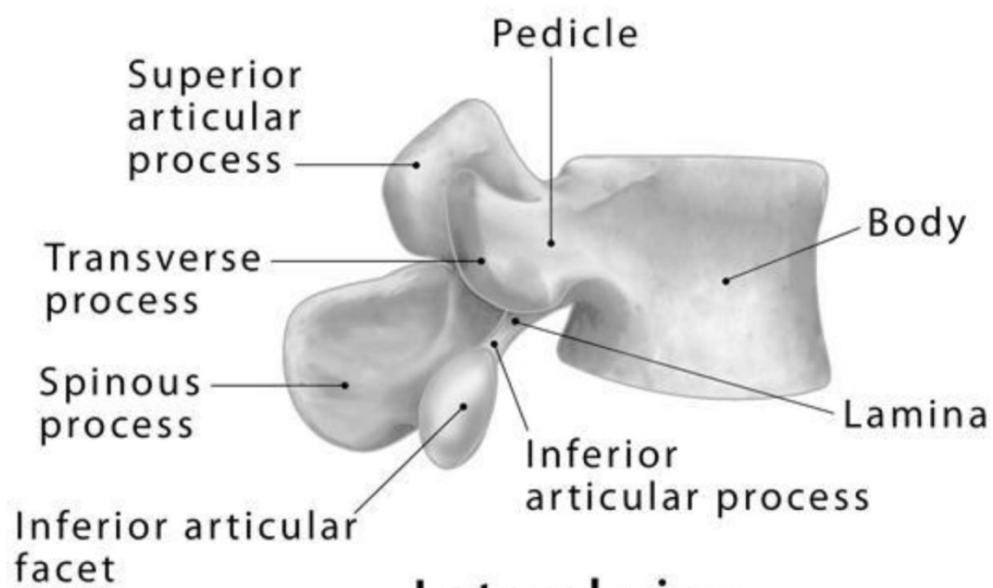
10.1 The following list of procedures or surgeries may be undertaken in isolation or combination, or as individual stages of one larger overall operation. A comparison table of the terms with layperson and medical professional or broadly clinically understood terms is provided. It may be helpful to view an illustration of spinal vertebrae to provide anatomical context to some of the terms used. In addition, it should be appreciated that there is an overlap of interpretation of the terms and each one may not be a single entity in itself. The term *decompression* can cover procedures such as laminectomy, foraminotomy, discectomy, microdiscectomy.

10.2 It should also be noted that the term *micro* in microdiscectomy evolved from the use of operating *microscopes* in this type of surgery. The operating microscope provides better illumination and magnification of structures, allowing access through smaller incisions, to structures located at greater depth and permitting the surgeon to operate with more precision. A microdiscectomy is not necessarily a lesser operation nor a more minimalist operation than a discectomy.

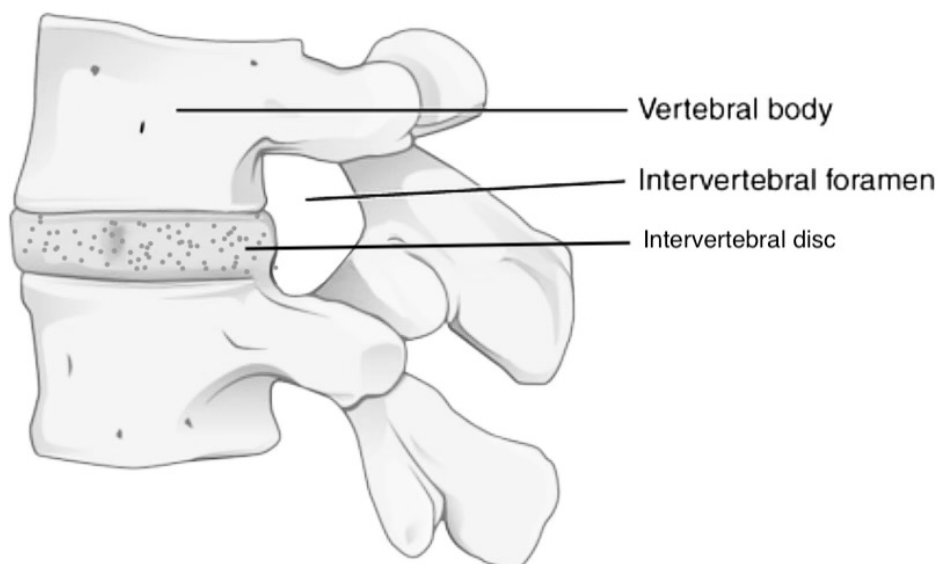
10.3 Illustration of a typical vertebra with labelled structures.



Superior view



Lateral view



Lateral view

Lateral view showing the intervertebral foramen in relation to the vertebral body and the intervertebral disc (where a nerve root exits from the spinal canal that would contain the spinal cord or in the lumbar spine the nerves of the *cauda equina*).

10.4 Patients who may be suitable to undergo spinal surgery could have one of the following conditions or combination of conditions: pain, spinal instability, trauma to the spine, involvement of the spine by tumours benign or malignant, deformity, infection, disturbances in cerebrospinal fluid dynamics, compression, compromise or potential compromise of neurological tissue and hence neurological function.

10.5 Identifying the source of pain and reliably attributing it to a spinal cause is a persistent albeit common challenge when assessing patients for surgery. There are numerous anatomical structures that have the potential to be a source of pain, numerous pathological conditions that can cause pain including conditions that change over time and may or may not be associated with different experiences of pain. Radiological appearances on x-rays, CT scans and MRI scans do not necessarily always correlate with pathological processes and the pain

experienced by patients. One should be cautious about attributing normal age appropriate degenerative (aging) changes to a pathological process creating the concept of a disease process.

10.6 The descriptive terms used by radiologists and other members of the medical profession as well as the lay public can be misunderstood when taken out of context when referencing the spine. For example, “*degenerative disc disease*” is not a disease at all. The degree of narrowing of a channel or foramen that a nerve root passes through might be graded as “*mild, moderate or severe or even stenosed*”, but use of the term severe does not necessarily indicate a degree of urgency or of impending disaster. Similarly with use of the word “*critical*” when describing apparent narrowing or compression in isolation from clinical assessment of the patient. These descriptions have very different implications for example compared to describing coronary artery narrowing with the impending risk of a heart attack.

10.7 It is useful to have a definition of spinal stability and then by implication there is a framework for assessing spinal instability. Spinal stability is defined as the ability of the spine under physiologic loads to limit patterns of displacement so as not to damage or irritate the spinal cord and nerve roots and, in addition, so as to prevent incapacitating deformity or pain due to structural changes. Conversely, instability refers to excessive displacement of the spine that would result in neurological deficit, deformity or pain. Spinal instability can be considered as acute (sudden onset) or chronic (slower in evolution) or an alternative view might be to consider instability as overt, anticipated or covert. The latter concept of covert instability is a more elusive idea where instability cannot be demonstrated but is implied from a combination of clinical and radiological findings.

10.8 Trauma to the spine may imply trauma or injury to several structures in isolation or combination involving the spinal column. For example, trauma to the spine may involve bony vertebrae, intervertebral discs, supporting ligaments, attached muscles as well as the neurological contents normally protected by, or passing through the spinal column. Associated medical conditions may influence the susceptibility of the spine to trauma or instability or deformity and hence the definition of spinal stability references physiological loads, but underlying pathology can effectively weaken the spine. Examples include, tumours eroding

or invading the bones or the vertebrae, infection destroying discs or vertebrae, metabolic or nutritional deficiencies weakening bones and muscle, movement disorders such as Parkinson's disease or dystonia (involuntary muscle contractions). In addition, the energy transferred to the body required to result in a traumatic event can be tolerated differently between patients of different ages, genders and frailty, emphasising that treatments and assessment of potential risks may be individualised to the patient.

10.9 Tumours of the spine may be primary bone tumours of the vertebrae (rare) and either benign or malignant, or they may be secondary or metastatic tumours to the spine. Examples of metastatic tumours include breast cancer, prostate cancer, renal cancer, lung cancers, bowel cancers and haematological cancers such as myeloma, lymphoma and leukaemia. All these tumours can weaken the integrity of the spinal column. In addition, there are tumours associated with neurological structures and the surrounding tissues which again may be benign or malignant or of a somewhat intermediate nature. Examples include schwannomas, and meningiomas (extrinsic to the spinal cord and nerves but intimately attached to these structures), as well as tumours or lesions that are more intrinsic such as ependymomas, lymphomas and astrocytoma. Even if a tumour is benign by definition of its pathological and histological classification, this does not mean its presence and influence on neurological structures is innocent but the prognosis for the patient may be more favourable. The pathology, anatomical location and involvement of associated structures such as blood vessels may determine what type of surgery is possible, how much tumour can be removed, whether the spine is rendered unstable by surgery and if as a result reconstruction and stabilisation of the spine is required to counter instability and / or prevent deformity.

10.10 Infection of spine may be considered either as a primary infection that may or may not require surgical involvement or potentially as a secondary event following spine surgery i.e. a wound infection. The secondary event would be considered a complication of spine surgery but not necessarily an avoidable complication. This will be considered later in paragraph 11.

10.11 Primary infections of the spine may involve the bones of the vertebrae resulting in a vertebral osteomyelitis, or the intervertebral discs known as discitis.

A widely used term is spondylodiscitis which implies an infection of the intervertebral disc and an adjacent vertebra or vertebrae. An abscess within the spinal canal is an epidural abscess but infections outside the spine but in adjacent structures such as muscles can be described as a para-vertebral abscess. These conditions may require spinal surgical involvement, by a neurosurgeon or an appropriately trained orthopaedic surgeon, to either identify the infective organism when this cannot occur through less invasive means (e.g. CT guided biopsy by a radiologist), to reduce the infective load by cleaning out the infected space, thus enhancing the effectiveness of antimicrobial treatment, or to provide stability to the spine which may have been rendered unstable and / or painful as a consequence of the infection.

10.12 Primary infections of the spine predominantly evolve having spread from elsewhere in the body through the bloodstream, known as haematogenous spread, which might be from an overt or covert source, or a specific event. Patients may have risk factors that make them susceptible to infection such as having a preexisting infection of the lungs, bladder or urinary tract, abrasions to the skin, intravenous drug use, malnutrition, smoking, diabetes and immunosuppression.

10.13 Some patients have disorders of cerebrospinal fluid (CSF) flow that can result in them having spinal surgical interventions. CSF is a clear fluid produced in the brain and spinal cord that protects the brain, helps with nutrient delivery and clearance of waste products of brain metabolism. It is continuously produced and reabsorbed maintaining a constant volume in healthy individuals. A Chiari malformation is a structural anomaly at the base of the skull where it joins the upper cervical spine column with abnormal displacement of neurological structures that impair normal CSF flow dynamics. Surgery for Chiari malformations often rests in the domain of both cranial and spinal neurosurgeons and either may have appropriate skills or expertise to manage this condition. Syringomyelia refers to the pathological formation of a fluid filled cavity within the structure of the spinal cord itself. It may be a consequence of trauma, infection, Chiari malformation, an arachnoid cyst or other space occupying lesions within the spinal canal such as tumours. The aim of surgery for both Chiari malformations and syringomyelia as well as drainage of arachnoid cysts is to restore normal CSF pathways, alter fluid pressure differentials that might be contributing to neurological impairment and to reverse any dysfunction or limit the progression of dysfunction and disability.

10.14 Relieving compression and compromise of neurological structures in the spine is one of the major aims and indications for spinal surgery when other non-operative treatments are ineffective, inappropriate or not indicated. This surgery may be undertaken for some indications in an emergency setting such as to relieve pressure on the nerves that make the *cauda equina* in the case of cauda equina syndrome, but more commonly decompression surgery in a variety of forms, is undertaken in an elective or planned setting. The commonest scenario would be for a patient with radicular pain (pain associated with a specific nerve root) with the pain radiating into an upper or lower limb. Other situations requiring a decompression by way of example include compression on the spinal cord commonly in the cervical spine (neck region) and much less commonly in the thoracic or dorsal spine (chest region). Patients present with symptoms of spinal cord dysfunction collectively known as myelopathy. Within the lumbar spine (lower back) compression of spinal nerves may cause a radicular pain (commonly referred to in lay terms as *sciatica* - a rather inaccurate term since it is not specifically the sciatic nerve itself that is compromised). In addition, a common situation requiring spinal decompression relates to spinal or neurogenic claudication – a clinical syndrome characterised by pain, weakness or numbness in the legs that is triggered by standing upright or walking and relieved by curling forwards or sitting down hunched forwards in a manner that opens up more space around the lumbar spine.

10.15 Primary decompression of the spine in any location is undertaken to relieve any pressure or potential irritation to nerve roots or the spinal cord. The decompression may be accompanied by a secondary procedure aimed at providing an enhanced recovery or avoidance of potential side-effects or consequences of the decompression itself. For example, a fusion procedure might be undertaken using a combination of bone graft, instrumentation such as metal screws, rods, plates with or without an interbody implant that sits in the intervertebral space where an intervertebral disc might have been removed to undertake the decompression. The interbody implants are typically referred to as “cages” since the earliest versions were made from a metal mesh. The instrumentation provides immediate stability to the spine following surgery. At the turn of this century there was an increase in the use of dynamic stabilisation aimed at restoring or maintaining physiological motion between vertebrae. Dynamic

stabilisation in the spine is designed to preserve some motion between vertebrae with the intention of reproducing a normal range of motion as an alternative to unnatural rigidity or excessive movement. An artificial disc replacement prosthesis might be considered appropriate for some patients rather than subjecting them to an interbody fusion following the decompression. An interbody fusion is a surgical technique that rigidly joins two vertebrae at the largest contact points of the vertebral body.

10.16 Main contraindications to spinal surgery

Many factors have to be considered in assessing if spinal surgery is contraindicated. The following is not intended to be an exhaustive list but provides a broad overview. A patient who has capacity to make decisions and who does not wish to undergo surgery is a primary contraindication to surgery, essentially a patient who withholds consent. This is particularly relevant if patients have not tried conservative (non-operative) treatments where the prognosis remains favourable without surgical intervention. Patients with severe medical conditions where surgery would place the patient at increased harm are presenting with contraindications to surgery. Examples include: active infection, uncorrectable bleeding disorders, severe cardiopulmonary disease where general anaesthesia would present unacceptable risks to the patient. In addition, for conditions that would require spinal instrumentation such as pedicle screws and rods or metal implants, poor bone health such as osteoporosis would be a contraindication. Further contraindications to surgery would be a mismatch between clinical presentations and any diagnostic imaging that does not reveal a legitimate and rational surgical target.

10.17 Comparison Table: Lay Explanation vs Medical Definition of Spinal Procedures

10.18

Procedure	Layperson Explanation	Medical Definition
Laminectomy	A surgery where part of the spinal bone is removed to relieve	Surgical excision of the lamina of one or more vertebrae to

	pressure on the spinal cord or nerves.	decompress the spinal cord or nerve roots.
Vertebroplasty	A procedure in which medical cement is injected into a broken spinal bone to strengthen it and reduce pain.	Percutaneous injection of bone cement into a vertebral body to stabilize a compression fracture and alleviate pain.
Kyphoplasty	Similar to vertebroplasty, but a balloon is first used to restore height before cement is injected.	A minimally invasive procedure involving balloon expansion within a vertebral body followed by cement injection to restore vertebral height and stabilise fractures.
Spinal Fusion	A surgery that permanently joins two or more spinal bones to reduce pain or correct instability.	A surgical procedure that creates a permanent union between adjacent vertebrae using bone grafts, implants, or instrumentation.
Pedicle Screw Fixation	Screws are placed into spinal bones to stabilise the spine during healing or fusion.	Placement of screws through the vertebral pedicles to provide rigid internal fixation of the spinal column, often used in spinal fusion.
Discectomy (including Microdiscectomy)	Removal of part or all of a damaged disc to relieve pressure on a nerve; microdiscectomy uses smaller incisions and magnification.	Surgical excision of herniated or degenerative intervertebral disc material; microdiscectomy utilises

		minimally invasive techniques with microscopic visualisation.
Spinal Cord Stimulator Implantation	A device is implanted to send electrical signals that reduce chronic pain sensations.	Surgical implantation of an epidural neurostimulation system that delivers electrical impulses to the spinal cord to modulate pain pathways.
Decompression	Any surgery done to relieve pressure on nerves or the spinal cord.	Surgical relief of pressure on neural elements by removal of bone, disc, ligament, or other compressive structures.
Foraminotomy	A procedure to widen the opening where a spinal nerve exits to relieve nerve compression.	Surgical enlargement of the intervertebral foramen to alleviate compression of an exiting spinal nerve root.
Nucleoplasty	A minimally invasive procedure that reduces disc pressure by removing part of the disc's soft centre.	Percutaneous decompression of the nucleus pulposus using thermal or mechanical energy to reduce intradiscal pressure and nerve root compression.

10.19 Spinal Surgical Procedures: Purposes, Objectives, and Broad Operative Procedures

(a) Laminectomy

Purpose and Objectives

The purpose of a laminectomy is to relieve pressure on the spinal cord or nerve roots caused by conditions such as spinal stenosis, tumours, disc herniation, or bone overgrowth. The objective is to increase space within the spinal canal, reduce pain, and improve neurological function.

Broad Operative Procedure

The surgeon makes an incision over the affected area of the spine. Muscles are gently moved aside to expose the vertebra. The lamina (the back part of the vertebral bone) is partially or completely removed. Once decompression is achieved, the area is inspected, bleeding is controlled, and the incision is closed. In some cases, spinal fusion may be added to maintain stability.

(b) Vertebroplasty

Purpose and Objectives

Vertebroplasty is performed to stabilise fractured vertebrae, most commonly due to osteoporosis or tumour involvement. The main objective is pain relief and prevention of further vertebral collapse.

Broad Operative Procedure

Under imaging guidance (X-ray or CT), a needle is inserted through the skin into the fractured vertebra. Bone cement (polymethylmethacrylate PMMA) is injected into the vertebral body, where it hardens rapidly, strengthening the bone. The needle is then removed, and no large incision is required.

(c) Kyphoplasty

Purpose and Objectives

Kyphoplasty aims to relieve pain, stabilise vertebral fractures, and restore vertebral height lost due to compression fractures, improving posture and reducing spinal deformity. The balloon expansion to restore vertebral body height is the key differentiating factor from a vertebroplasty. Restoring vertebral body height attempts to prevent a permanent forward bending or kyphosis of the spine.

Broad Operative Procedure

A small incision is made, and a narrow tube is guided into the vertebra. A balloon is inserted and inflated to high pressures to create space and partially restore height. The balloon is removed, and bone cement is injected into the cavity. Having created space with the balloon expansion the bone cement can be injected at lower pressures and with greater predictability of how it will fill bony spaces than with a vertebroplasty. The cement hardens to stabilise the vertebra.

(d) Spinal Fusion

Purpose and Objectives

The goal of spinal fusion is to eliminate movement between unstable vertebrae and correct deformity. It is commonly used for instability, severe degeneration, fractures, or deformities such as scoliosis. Pain associated with any of these conditions may be alleviated by spinal fusion but this is not a guaranteed outcome.

Broad Operative Procedure

After exposing the spine, the surgeon places bone graft material between the affected vertebrae. The bone graft may be from the patient's own bone known as autograft, treated donated human bone known as allograft or alternatively a synthetic material may be used. Metal hardware (screws, rods, or plates) may be used to hold the bones in place while fusion occurs. Over time, the bones heal together into a single solid unit. Bone graft should still be used even if metal hardware is introduced into the spine.

(e) Pedicle Screw Fixation

Purpose and Objectives

Pedicle screw fixation provides immediate spinal stability, supports fusion, and corrects alignment after trauma, degeneration, or deformity.

Broad Operative Procedure

Screws are carefully inserted into the pedicles of selected vertebrae historically using anatomical landmarks alone but with x-rays and image intensifier radiological support during the latter decade of the 20th century. In more recent years, radiological guidance in combination with computer assisted imaging guidance, often referred to as neuro-navigation has been used to increase the

accuracy of pedicle screw placement. The screws are connected by rods or plates to stabilise the spine. This is often performed as part of a spinal fusion procedure.

(f) Discectomy (including Microdiscectomy)

Purpose and Objectives

Discectomy is intended to remove disc material pressing on a nerve root or spinal cord, relieving pain, numbness, or weakness. Microdiscectomy aims to achieve the same goal with less tissue disruption since the operating microscope allows surgery through smaller access incisions.

Broad Operative Procedure

Through an incision in the back or neck, the surgeon accesses the affected disc. The portion of the disc causing compression is removed. In microdiscectomy, a microscope and potentially smaller instruments are used through a smaller incision to minimise muscle and tissue damage.

(g) Spinal Cord Stimulator Implantation

Purpose and Objectives

This procedure aims to reduce chronic pain that has not responded to other treatments. The objective is to alter the transmission of pain signals generated by nerves entering the spinal cord before those signals can reach the brain and be interpreted as a painful sensation.

Broad Operative Procedure

Electrodes are placed in the epidural space near the spinal cord but not directly on the spinal cord. These are connected to a pulse generator implanted under the skin (usually in the buttock or abdomen). The device sends electrical impulses that interfere with pain transmission.

(h) Decompression

Purpose and Objectives

Decompression surgery aims to relieve pressure on neural structures caused by stenosis, disc herniation, tumours, or bone overgrowth.

Broad Operative Procedure

The surgeon removes or reshapes structures compressing nerves, such as bone, ligaments, or disc material. Decompression may involve procedures like laminectomy, discectomy, or foraminotomy and is tailored to the patient's condition and the location of compression or compromise of neural structures.

(i) Foraminotomy

Purpose and Objectives

The objective of foraminotomy is to relieve compression of a spinal nerve as it exits the spinal canal through the intervertebral foramen.

Broad Operative Procedure

The surgeon enlarges the intervertebral foramen by removing bone or soft tissue that is narrowing the space. This creates more room for the nerve root and reduces symptoms such as radiating pain.

(j) Nucleoplasty

Purpose and Objectives

Nucleoplasty is designed to reduce pressure within a disc and relieve mild nerve compression without major surgery.

Broad Operative Procedure

A needle is inserted into the disc under imaging guidance. A specialised probe removes or shrinks a small portion of the disc's soft centre using thermal or radiofrequency energy, lowering internal disc pressure. This is a less frequently undertaken procedure in the United Kingdom although it was more commonly undertaken at the turn of the 21st Century. It is still undertaken in many clinical settings in Europe and around the world.

k. Other types of spinal surgery commonly carried out by neurosurgeons over the period in which the Inquiry is interested.

None

11. What are the main risks, benefits and alternatives (in broad terms) to the surgeries listed above, as would have been generally understood and accepted over the relevant period.

11.1 All operations are accompanied by risk. The risks naturally vary according to the nature of the specific operation and additional factors. One may consider patient factors, surgical and pathology related factors and technical related factors. Risk factors may be modifiable and risks mitigated but not eliminated. There are also risks common or generic to many operations that may occur as the body responds to the effects of surgery and anaesthesia. Examples of such risks or adverse events include: deep venous thrombosis, pulmonary embolism (blood clot in the vessels of the lungs), reactions to medications and anaesthesia resulting in cardiovascular compromise. The consequences could be as severe as resulting in the death of the patient.

11.2 Patient risk factors may be related to factors that cannot be modified such as age, where patients at the extremes of age are more vulnerable and susceptible to adverse events. Other, potentially modifiable patient risk factors include: hypertension, smoking, diabetes, obesity, necessary medication (such as “blood thinners” like aspirin or warfarin or related medication). In addition, patients who are immunosuppressed for example requiring long-term steroids or who have had organ transplants will be more vulnerable.

11.3 Surgical and pathology related risk factors may vary according to anatomical location for example an adverse event from an operation in the cervical spine could result in tetraplegia (all four limbs paralysed) compared to the same adverse event occurring in the thoracic spine which could result in paraplegia (both legs paralysed). An adverse event by way of example could be a blood clot or haematoma developing that compresses the spinal cord, an interruption in the blood supply that causes loss of function of a region of the spinal cord (as spinal cord infarct), misplacement of spinal instrumentation such as a screw so that it damages the spinal cord or infection resulting in an abscess that compresses or infarcts the spinal cord. Such adverse events essentially interrupt the structure of the nervous system resulting in loss of function. Hence discussions about risk need to be nuanced to the particular circumstances of the patient and are not generic to all spine operations. The pathology may dictate the anatomical approach required for surgery and in turn this may determine if any adjuvant

interventions are required which in their own turn will carry associated risks. When considering risk in spinal surgery it is necessary to appreciate the different vulnerabilities of tissues and the consequences of adverse events in different regions of the spine. A post-operative haematoma in the lumbar spine has different risks and consequences compared to a similar haematoma in the cervical spine.

11.4 Technical related factors could include issues related to patient positioning for surgery e.g. risk of pressure sores, loss of vision with prone positioning to avoid direct pressure on the eyes, or maintaining body temperature from warming blankets during lengthy procedures since changes in temperature can affect body physiology for example blood clotting, cardiac rhythm and increase risk of infections. Technology factors such as monitoring equipment failing, loss of accuracy of image-guidance (neuro-navigation) systems, longer-term risks of implants or spinal metalwork failing may also be considered.

11.5 There are risks associated with non-operative or conservative management. These risks such as progression of deformity, spread or growth of a tumour, reduced likelihood of resolution of pain symptoms by way of examples, need to be considered and weighed appropriately and contextualised given the risks of surgery.

11.6 In addition to general risks outlined above, risks that spinal patients are exposed to include: vascular injury resulting in bleeding, ischaemia, venous engorgement and swelling or oedema of neural structures. Deficits in the dura or thinner arachnoid tissue layers that surround neural structures and that contain CSF, present a challenge since a watertight closure of these layers must subsequently be achieved and can be technically difficult requiring microsurgical skills and is often time-consuming lengthening the duration of an operation. When this occurs unintentionally it may be referred to as an incidental durotomy. (This is not uncommon and may occur in 3-8% of spinal operations). The term unintentional is used to indicate that a dural opening is not a necessary part of the operation but it can occur due to tissue layers being stuck to each other, the presence of scar tissue, sharp shards of bone, tissue being caught in surgical instruments. In some instances there is a complete lack of dura as an anatomical variant. By necessity, operations on the spinal cord itself such as tumours of the spinal cord or drainage of abnormal fluid collections within the spinal cord require

an opening, and an intentional durotomy (incision into the dura mater, the tough outer membrane covering the brain and spinal cord) is made. Infections in spine surgery may range from superficial wound infections occurring in 1-4% of cases, to rarer deep wound infections, spinal abscess formation or meningitis. When instrumentation (metal screws, rods, interbody cages or associated implants) is used in the spine there are longer-term risks of the metalwork breaking or dislodging over time which may be associated with non-union (the bone graft not forming a solid bridge of bone) or potentially infection around the metalwork. A recognised risk of spinal instrumentation is the development of adjacent level pathology which may be referred to a junctional failure (at the junction of a mobile region of the spine to the instrumented and now immobile section of the spine).

11.7 A specific risk that deserves special mention is the concept of incorrect level spinal surgery. There are numerous reasons that spinal surgery can be undertaken at the incorrect level. These range from anatomical variants, discrepancies in imaging quality, subtle intra-operative changes in position, body habitus (the shape of the patient – very large patients being more challenging to accurately identify the correct level), previous surgery and scar tissue distorting the expected surgical field, inaccurate reporting of imaging produced pre-operatively, difficulties correlating MRI scan images to plain x-rays or intraoperative image intensifier images, inaccurate registration of neuro-navigation. Surgeon error such as miscounting vertebrae can occur. This is less of an issue in the lumbar or cervical spine where reference landmarks are more reliable, but correctly identifying individual thoracic vertebra can be challenging. There is also the risk of incorrect *side* surgery (left vs right).

11.8 Identifying the correct level for spinal surgery has been a concern for many years. An old technique for lumbar spine surgery would be to make a large incision, identify the solid sacrum and then count upwards. The sacrum is a large triangular bone at the base of the spine that connects the vertebral column to the pelvis and is formed from five fused vertebrae. (illustration below). This was going out of fashion in the early 1990's and much more reliance on intra-operative radiology confirmation of the surgical level evolved, initially with plain x-rays, then with availability of mobile fluoroscopy with image intensifiers and more recently intra-operative 3-D image acquisition similar to a CT scan. The x-ray technique would involve a surgical instrument or needles being placed against a recognised

anatomical landmark and an x-ray would be taken and the film image subsequently developed so the surgeon could count and identify vertebrae or disc spaces in relation to a known landmark (for example the upper border of the sacrum or sacral promontory). Fluoroscopy was a more advanced technique that could produce an image in real time, with the most modern systems allowing the construction of a 3-D image that could be viewed in multiple planes enhancing the surgeons appreciation of the specific patient's anatomy.

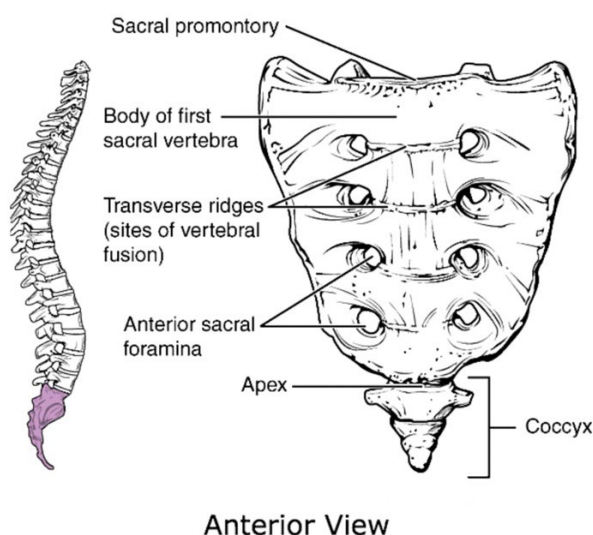


Illustration of the sacrum in relation to the rest of the spinal column.

11.9 The table below (11.11) lists the procedures previously referenced above in paragraphs 10.17 outlining the main risks, benefits and alternatives that could be considered during the relevant time period of 1995-2015.

11.10 In general, alternatives to invasive spinal surgery included: analgesic and anti-inflammatory medication, physiotherapy and exercise therapy, lifestyle modification, nerve root injections, the use of orthoses such as braces or walking aids, multi-disciplinary pain management as well as observation and allowing the natural history of innocent conditions to occur without intervention.

11.11 Summary of Spinal Procedures: Benefits, Risks, and Alternatives

Procedure	Potential Benefits	Material Risks and Complications	Reasonable Alternatives
Laminectomy	Decompression of the spinal cord and/or nerve roots with potential improvement in pain, gait, and neurological function.	Infection; haemorrhage; dural tear with cerebrospinal fluid leakage; nerve injury or deterioration in neurological function; post-operative spinal instability potentially requiring further surgery; persistent or recurrent symptoms.	Physiotherapy and analgesia; epidural steroid injections; less extensive decompressive procedures; observation in mild or stable cases.
Vertebroplasty	Potential rapid reduction in pain associated with vertebral compression fractures; minimally invasive procedure; short recovery period.	Cement leakage with potential neural, vascular, or pulmonary complications; infection; adjacent vertebral fractures; uncertain long-term efficacy.	Analgesia and external bracing; osteoporosis assessment and treatment; kyphoplasty; conservative management with observation.
Kyphoplasty	Pain reduction and stabilisation of the fractured vertebra; partial restoration of	Infection; cement leakage; balloon rupture or failure; adjacent vertebral fractures.	Vertebroplasty; non-operative fracture management;

	vertebral body height; reduced risk of cement leakage compared with vertebroplasty.		analgesia and physiotherapy.
Spinal Fusion	Stabilisation of unstable spinal segments; reduction of pain related to abnormal segmental motion; correction of deformity where present.	Failure of fusion (non-union or pseudoarthrosis); infection; instrumentation failure; adjacent segment degeneration; persistent or chronic pain despite fusion.	Continued conservative treatment; decompression without fusion in selected cases; external bracing; structured pain management programmes.
Pedicle Screw Fixation	Immediate mechanical stabilisation of the spine; increased likelihood of successful fusion; correction and maintenance of spinal alignment.	Malposition of screws; neural or vascular injury; hardware failure or loosening; infection.	Non-instrumented fusion techniques; external immobilisation (bracing); limited or alternative fixation methods.
Discectomy / Microdiscectomy	Potential for rapid relief of radicular pain; high success rates in appropriately selected patients; reduced tissue disruption and faster recovery	Recurrent disc herniation; nerve injury; dural tear with cerebrospinal fluid leak; infection; persistent or recurrent pain.	Non-operative management including analgesia and physiotherapy; epidural steroid injections; observation and watchful waiting.

	with microdiscectomy.		
Spinal Cord Stimulator Implantation	Reduction in chronic neuropathic pain in selected patients; adjustable and reversible therapy; potential reduction in opioid requirements.	Infection; lead migration or device failure; hardware malfunction; inadequate or loss of pain relief.	Medical pain management; multidisciplinary pain rehabilitation programmes; nerve blocks; intrathecal drug delivery systems.
Spinal Decompression (General)	Relief of neural compression with potential improvement in pain and functional capacity; preservation of spinal motion where fusion is not required.	Incomplete or absent symptom improvement; nerve injury; iatrogenic spinal instability; requirement for further surgical intervention.	Non-surgical management; injection-based therapies; observation.
Foraminotomy	Targeted decompression of the affected nerve root with relative preservation of spinal stability when appropriately performed.	Nerve injury; persistent or recurrent symptoms; spinal instability if excessive bone removal occurs.	Conservative management; discectomy; laminectomy.
Nucleoplasty	Minimally invasive	Limited or uncertain clinical	Conservative management;

	technique with shorter recovery compared with open surgery; reduction of intradiscal pressure.	effectiveness; disc injury or degeneration; infection; potential requirement for subsequent surgical intervention.	discectomy or microdiscectomy; epidural steroid injections.
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12 Please set out any key developments in the period in which the Inquiry is interested in the approach to the listed surgeries, including techniques generally used and approaches to determining suitability for the surgery.

12.1 Between the years 1995 – 2015 there were substantial developments in spinal surgery coming from both the neurosurgical and orthopaedic communities. Traditionally neurosurgeons had mainly been concerned with pathologies affecting the contents of the spinal canal i.e. the spinal cord and the spinal nerves while orthopaedic surgeons had focussed more on the bony vertebral column and associated deformity or injuries to the vertebral column. Considerable overlap between the specialties emerged although clearly separated areas of expertise persist today. Specifically, neurological structures within the dura remain in the domain of neurosurgeons, complex deformity such as scoliosis surgery is largely undertaken by orthopaedic spine surgeons. Decisions over who would offer a specific type of surgery could be considered an evolutionary process depending on skill mix, expertise, professional interest. Drivers for developing a particular area of surgery could be a combination of local demand, increasing recognition of conditions for example as a consequence of more people undergoing MRI scanning, as well as surgeons developing an interest in a particular branch of surgery or learning about such surgery from peers nationally or internationally.

12.2 During the period concerned there was an increase in cross-specialty training providing neurosurgeons with exposure to orthopaedic techniques and vice versa. This served a number of purposes and achieved several goals. First, for neurosurgeons needing to access the spinal cord and spinal nerves via the

bony vertebral column, there would be greater appreciation of orthopaedic surgical techniques for operating on bone. Second, neurosurgeons would be more aware of the potential for spinal instability or spinal deformity as a consequence of the surgical exposure and thus greater understanding of when spinal instrumentation for stabilisation or reconstruction would be required. Third, orthopaedic surgeons could improve their microsurgical skills for when they might be required to repair a defect in the dura. Fourth, cross-specialty training facilitates knowledge exchange so surgeons could gain knowledge in previously unfamiliar areas. For example, orthopaedic surgeons have a lot of training on bone biology and biomechanics which during the 1990's and early 2000's would not have been part of the neurosurgical mainstream training. For orthopaedic surgeons use of the operating microscope to enhance visualisation of structures and learning about less invasive techniques would have been an advantage of cross-specialty training. In the present day it is now common for neurosurgeons and orthopaedic surgeons to collaborate when planning and undertaking complex spinal surgical procedures.

12.3 Over the past forty years there has been a trend away from large surgical exposures to smaller, less invasive interventions through smaller incisions. This has been aided by increasing adoption of the operating microscope that provides greater illumination, magnification of structures and hence enhanced visualisation of pathologies for which a patient is undergoing surgery. An operating microscope is a large, expensive piece of equipment. During the relevant time period all neurosurgical units would have a minimum of one or two operating microscopes. An alternative to an operating microscope, and still used in many circumstances, are surgical loupes. These are like small binoculars fixed to a spectacle frame that provide a fixed amount of magnification at a fixed focal distance. They allow the surgeon to have more freedom of movement when operating but lack an integrated light source and as mentioned the amount of magnification is fixed. Smaller incisions do not necessarily result in better long-term outcomes but may certainly in the short-term be less traumatic to the tissues and promote earlier recovery from surgery. The trend to smaller incisions saw the evolution of tubular retractors (which separate the tissue as opposed to cutting or stretching it further) to provide minimally invasive access to the spine, sometimes with a skin incision of 1.5 – 2.0 cm. An even more minimally invasive technique is the evolution of true endoscopic spine surgery delivered via rigid endoscopes but through skin incisions less than

1 cm. An endoscope is a tube with a light source and camera for looking inside cavities within the body. Typically there are small working channels through which specifically designed surgical instruments can be passed. Endoscopic spine surgery was undertaken in very few centres in the United Kingdom during the relevant time period although it is being adopted much more widely in the present day.

12.4 The 1990's saw an increase in the use of pedicle screws placed in the vertebrae to provide rigid internal fixation with the potential for improved biomechanics and immediate stabilisation of the spine. Previously, internal fixation or instrumentation of the spine may have used a combination of metal rods and wires looped through vertebrae and twisted or secured using clamps to provide a solid structure. Popularity for the use of pedicle screws increased substantially in part because they provide a solution for potential instability that might ensue from the removal of tissue necessary for the access to otherwise inaccessible pathologies. Hence, more extensive bone or joint removal that allows greater access to pathology with safer and more advantageous trajectories that would, as a consequence, result in spinal instability, could have a mitigation of immediate stability provided by pedicle screws and connecting rods. Pedicle screws themselves evolved as biomechanical and clinical evidence drew attention to improved design possibilities as well as limitations of existing designs. A pedicle screw can be inserted (using a screw specific screw driver) into the pedicle of the vertebra and the thread of the screw prevents pull out or displacement of the screw. Screws can be inserted under direct vision using anatomical landmarks and positioning can be enhanced by using x-ray images or more commonly fluoroscopy to help in the placement of screws. It should be noted that careless use of fluoroscopy without an appreciation of parallax (the displacement or difference in the apparent position of an object viewed along two different lines of sight) can result in misplacement of pedicle screws. Pedicle screws provide immediate stability but longer-term maintenance of stability requires bone growth and bony fusion around the construct. This is a biological process that can be enhanced by the surgeon preparing the bone surfaces (roughening them using surgical tools) combined with placement of bone graft taken either from the patient themselves (referred to as autograft) or cadaveric bone (referred to as allograft) or in some instances synthetic bone graft substitutes. Pedicle screws firmly anchored in bone provide more structural support than other constructs with metal

wires and cables looped around bony points of the vertebrae and twisted snugly down onto a supporting metal rod. Pedicle screws can be inserted by neurosurgeons or orthopaedic surgeons with appropriate experience or training and skill.

12.5 The late 1990's saw the emergence of the concept of dynamic stabilisation and motion preservation in the spine as an alternative to rigid fixation and immobilisation. The hypothesis underpinning dynamic stabilisation is that the vertebrae and joints allow movement so permitting some movement to continue might be more desirable than enforcing rigidity on a section of the spine. Radiologically one might see accelerated degenerative changes in discs and vertebrae adjacent to a fused segment of the spine, this would not necessarily correlate with clinically important symptoms (or even any symptoms at all). The case for dynamic stabilisation and motion preservation over fusion has not been proven. Although not an entirely new concept, progress in biocompatible materials and biomechanical engineering saw the introduction of devices such as intervertebral disc replacements for both the cervical or lumbar spine, interspinous distraction devices designed to distract vertebrae and stretch out compressing ligaments away from neural structures, and elastic materials designed to reproduce the effects of spinal ligaments.

12.6 During the 1990's and early 2000's many of the devices generically referred to above were relatively easy to introduce into practice in Europe and the United Kingdom. Regulation of medical devices was less robust despite the introduction of the Medical Device Directive in 1993. The European Union including the United Kingdom amended the Medical Device Directive in 2007 and it has subsequently been replaced by the Medical Device Regulation in 2021 albeit with transition arrangements. The Medical Device Directives and subsequent Regulation relate to requirements for manufacturers. They did not directly impose constraints on clinicians or surgeons. Manufacturers would have to provide Instructions For Use (IFUs) and the expectation would be for a surgeon to understand how and when to use medical devices either through reviewing the appropriate literature, or attending training courses or professional guidance and instruction in a particular technique. Subsequently, manufacturers have taken a more proactive role in ensuring surgeons are trained in the indications and techniques to use a specific device. This provides some background to the

increase in available spinal devices and implants with relatively limited long-term data or evidence of efficacy during the period 1995 – 2015.

12.7 Intraoperative neurophysiology monitoring (IOM) was introduced in the 1970's. The purpose of the monitoring is to provide an assessment either intermittently or continuously of the functioning of brain and / or spinal cord activity where a change such as reduced or lost signal could alert the surgeon and anaesthetist to possible danger to the neural tissue potentially warranting heightened caution or alterations in surgical and anaesthetic techniques. Its use continues up to the present day. Initially monitoring sensory spinal cord pathways, motor (movement controlling) pathway monitoring was introduced in the 1980's. Small needle electrodes are placed on the scalp and on the limbs or to specific muscles. Baseline reading from the electrodes are taken once the patient is anaesthetised. During the operation electrical stimuli can be generated and detected by the neurophysiologist. Changes in the detected magnitude of the electrical impulse or the time it takes between stimulus and detection can indicate altered spinal cord, nerve or brain function. Specific anaesthetic techniques have to be used if intraoperative neurophysiology monitoring is to be used. By the 1990's multimodal monitoring of intraoperative spinal cord integrity and function was available. There remains ongoing debate regarding its usefulness but generally it is an accepted monitoring standard when correcting significant deformities of the vertebral column or when operating directly on the spinal cord itself.

12.8 Improvements in imaging the spinal column and associated structures including the spinal cord and nerve roots evolved between 1995 – 2015. Historically, imaging of the spinal cord and nerves was limited to interpretation of myelograms, x-rays taken of the spine following injection of a radio-opaque contrast material into the spinal canal or CSF filled space within the dura. Myelograms are useful for outlining CSF spaces and distortions in the appearance of CSF spaces or interruptions in flow of CSF might indicate the location of pathology for example an intradural tumour causing distortion to the shape of the spinal cord. However, myelograms do not directly provide a detailed image of the pathology. One could describe a myelogram as outlining an absence of normal anatomy rather like inferring an object by its shadow rather than direct observation of the object itself. Magnetic Resonance Imaging gradually became more available

during the 1980's and 1990's providing high resolution images of soft tissues that were previously less visible with techniques such as myelograms or CT scanning. MRI scans bring advantages to imaging the spine outlining with greater clarity and precision both anatomy and pathology. Differences in contrasting tissues and elements can be identified such as differences between blood, CSF, nerves, intervertebral discs and tumours. Images can be displayed in multiple planes giving greater appreciation of the relationships between structures. In addition, MRI scans can help differentiate pathologies such as tumours, scar tissue, infection or normal aging tissue by way of examples. A particular advantage of MRI scanning is the avoidance of harmful ionising radiation. Not all patients are suitable for an MRI scan and particularly during the relevant period patients with certain implants including pacemakers or older cerebral aneurysm clips would have been excluded from having an MRI scan and hence older imaging techniques would still be used in their investigations. CT scanning acquires images by passing a narrow beam of x-rays through the area of the body to be imaged and the emerging x-rays are detected on a digital detector. Different body tissues absorb x-rays to a greater or lesser extent and mathematical algorithms reconstruct the detected signals into images. Modern CT scanners can reconstruct the images in multiple planes, can acquire images very rapidly and they are a valuable tool in scanning large regions of the body rapidly which is particularly useful for evaluating trauma. CT scans are very helpful for identifying pathology that subsequent MRI scanning can help to differentiate. CT scanning is also excellent for assessing bony anatomy which is otherwise less well defined on MRI scans. Technology for CT scans and MRI scans has advanced significantly between 1995 and 2015 and even more so in recent years. Initially image acquisition would have been quite slow and of limited resolution and clarity. The obvious hazard with CT scanning is the patient gets exposed to ionising radiation. Pre-operative imaging advances enabled surgery to be more targeted to the most appropriate pathology that correlated with the history given by the patient combined with appropriate finding on physical examination. Advanced imaging also increased awareness that imaging anomalies alone were not sufficient indications for surgery as incidental findings and non-concordant pathologies, especially in relation to degenerative changes could be identified. To have identified something amenable to surgery there would have to be a strong clinical correlation with the patient's symptoms, appreciation of the natural history of what might happen if no intervention was undertaken, consideration would be given for monitoring and observing the patient

or repeated assessment, alternative treatment options if appropriate could be discussed along with an explanation of any surgical risks and hazards, uncertainties and expectations. Hence the clinical context is of paramount importance and not just the incidental identification of a curiosity on the scan.

12.9 Intraoperative spinal imaging (providing real time anatomical visualisation for the surgeon during spinal surgery) evolved between 1995 – 2015. Predominantly used to confirm the appropriate spinal level to undertake surgery, a pre-incision x-ray would be taken and more crucially a post-incision x-ray would be taken at the proposed surgical target in the spine. These would indicate the approximate location to make the first incision and then more precisely confirm the correct location to undertake surgery. If the second x-ray indicated the incorrect level for spinal surgery, it would be possible to adjust the surgical approach to more accurately approach the intended level for surgery. This has been a well-established technique for many decades predating the period that concerns this Inquiry. Historically, the surgeon would have to wait for the x-ray images to be developed to see the images before proceeding further. This would add to the duration of the operating, increasing risk. Increased use of fluoroscopy using radiology tools known as image intensifiers allowed real-time imaging to assist in identifying and confirming the appropriate levels for spinal surgery. Image intensifiers started to be used in spine surgery in the 1970's. Image intensifiers produce an image that looks like an x-ray image but by converting very low doses of x-rays and amplifying the signal produced into a picture that can be seen in real time. This allows multiple images or even moving images to be produced and viewed within the operating theatre. In addition, image intensifiers were increasingly utilised to guide surgeons in their placement of implants such as pedicle screws based on characteristic radiological landmarks of vertebrae. This had the potential to improve the accuracy of implant placement compared to freehand techniques reliant on directly observable anatomical landmarks, or, to confirm adequacy of the placement and trajectory of any spinal implants. During the late 1990's to early 2000's computer assisted spinal navigation evolved. Placing pedicle screws freehand requires an understanding and appreciation of 3-D anatomy, individual patient variation, relevant bony anatomy at different levels of the spine, accounting for alterations due to deformity or degenerative changes and methodical and cautious initiation of screw holes, checking trajectory to ensure the walls of the pedicle had not been breached and skilled hand eye

coordination. Even with the best of surgeons, not all screws would have a perfect placement.

12.10 Computer assisted neuro-navigation can be likened to a Global Positioning System used to navigate and confirm position. This was established technology in cranial neurosurgery becoming widely adopted in the mid 1990's but presented some challenges when applied to the spine. A fixed reference array of reflective markers or light emitting source in a fixed pattern has to be attached firmly to a known structure such as a spinous process. A 3-D image of the spine taken from a CT scan or a combination of fluoroscopic images is then generated. Then, directly observable bony landmarks must be co-registered to the 3-D generated image. Co-registration involves matching real-time anatomical points on the patient to corresponding points on the image. The surgeon navigates from the image which can represent structures out of sight and otherwise invisible to the direct vision of the surgeon. One can then "navigate" within the operative field. The major challenge is that vertebrae move in relation to each other because of their joints (intervertebral discs and facet joints), reducing accuracy as the surgeon operates further away from the fixed reference frame.

12.11 Between 1995 - 2015 there was a move away from a reductionist model of spinal pathology requiring surgery particularly in relation to degenerative conditions such as disc herniations and spinal stenosis towards a more symptom focussed approach to management. Greater focus on patient understanding and expectations of the management of their condition emerged. Clinicians had been trained to look out for so called "red flag" signs indicating potential emergency or important conditions that warranted further investigation. During the 1990's and 2000's the concept of "yellow flags" evolved. These had relevance in the spinal community with respect to long-term disability and chronic pain following an episode of back pain with or without associated trauma. Yellow flags highlight psychosocial circumstances that may contribute to disability which in turn can contribute to caution and a more circumspect approach to offering and undertaking surgery. Yellow flags are listed in the section below: they are not precursors of red flags (taken from NHS Scotland webpages:

<https://www.rightdecisions.scot.nhs.uk/dgrefhelp-nhs-dumfries-galloway/musculoskeletal-system/spinal-pathway/yellow-flags/>)

12.12 Yellow Flags (NHS Scotland) – Psychosocial Risk Factors⁷ [ELJ0001-00075]

Domain	Indicators (Yellow Flags)
Attitudes	Belief that pain is potentially harmful or disabling Belief that pain must be abolished before returning to work Expectation of increased pain with activity or inability to predict capability Catastrophic thinking and misinterpretation of bodily symptoms Belief that pain is uncontrollable Passive attitude to rehabilitation
Behaviours	Extended rest or disproportionate downtime Reduced activity levels and withdrawal from activities of daily living Poor compliance with exercise, physical activity, or cycling Avoidance of normal activities and lifestyle substitution Reports of very high pain intensity (e.g. NRS 10/10) Poor sleep quality since onset of pain Increased alcohol or substance use since pain onset Smoking
Compensation Issues	Lack of incentive to return to work Disputes regarding access to benefits History of claims related to other injuries Previous episodes of back pain with

⁷ <https://www.rightdecisions.scot.nhs.uk/dgrefhelp-nhs-dumfries-galloway/musculoskeletal-system/spinal-pathway/yellow-flags/> 31 July 2026

	sickness benefits Involvement in a medico-legal claim
Disability / Healthcare Factors	Health professionals sanctioning disability Conflicting diagnoses causing confusion Use of unfamiliar medical language contributing to catastrophising Dramatisation of symptoms by professionals or dependency on treatment Ongoing receipt of passive treatment Expectation of a quick or easy cure Dissatisfaction with previous treatment for back pain Advice to change or withdraw from employment
Emotions	Fear of increased pain with activity Depression or loss of enjoyment Irritability Anxiety and heightened bodily awareness Feeling stressed and lacking control Social anxiety or withdrawal from social activity Feelings of uselessness or low self-worth
Family	Overprotective spouse or partner reinforcing pain behaviours Solicitous behaviour from spouse or partner Socially punitive responses from spouse or family Limited family support for return to

	work Lack of someone to talk to
Work	History of manual or physically demanding work Repetitive or monotonous work Poor work history including frequent job changes or interpersonal conflict Belief that work is harmful or dangerous Unhappy current work situation Low educational or socio-economic status High biomechanical demands Lack of graded return-to-work options Negative workplace experiences regarding back pain Limited employer interest or support

12.13 The period of interest 1995-2015 saw a rise in the use of outcome measures, mainly in the setting of clinical studies, to support the evidence base and to inform interpretation of clinical trials. Prior to the relevant period very little measurable outcome data was available following spinal surgery. Examples of tools used to measure outcome from both non-operative and operative management of spinal conditions include Visual Analogue Scales, Oswestry Disability Index, Short Form – 36. These all attempt to provide a measure of change in symptoms or importantly, a change in patient function (does the intervention make any useful difference). Importantly, did it make any difference to the patient in a way that could be recorded and compared before and after an intervention. The use of outcome measures reflects the general shift within the medical profession toward evidence-based medicine as well as toward functional assessment with an emphasis on what matters to patients. The outcome measures have been validated in many populations of patients. The Oswestry Disability Index specifically measures how back pain affects daily activities while Short Form- 36 evaluates general physical and mental well-being across eight domains. The results are applicable to individual patients as well as being useful

for populations of patients especially in studies evaluating interventions or treatments.

12.14 Patient screening for suitability to undergo surgery developed during 1995 – 2015. As indications for surgery increased with improved imaging and a rise in degenerative spine conditions associated with increased longevity, co-morbidities including physical and psychological health resulted in more participation in multi-disciplinary team assessments. In addition, moderation of expected outcomes, recognition of uncertainty of benefit and consideration of patient values and preferences became common practice. Patient selection, through clinical consultations and MDT discussions became as important as technical surgical skill.

12.15 Vertebroplasty and kyphoplasty gained prominence during the years 1995-2015. These related procedures involve the minimally invasive injection of bone cement into a vertebra that has fractured often as a consequence of osteoporosis and metabolically weakened bony architecture. Good quality imaging in both antero-posterior and lateral planes is required to safely undertake these techniques. Increased access to image intensifiers or biplanar radiology imaging suites saw an increase in these procedures. Neurosurgeons, orthopaedic surgeons and interventional radiologists might undertake these procedures. By the late 2000's an appreciation of the age of the identified vertebral fracture, the underlying pathology, changing pain severity, progress or otherwise with conservative therapy, correlation with imaging, exclusion of non-fracture pain sources as well as a trial of conservative therapy, were all factors to consider before undertaking vertebroplasty or kyphoplasty.

12.16 In summary during 1995 – 2015, there were technological improvements that allowed clinicians to “see” into the spinal canal and to image the body with greater resolution – particularly MRI scanning. Improvements in imaging may have increased potential targets and indications for surgery. Improvements in hardware such a pedicle screws and rods increased the technical possibilities and potential invasive opportunities to address suspected pathology. Minimally invasive approaches did not necessarily equate to minimal risk. Debates surrounding motion preservation versus fusion in the spine emerged and continue. There has been an increase in the use of instrumentation in the spine while at the same time

a greater appreciation of factors that influence patient outcomes has risen in importance and moderates patient selection. There has been an increase in patient autonomy as well as consent processes for patients considering surgery. What may be considered “best practice” today in 2026 is a gradual accumulation of layers of information, emerging evidence, consensus, financial scrutiny of value for money making what may be described as a “patchwork quilt” of accepted practice in spinal surgery and neurosurgery. Presently in England, surgeons work within a framework of: National Institute for Health and Care Excellence (NICE) guidelines informed by systematic reviews of evidence, resulting in Interventional Procedures Guidance; British Association of Spine Surgeons (BASS) clinical pathways as well as NHS Commissioning and Quality Frameworks such as Service Specifications and Getting It Right First Time (GIRFT) recommendations. There has also been an increase in utilisation of the British Spine Registry driving compliance with Best Practice Tariffs – which predominantly enforces financial constraints, increases data collection and highlights regional variance in practice. 2015 saw a landmark UK Supreme Court ruling that changed the standards for medical consent *Montgomery v Lanarkshire Health Board 2015* [ELJ0001-00077]. This meant the consent process should be a much more individualised discussion between surgeon and patient where reasonable treatment options and not just the surgeon’s particular preference should be discussed and explained, and importantly that there should be disclosure and discussion about any material risk that an individual patient might consider to be significant. The change in consent moves away from historically medically paternalistic consent practices towards individualised patient centric practice.

Intracranial surgery

13 Please explain the following issues with which patients may present to a neurosurgeon:

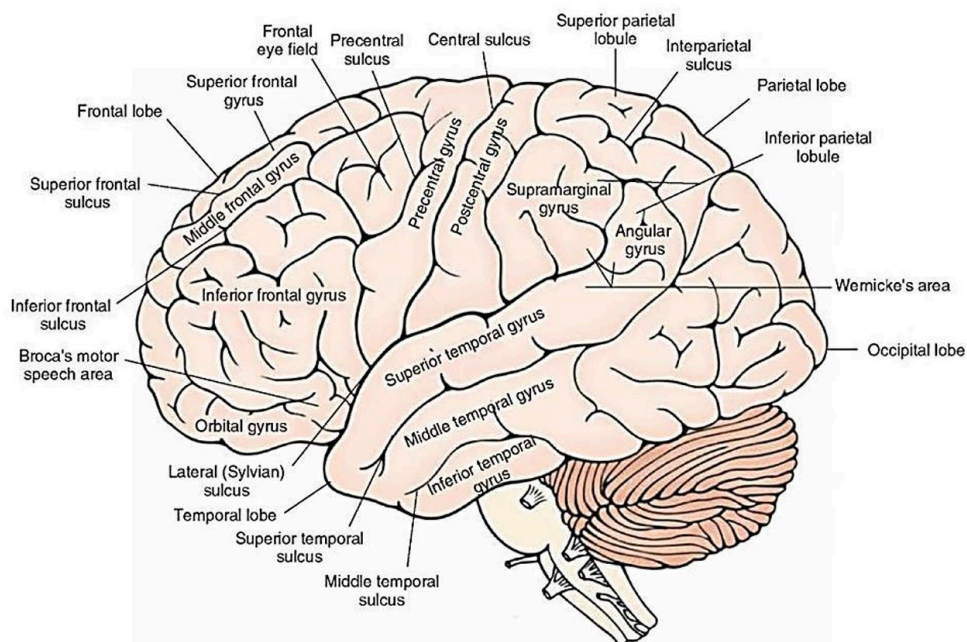
- (a) Glioblastoma Multiforme (GBM);**
- (b) Meningioma;**
- (c) Sarcoma;**
- (d) Neuroma, including acoustic neuroma;**

- (e) Pituitary Tumour;
- (f) Hemangioblastoma;
- (g) Arteriovenous Malformation (AVM);
- (h) Hydrocephalus;
- (i) Traumatic Brain Injury (TBI);
- (j) Epilepsy;
- (k) Trigeminal neuralgia;
- (l) Intracranial hypertension;
- (m) Ischaemic stroke/ blood clot;
- (n) Brain haemorrhage;
- (o) Arterial dissection;
- (p) Intracranial infection;
- (q) Parkinson's disease;
- (r) Multiple sclerosis; and
- (s) Any other common brain or intracranial conditions or injuries with which a patient may present to a neurosurgeon.

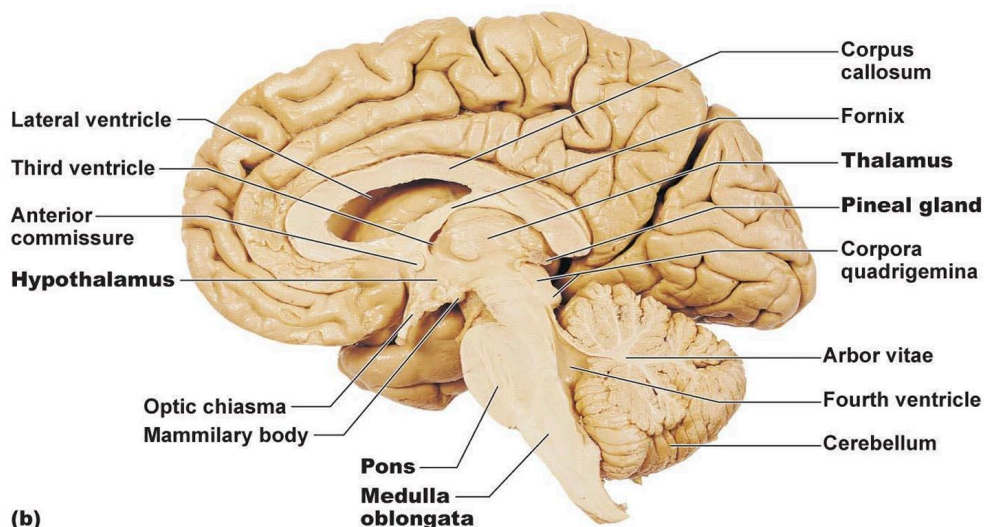
13.1 A neurosurgeon treats many intracranial conditions. These include traumatic brain injury, tumours of brain and nearby tissues, vascular conditions (e.g. aneurysms; arteriovenous malformations, intracranial haemorrhage), congenital pathology (e.g. some cases of hydrocephalus, Chiari malformation), intracranial infections (e.g. abscess) and functional conditions (e.g. movement disorders such as Parkinsons Disease, spasticity from multiple sclerosis, trigeminal neuralgia and epilepsy).

Whilst neuroanatomy is a complex subject the following images are provided to assist the Inquiry.

13.1.1 This figure shows the principal convolutions (gyri) of the right cerebral hemisphere. While appearances on the left are similar, different areas of the brain subserve different functions.

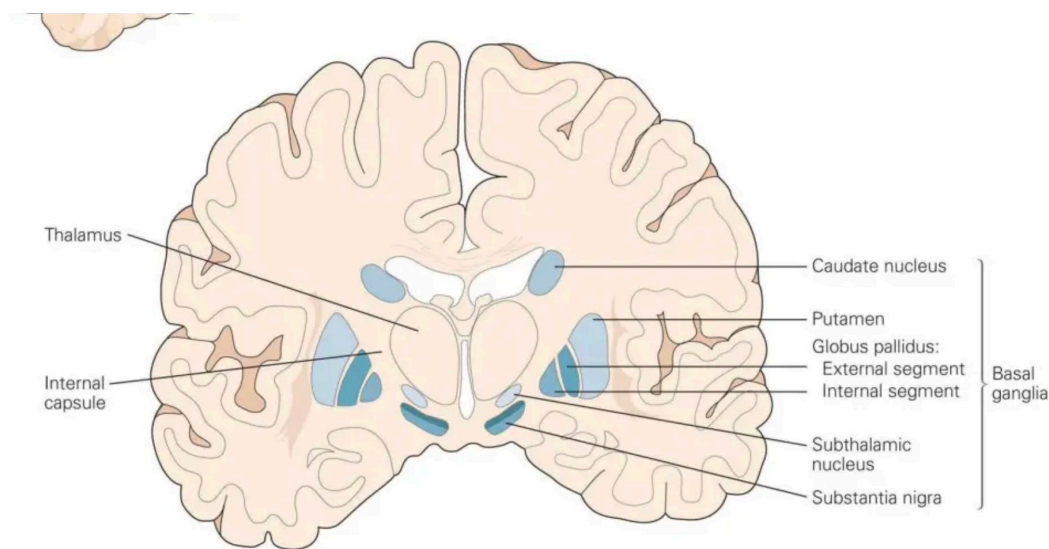


13.1.2 This figure shows the medial surface of the right side of the brain. Note the corpus callosum: this is a substantial neuronal connection between the hemispheres. Also note the brainstem (midbrain [unlabelled], pons and medulla) that provides the connection between the brain and spinal cord. The cerebellum (balance and motor control) is attached to the posterior aspect of the brainstem.

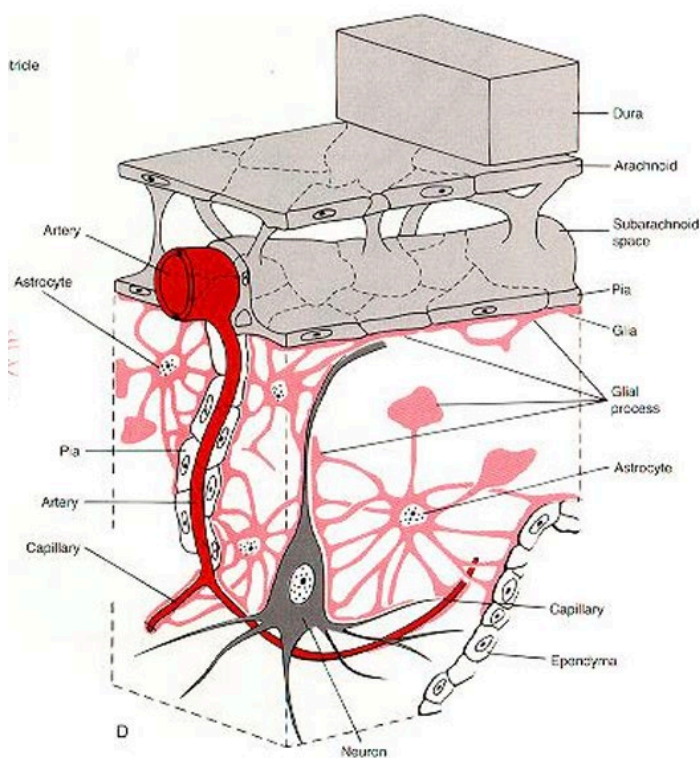


13.1.3 The basal ganglia and ventricles are contained within the brain. The basal ganglia integrate motor functions and are targets for the

treatment of movement disorders. The ventricles [unlabelled] contain cerebrospinal fluid and can enlarge in disease processes (hydrocephalus). The lateral (one in each hemisphere) and third ventricle (a midline structure) are shown in this figure (white spaces).



13.1.4 This figure illustrates the blood vessels on the surface of the brain and their relationship to astrocytes (a type of glial cell that supports nerve cells both physically and physiologically) and neurones (nerve cells).



13.2 When assessing clinical presentation, a neurosurgeon considers the onset of the symptoms (e.g. sudden; gradual) and the nature and character of symptoms. The most common symptoms and signs caused by intracranial pathology include:

- Symptoms and signs of raised intracranial pressure including headache, nausea, vomiting, blurred vision, papilloedema⁸ and impaired level of consciousness.
- Symptoms and signs of a focal neurological deficit. These symptoms are dependent upon the location of the pathology and include cranial nerve⁹ deficits, limb weakness (usually on one side of the body); sensory impairments (usually on one side), coordination deficits and visual field deficits.
- Seizures. These involve sudden uncontrolled electrical activity in the brain which temporarily disrupts the communication of nerve cells. These can

⁸ Papilloedema = swelling of the optic nerve. Detected on examination of the eye with an ophthalmoscope

⁹ Cranial nerve = these are the nerves that arise in the brain and subserve senses of vision, hearing, smell and taste. The cranial nerves supply muscles that move the face, chew food, move the tongue, coordinate swallowing and other vital functions. There are 12 pairs of cranial nerves.

be focal affecting a localised part of the body (partial) or generalised, affecting the whole body. The patient may be awake and aware (simple), awake and unaware (complex) or unconscious (complex). Epilepsy is the term used when a patient has repeated seizure activity.

13.3 With increasing use of CT and MRI scans during the relevant period, intracranial neurosurgical pathology was often identified as an incidental finding i.e. the finding of an abnormality was not the cause of the symptoms that led to the request to perform a scan. Incidental findings often do not require treatment due to the balance of risks favouring a conservative approach of leaving untreated. Sometimes surveillance scans are used to monitor incidental pathology (e.g. an incidental asymptomatic benign tumour). Sometimes no further scans are required.

(a) Glioblastoma Multiforme (GBM)

13.4 This is the most aggressive (grade 4) of a family of tumours arising from glial, or supportive, cells within brain tissues. Treatment normally entails an operation to obtain tissue for diagnosis. This may be performed as a biopsy, or, if the tumour is accessible and the patient's condition conducive, as a tumour debulking operation via a craniotomy (defined below). Due to the infiltrative nature of GBMs causing an ill-defined boundary between tumour and functioning brain tissue, complete excision of the tumour is rare. Most patients receive adjuvant treatment comprising radiotherapy and chemotherapy after recovering from surgery. The prognosis is generally considered to be poor. There have been major advances in understanding the processes causing gliomas in the last decade. During the relevant period, the prognosis for a patient with a high-grade glioma would have been generally poor with a median survival time of around 12 months. The mainstays of treatment were surgical debulking and radiotherapy. The addition of temozolomide radiotherapy following the research of Stupp et al (2005) [ELJ0001-00073] increased the median survival to 14.6 months. In their study the survival times at 2 years were 26.5% for a patient receiving post-resection radiotherapy and chemotherapy, and 10.4% for those receiving post-operative radiotherapy alone.

(b) Meningioma

13.5 This is a tumour arising from intracranial membranes: specifically, from arachnoid cap cells. Most meningiomas are attached to the dura, the membrane that lines the skull and divides the cranial cavity into compartments. Around 90% of meningiomas are Grade 1 (benign), 10% are Grade 2 (atypical) and less than 1% are Grade 3 (malignant). Some meningiomas are readily accessible. Others occur in areas of the cranial that are difficult to access due to proximity to critical structures such as the brain stem, major arteries, venous sinuses¹⁰ and the cavernous sinus¹¹. Rarely meningiomas can invade surrounding structures such as the orbit (eye socket) and the spaces that lie immediately beneath the skull base (e.g. infratemporal and pterygopalatine fossae). The orbit contains the eyeball (globe), and the muscles, nerves and blood supply to the intraorbital structures. The infratemporal and pterygopalatine fossae are adjacent to each other lying beneath the temporal bone and cheek bone (maxilla). They contain important nerves, muscles and blood vessels that supply the face, jaw, salivary and lacrimal (tear) glands.

(c) Sarcoma

13.6 Sarcomas are very rare intracranial tumours. The diagnosis is normally only made after a tumour resection. They are normally malignant and infiltrate brain tissue. This usually results in incomplete resection causing a high risk of early recurrence despite adjuvant treatments.

(d) Neuroma, including acoustic neuroma

13.7 Intracranial neuromas are tumours that grow from nerves that emerge from the brain. Most neuromas arise from cells that envelope the neuronal axon¹². These cells are called Schwann cells: neuromas are therefore often referred to as schwannomas. The most common tumour of this type is called a vestibular schwannoma, or an acoustic neuroma. Such a tumour normally presents with unilateral sensorineural hearing loss, tinnitus and balance impairment. The

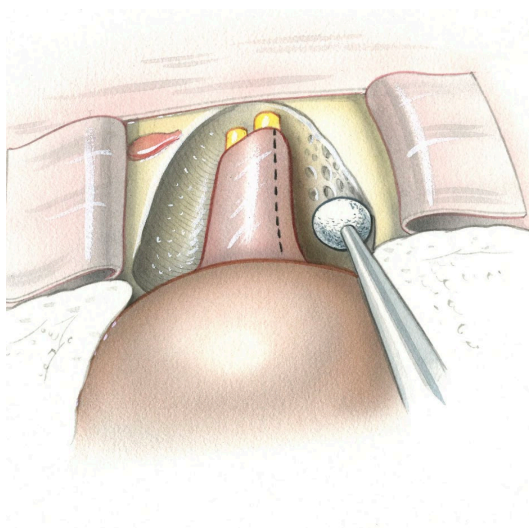
¹⁰ Venous sinus = arteries provide the brain with an oxygenated blood supply. Veins drain deoxygenated blood from the brain tissue. The veins then drain into much larger veins, the venous sinuses. These then drain to the large veins of the neck, such as the jugular vein, returning blood to the heart to be reoxygenated as it is pumped to the lungs before being pumped back to the brain.

¹¹ Cavernous sinus = a venous sinus that contains several cranial nerves. The cavernous sinuses lie in the skull base and normally interconnect across the midline, the central axis dividing the left and right hemispheres of the brain.

¹² Axon = nerve fibre.

tumour is in a difficult to access recess within the head, normally commencing in the internal auditory canal and extending into the cerebellopontine angle (CPA). Most patients with a vestibular schwannoma present to an Ear, Nose and Throat (ENT) specialist. Nowadays, management is normally undertaken by a Skull Base team with management options including surveillance, stereotactic radiosurgery¹³ delivered with a Gamma knife or a LINAC machine or open surgery. As explained below, in the relevant period, retrosigmoid surgery was often undertaken by a neurosurgeon alone. Surgery can be performed via the bone of the ear (translabyrinthine approach) with participation of an ENT surgeon and a neurosurgeon. Alternatively, and more commonly, surgery can be performed via a retrosigmoid approach. In 1995 this approach was often performed independently by a neurosurgeon. The tumour component within the internal auditory canal (intracanalicular tumour) is difficult to access and residual tumour was a common post-operative sequela. During the 1990s changes occurred such that an ENT surgeon often assisted during a retrosigmoid operation by drilling bone to enable removal of the component within the auditory canal, minimising risk to anatomical structures contained within the adjacent bone (e.g. breaching the nearby posterior semicircular canal causes severe hearing loss and vertigo). The image below shows drilling to access the intracanalicular component of the tumour. The development of multidisciplinary care evolved during the 1990s and the first decade of the 21st Century. This is an example of a multi-disciplinary approach which started to be adopted over the relevant period to provide better patient care.

¹³ Stereotactic radiosurgery (SRS) = a very focussed form of radiotherapy, usually delivered as a single day case treatment. SRS can be delivered with a Gamma Knife, a modified linear accelerator (LINAC), or Cyberknife.



(e) Pituitary Tumour

13.8 The pituitary gland is located at the base of the brain. The pituitary gland has a central role in the regulation of hormones including steroids, growth hormone, thyroid hormones, hormones of pregnancy and sex hormones. A pituitary tumour is normally a benign lesion that arises from the pituitary gland. The common type of pituitary tumour is an adenoma. A craniopharyngioma is a rarer tumour that can present in children and older adults. A pituitary tumour patient may present because of the tumour compressing nearby structures: visual field loss from optic nerve/ optic chiasm compression is a common presentation. Impaired eye movements can also occur. Sometimes a pituitary tumour can secrete hormones that result in symptoms. This is known as a functioning tumour. Excessive secretion of growth hormone as a result of the presence of a tumour can cause acromegaly in adults. An acromegalic patient may report an insidious increase in hand and foot size, prominence of the jaw, tongue enlargement, oily skin, diabetes, carpal tunnel syndrome, hypertension and cardiac problems. There is also an increased risk of colon cancer. Excessive secretion of steroids secondary to a pituitary tumour can cause Cushing's Disease. This is characterised by centripetal deposition of fat, weight gain, proximal muscle wasting making it difficult to climb stairs and stand from a seated position, osteoporosis and an increased susceptibility to fractures, bruising of skin, psychiatric symptoms, hypertension and diabetes. In some patients with a pituitary tumour there is a failure to secrete sufficient hormones. This causes vague symptoms including fatigue, cold intolerance, loss of libido and dulling of

mental faculties. Rarely a patient may present with a bleed or infarction¹⁴ within a pituitary tumour: this is called pituitary apoplexy. This normally presents acutely with severe visual symptoms and the features of pituitary underactivity listed above. Treatment of pituitary tumours requires a multidisciplinary approach with input from the neurosurgeon, radiologist, ophthalmologist and endocrinologist. In the first decade of the relevant period, it would have been common practice to communicate with radiology, endocrinology and ophthalmology specialists on a case-by-case basis. Over the last 20 years, formal multidisciplinary teams have developed so that weekly or fortnightly meetings are held to advise upon best management based upon radiological appearances, endocrine and visual function. Management would normally be surgical if vision was threatened or symptoms were arising from excessive, or reduced, hormone secretion. Otherwise, many patients, particularly those with small tumours, would be managed with endocrinological, ophthalmological and radiological follow-up.

13.9 The most used surgical approach for a pituitary tumour is via the trans-sphenoidal route. This necessitates an incision just beneath the upper lip or within the nostril. Surgery then proceeds through the nasal cavity to the sphenoid bone. This is then opened to reveal the sphenoid air sinus before the floor of the bone encasing the pituitary gland is opened. The tumour is then normally removed using a combination of suction and ring curettes (small, surgical instruments with a ring on the end used to remove tissue). Nearby structures include the carotid arteries. To minimise risk, intra-operative image intensifier images (x-rays) were used during most of the relevant period to guide surgical access. During the early part of the relevant period clinicians were trained to POPUMET¹⁵ Regulation Standards and could operate radiographic equipment after attending a generic POPUMET Training Course. In 2000 regulations changed. Following introduction of (IR (ME)R¹⁶), most intraoperative x-rays were taken by a radiographer, although appropriately trained clinicians could still operate machinery. A key change was that (IR(ME)R introduced training with a higher tier of complexity for those operating machinery compared to the generic training required to request x-rays. In most

¹⁴ Infarction = deprivation of blood flow sufficient to cause irreversible cell death. Infarcted tissue often becomes swollen, and this can cause compression of the optic nerves or optic chiasm in a pituitary apoplexy case.

¹⁵ POPUMET = Ionising Radiation Protection of Persons Undergoing Medical Examination or Treatment Regulations

¹⁶ (IR(ME)R = Ionising Radiation (Medical Examination) Regulations

hospitals, Standard Operating Procedures would then have been for intra-operative x rays to have been performed by a radiographer. In the last 2 decades, surgeons prefer the greater accuracy of image guided neuronavigational techniques. Furthermore, the last twenty years have seen most pituitary surgeons adopt an endoscopic¹⁷ rather than a microsurgical approach. In the relevant time period, either approach would be considered reasonable. A microscopic approach comprises exposure of the pituitary gland through a trans-nasal approach with a microscope deployed to better illuminate and magnify appearances. A disadvantage is that the surgeon cannot see around corners into the recesses of the pituitary fossa. An endoscopic approach deploys a similar trans-nasal corridor of access to the pituitary gland. Endoscopes are tubular devices that can illuminate and magnify appearances. They have an advantage in that an angled lens enables the surgeon to see around corners, into the recesses of the pituitary fossa. This may confer benefit with surgery perhaps being safer with an improved chance of complete tumour resection. Endoscopic resection was adopted during the early 2000s and became the majority technique by around 2013.

13.10 Rarely, a very large pituitary tumour or a calcified pituitary tumour, would be reasonably treated surgically via a craniotomy.

(f) Haemangioblastoma

13.11 A haemangioblastoma is a benign tumour that can occur in the brain or spinal cord. Brain lesions are much more common. The majority of these occur in towards the lower part of the back of the head in the posterior fossa¹⁸. They commonly present with symptoms of raised intracranial pressure, often due to obstructive hydrocephalus, and/ or balance and coordination impairment. The genetically inherited deficiency of a tumour suppressor gene can lead to the patient developing haemangioblastomas, renal cell cancer, pancreatic tumour, pheochromocytoma, retinal haemangioblastomas, cysts in other organs and abnormalities of blood composition. Therefore, sometimes there is a family history of haemangioblastomas. These tumours are very vascular, meaning that they develop from and therefore involve blood vessels.

¹⁷ Endoscope = a small surgical telescope. The view from the tip of the endoscope can be angulated to enable the surgeon to see around corners.

¹⁸ The cranial cavity is divided into spaces which are an anterior cranial fossa, where the frontal lobes lie; bilateral middle cranial fossae, where the temporal lobes are found and the posterior fossa which contains the cerebellum and brainstem.

13.12 Treatment now and during the relevant time period is normally surgical excision, occasionally preceded by a radiological embolisation procedure. Embolisation is a procedure conducted by an interventional radiologist that aims to occlude arteries supplying the tumour, thereby reducing the likelihood of major intraoperative haemorrhage. While surgery for a small haemangioblastoma can be relatively straightforward, surgery for a large hypervascular tumour (one involving numerous blood vessels) can be an extremely challenging undertaking due to the potential damage to the blood vessels which can be caused by the surgery.

(g) Arteriovenous Malformation (AVM)

13.13 An AVM is a congenital abnormality of blood vessels characterised by the flow of blood from arteries, directly into veins: intervening capillaries are missing which would normally serve to assist in the exchange of blood between arteries and veins and transmit oxygen, nutrients and waste products between blood and surrounding tissues. Veins normally contain slow flowing blood at low pressure. In an AVM, the veins become tortuous and the walls thicken as a compensatory response to faster flowing blood at a higher pressure than normal, a phenomenon caused by the lack of the usual capillaries. An AVM is like a knot of blood vessels in the brain. AVMs are commonly compact and well defined. Sometimes an AVM can be diffuse with an indistinct boundary between abnormal and normal. AVMs can be found as incidental findings. They can present with a spontaneous intracranial haemorrhage, often in adults aged 20 to 40 years. Sometimes an AVM can cause a seizure without causing a haemorrhage. It is rare for an AVM to present with transient neurological symptoms or severe non-haemorrhagic headaches.

13.14 Imaging investigations, including angiography (defined below), confirm the diagnosis. Treatment options during the relevant period were the same as those in current use and lie between (1) no treatment, (2) stereotactic radiosurgery to gradually occlude the AVM over a period of 2 to 4 years as a response to the radiation, (3) open surgery to resect (cut out) the AVM, and (4) embolisation of the blood flow of the AVM. Embolisation aims to (i) try and completely obliterate the AVM or (ii) reduce the volume of the AVM by blocking the blood flow to it, increasing the success rate of subsequent surgery or stereotactic radiosurgery. Surgery is normally undertaken via a craniotomy (defined below) and can be an

extremely challenging procedure due to the risk of excessive haemorrhage during removal.

(h) Hydrocephalus

13.15 The brain normally manufactures 500ml of cerebrospinal fluid (CSF) (defined above) throughout each day. This continuously flows from the site of production (mainly the lateral ventricles) through fluid pathways in the brain and around the spinal cord before being reabsorbed into a large venous sinus to keep the system in equilibrium. Hydrocephalus is a condition characterised by excessive accumulation of (CSF) in the brain because of obstruction to the normal flow of fluid or due to abnormal reabsorption of fluid: overproduction of CSF is not a common cause of hydrocephalus.

13.16 Obstruction can be due to congenital causes, e.g. aqueduct stenosis, Dandy Walker malformation, or acquired causes such as a tumour causing a critical narrowing of the CSF pathway. Hydrocephalus can present acutely with life-threatening elevations of intracranial pressure causing headaches and impaired conscious level. In older patients (>60 years), a more gradual presentation of gait disturbance, urinary urgency and cognitive decline can occur. This is known as idiopathic normal pressure hydrocephalus (iNPH). The aetiology appears to be due to malabsorption of CSF rather than due to obstructed flow within the brain, although exact mechanisms are poorly understood. The definitive treatment of hydrocephalus during the relevant time period was normally the insertion of a shunt to divert CSF from one of the lateral ventricles of the brain, to the peritoneal cavity in the abdomen, where CSF gets reabsorbed into the body tissues and circulation: a ventriculoperitoneal shunt (VP shunt). This is a surgical device which involves fluid draining from the intracranial catheter when a valve opens due to pressure increase to a certain level. The fluid then drains into a distal catheter. Sometimes a CSF diversion can be performed internally in the brain to bypass a blockage in the Aqueduct of Sylvius. This is called an endoscopic third ventriculostomy (ETV). ETV procedures started to become more popular in the mid-1990s, particularly in the paediatric population.

13.17 Acute hydrocephalus often occurs at the time of an acute presentation as a manifestation of a previously undiagnosed causative pathology. Such causes include subarachnoid haemorrhage, tumour and infection. In acute cases a

temporary fluid diversion in the form of an external ventricular drain (EVD) can be used. This is a catheter used to drain the fluid away. An EVD can be inserted into the frontal horn of a lateral ventricle, typically on the right. CSF can flow through the EVD and additional tubing to be captured into a closed-system reservoir at the bedside. This diversion is commonly a temporary measure during an acute neurosurgical illness. Although a VP shunt is sometimes required, in many patients, an EVD can be removed after a period of 1-3 weeks.

(i) Traumatic Brain Injury (TBI)

13.18 Traumatic brain injuries occur in all age groups. In adults, the commoner causes are falls, road traffic accidents and assaults. Injuries are normally classified according to the conscious level of the patient on arrival of paramedics or on arrival at hospital: mild (GCS 13-15), moderate (GCS 9-12) and severe (GCS 3-8) categories are recognised. The conscious level is assessed using the Glasgow Coma Scale: this summates as a score between 15 (normal) and 3 (profound coma)¹⁹. The primary injury is the damage caused to the brain by the actual trauma. Early CT scans provide information concerning the intracranial sequelae after trauma. Intracranial bleeding can occur into the brain and the spaces around the brain. A haematoma can compress brain tissue and impair the blood flow to the brain. Similarly bleeding, bruising (contusions) or swelling in the brain can increase in severity in the hours or days after the injury causing impaired blood flow to the brain. Brain injuries and polytrauma (injuries to multiple other parts of the body) can also cause reduced oxygenation and low blood pressure. These additional and delayed insults are considered as secondary injuries to the brain: intensive therapy unit (ITU) care normally aims to try and prevent secondary injury where possible.

13.19 The role of a neurosurgeon in the management of traumatic brain injuries is to work with other medical professionals to identify and treat surgically amenable abnormalities to reduce brain compression and intracranial pressure. For patients

¹⁹ Glasgow Coma Scale.

Eye opening: Spontaneously 4; To speech 3; To painful stimulus 2; No eye opening 1

Verbal response: Orientated 5; Confused 4; Inappropriate words 3; Incomprehensible sounds 2; No speech 1

Motor response: Obeys command 6; Localises pain 5; Flexion to pain 4; Abnormal flexion to pain 3; Extends to pain 2; No response 1

with a moderately severe or severe injury, intracranial pressure monitoring is commonly used to measure intracranial pressure. This enables calculation of the blood pressure perfusing the brain: the cerebral perfusion pressure (CPP). Suboptimal CPP can be treated with medications to reduce intracranial pressure and medications to augment blood pressure. During the relevant time period, mannitol 10-20% was frequently used to lower intracranial pressure. This was often prescribed by a neurosurgeon. Inotropic drugs, related to adrenaline, elevate blood pressure and are, and were used during the relevant time period. They are normally prescribed by the intensive care team. Intracranial pressure monitoring, using a sensor probe implanted via a small surgical opening in the skull, for non-haematoma causing traumatic brain injuries is now routine practice, however this technique was not used on a regular basis in all neurosurgical units until the early 2000s. In those units not utilising intracranial pressure monitoring, clinical condition of the patient was the main tool to guide management options.

13.20 Surgical procedures commonly deployed in the management of traumatic brain injury include a craniotomy to evacuate an intracranial haematoma or contusions (damaged tissue in which capillaries and other small blood vessels have been ruptured); burr holes (a small hole drilled into the skull by the neurosurgeon) to wash out a chronic subdural haematoma (a collection of blood between the skull and the surface of the brain), particularly in older patients; a craniectomy to decompress the brain (+/- evacuation of any associated haematoma or contusion) and insertion of a device to measure and monitor intracranial pressure, either in association with a craniotomy or craniectomy or as a standalone procedure in a patient without any surgically significant intracranial haematomas.

13.21 Neurosurgeons are key at recognising complications of TBI, involving appropriate specialists and working closely with rehabilitation doctors and therapists.

(j) Epilepsy

13.22 Epilepsy can occur as a symptomatic complex in any patient with a cranial neurosurgical condition including TBI, brain tumour, AVM, hydrocephalus or infection. Epileptic seizures can be partial or generalised. Most generalised seizures are associated with a reduced level of consciousness. Partial seizures

may be “simple” with no impairment of consciousness or “complex” with a reduction in level of consciousness. Most epilepsy seizures can be treated effectively with anti-epileptic drugs. Neurosurgeons often prescribe prophylactic anti-epileptic drugs (AEDs) for patients undergoing cranial surgery and for those with a history of a recent TBI. For neurosurgical patients with seizures an AED would be prescribed. During the relevant period the most used AEDs were phenytoin, sodium valproate and carbamazepine. For patients with refractory (drug resistant) seizure events, a neurologist would normally guide treatment through a stepwise increase in dose and the introduction of polypharmacy.

13.23 If an epileptic patient has a clear structural intracranial cause, e.g. an intrinsic tumour, a neurosurgeon would reasonably treat the cause e.g. tumour resection. If scans do not identify the cause of refractory seizures, referral to a specialist epilepsy service is appropriate to ensure an accurate diagnosis is made and to optimise pharmacological treatments. Video electroencephalogram (EEG) monitoring, sometimes with implanted EEG electrodes, may identify precise electrical abnormalities that can become the focus of potential surgical treatments.

13.24 Surgical treatments are highly specialised and are considered a branch of functional neurosurgery. Treatments revolve around resection of an epileptic focus (e.g. temporal lobectomy, selective amygdalohippocampectomy, disconnection surgery (e.g. corpus callosum, hemispherectomy, subpial transections) and stimulation treatments (e.g. vagal nerve stimulation (VNS) or Deep Brain Stimulation (DBS)). None of the Experts are specialists in this area of practice. In the UK the volume of surgical procedures performed for epilepsy during the relevant time period was low, with anterior temporal lobectomy being the commonest procedure for a condition called mesial temporal sclerosis. The exact number of procedures performed in the UK during the relevant period is not known but probably is a few hundred per annum. The utility of epilepsy surgery has increased in the last decade, particularly in the paediatric population, with the development of multidisciplinary teams. In the relevant period, epilepsy surgery in children was confined to specialist centres.

(k) Trigeminal neuralgia

13.25 Trigeminal neuralgia is a condition characterised by severe, episodic facial pain afflicting one or more divisions of the trigeminal nerve (the largest cranial

nerve, responsible for sensory information from the face and controlling muscles used for chewing). It normally affects adults over the age of 50 years. Typically, pains are transient, excruciating in severity and are triggered by cold, chewing, teeth brushing and other minor stimuli. Surgical treatment is normally by a cranial neurosurgical rather than a peripheral nerve surgeon.

13.26 The initial management is with medication, typically, but not exclusively carbamazepine. For recurrent or refractory pain, or in patients who are intolerant of medications, treatment options include invasive procedures including open surgery. Invasive procedures also include radiofrequency (RF) lesioning, balloon compression of the trigeminal ganglion and glycerol injections into Meckel's cave, which lies in close proximity to the trigeminal nerve. Rarely, during the relevant period, peripheral nerve ablations were performed: e.g. phenol ablation of the infra-orbital nerve: an outpatient technique that caused nerve damage thereby, in theory, reducing the transmission of the pain messages to the brain. More commonly, especially in younger patients, a microvascular decompression of the trigeminal nerve is undertaken. This is an open brain operation (craniotomy or craniectomy) and involves the interposition of a piece of sponge-like material between a blood vessel (usually arterial) and the trigeminal nerve root. Nowadays, scans would be performed pre-operatively to demonstrate neurovascular conflict as the cause of trigeminal neuralgia before embarking upon this operation. In the first 5 to 10 years of the relevant period, pre-operative imaging was often unable to resolve whether or not any neurovascular conflict existed. In these cases, speculative surgery, based upon the clinical history was reasonably performed. An additional non-invasive therapeutic approach using stereotactic radiosurgery (Gamma knife, LINAC or Cyberknife) has become popular in the last decade.

(i) Intracranial hypertension (IHH)

13.27 Intracranial hypertension is the name given to elevated intracranial pressure. Intracranial pressure (ICP) is normally between 5 and 15 millimetres of mercury when a patient is lying flat. Elevated intracranial pressure can occur in association with many neurosurgical pathologies including traumatic brain injury, brain tumours hydrocephalus and spontaneous intracranial haemorrhage.

13.28 There is a condition called idiopathic intracranial hypertension (IIH). This was previously called benign intracranial hypertension (BIH) but the change in name was adopted due to the serious complications that can occur in this condition.

13.29 Most patients with IIH are female. Most have an elevated Body Mass Index (BMI >30; not infrequently >40). The presenting complaint normally comprises headaches and visual impairment. MRI scans may show some signs of the condition and are useful at excluding venous sinus thrombosis as a cause of elevated intracranial pressure. Many patients with IIH are managed by neurologists who often treat with medications to reduce CSF production and treat headaches. Neurologists often perform lumbar punctures to reduce intracranial pressure. In this procedure a needle is inserted into the lumbar spinal canal enabling the measurement of pressure and the removal of CSF to reduce pressure.

13.30 Involvement of an ophthalmologist is critical in the management of these patients. Elevated intracranial pressure can reduce blood flow to the optic nerves. This can cause restricted visual fields and loss of visual acuity: papilloedema can occur. In severe cases this can result in severe visual impairment.

13.31 Treatment of elevated intracranial pressure is necessary to try and prevent these conditions evolving. Surgical treatments revolve around reduction of intracranial pressure using a ventriculoperitoneal (VP shunt) or lumboperitoneal shunt (LP shunt). Placement of a shunt into the lateral ventricle is difficult in a patient with IIH due to the small size of the lateral ventricles. Image guidance (neuro navigation or, during the earlier part of the relevant period, a stereotactic frame²⁰) is therefore used to optimise placement of a ventricle catheter. The shunt is then normally tunnelled through the body down to the peritoneal cavity in the abdomen where fluid is absorbed. A lumboperitoneal shunt diverts CSF via a catheter inserted into the lumbar spinal canal to the peritoneal cavity.

13.32 Due to the obesity that is commonly seen in patients with this condition, complications with the lower end of the shunt including misplacement and

²⁰ Stereotactic frame. This is a geometric frame screwed to the patient's skull. Scans are then performed with the frame in situ. The surgeon can then calculate the exact position of the surgical target (e.g. small ventricles in this case) with reference to the frame. These coordinates can then be used to enable precise insertion of the catheter.

postoperative displacement of the catheter are common. Sometimes ophthalmologists adopt a different approach to neurosurgery by performing an optic nerve fenestration to minimise the harmful effects of elevated intracranial pressure upon the optic nerve. Rarely, in refractory cases, bone can be removed by a neurosurgeon in the form of a craniectomy in both temporal regions [bitemporal craniectomy]. The aim of this procedure is to reduce the intracranial pressure alleviating the damaging effects of this condition upon the optic nerves.

(m) Ischaemic stroke/ blood clot

13.33 Ischaemic strokes involve sudden interruptions of blood flow and are typically caused by occlusive disease of the carotid, or less commonly the vertebral arteries. Stenotic [narrow] vessels cause reduced and turbulent blood flow. Debris (atheroma) and platelet²¹ aggregates occlude blood vessels, most commonly the middle cerebral artery. This causes an ischaemic stroke. Normal brain requires a blood flow of approximately 50-60 ml/100g/minute, although exact levels depend upon the precise region of the brain. If the blood flow to the brain falls below 10 ml/100g/minute, rapid, irreversible cell death occurs. This is known as a cerebral infarct, or more commonly, an ischaemic stroke. Cerebral infarcts normally cause the infarcted brain to swell in the first few days after infarction. Typical symptoms include hemiplegia (profound weakness of one side of the face, the arm and lower limb); hemiparesis (less severe weakness in the same distribution as hemiplegia), speech disturbance and reduced level of consciousness.

13.34 Most stroke cases are managed by general physicians, or in the last 15 years, the emerging speciality of stroke physicians and stroke neurologists. Although mechanical thrombectomy²², coupled with pharmacological treatment, is now the treatment of choice for many cases of ischaemic stroke, this was not an option during the relevant period. In 2007, a pooled analysis of three randomised clinical trials investigating the use of decompressive craniectomy after middle

²¹ Platelets = particles in the blood that play a part in causing blood to clot.

²² Mechanical thrombectomy = a procedure performed by an interventional neuroradiologist, or other appropriately trained specialist, to remove occlusive thromboembolic material from the internal carotid artery or middle cerebral artery to treat ischaemic stroke symptoms.

cerebral artery ischaemic stroke (Vahidi *et al.*, 2007),²³ [ELJ0001-00072] [ELJ0001-00079] supported the assertion that a decompressive craniectomy could be considered within 48 hours of a patient sustaining a very severe (malignant) middle cerebral artery occlusion. A decompressive craniectomy involves removal of a large piece of skull to decompress the swollen brain, thereby reducing ICP. If the patient makes a satisfactory recovery, a cranioplasty procedure can be performed to restore cosmesis and brain protection at a later date.

13.35 Subarachnoid haemorrhage is a condition managed by neurosurgeons. The commonest cause of spontaneous, rather than post-traumatic, subarachnoid haemorrhage is bleeding from a ruptured cerebral aneurysm. Ischaemic strokes commonly occur (20-25%) as a complication of aneurysmal subarachnoid haemorrhage, particularly within the first 2 weeks of the bleed. This type of stroke presents as a “delayed ischaemic deficit”. The mainstays of treatment are (i) prevention: prescribe fluids and nimodipine once the diagnosis of subarachnoid haemorrhage is made and (ii) augmenting cerebral blood flow with vasoactive medications to try and avert the evolution of ischaemia into infarction (death of tissue resulting from loss of blood flow).

13.36 Blood clot is a lay term for a haematoma. These are discussed in the Brain Haemorrhage section (n)

13.37 In the 1990s, a small number of neurosurgeons undertook carotid endarterectomy operations on patients with severe narrowing of the carotid arteries (>70% stenosis). The aim of surgery was to reduce the risk of a future stroke. This operation is now mainly undertaken by vascular rather than neurosurgeons.

(n) Brain haemorrhage

13.38 Brain haemorrhages can occur as a consequence of trauma or as a spontaneous event. Traumatic haemorrhages occur into the extradural space, the

²³ Katayoun Vahedi, Jeannette Hofmeijer, Eric Juettler, Eric Vicaut, Bernard George, Ale Algra, G Johan Amelink, Peter Schmiedeck, Stefan Schwab, Peter M Rothwell, Marie-Germaine Bousser, H Bart van der Worp, Werner Hacke, for the DECIMAL, DESTINY, and HAMLET investigators. Early decompressive surgery in malignant infarction of the middle cerebral artery: a pooled analysis of three randomised controlled trials. *Lancet Neurol* 2007; 6: 215–22

subdural space²⁴, the subarachnoid²⁵ space and into the brain tissue. Neurosurgeons often need to remove traumatic intracranial haematomas to prevent secondary ischaemic brain damage.

13.39 Spontaneous intracranial haemorrhages can occur into the subarachnoid space (subarachnoid haemorrhage), or into the brain tissue (intracerebral haematoma, also known as an intraparenchymal haematoma).

13.40 In 80% of cases of spontaneous subarachnoid haemorrhage cases a causative ruptured cerebral aneurysm is identified. In approximately 20% of spontaneous subarachnoid haemorrhage cases no cause for the haemorrhage is identified. A patient with a spontaneous subarachnoid haemorrhage normally presents with a sudden onset of severe headache. A loss of consciousness is commonly associated with this. In 1995 the standard management of such a patient would be to admit to hospital, treat with fluids, analgesics and nimodipine, intubate and ventilate if appropriate, confirm the diagnosis with a CT scan and undertake cerebral angiography. If a culprit aneurysm was identified, a craniotomy and surgical clipping would normally be used to occlude the aneurysm to prevent further haemorrhage if the patient was in a reasonable clinical condition. Clipping of an aneurysm is a high risk procedure in which the surgeon performs a craniotomy (window in the skull) and then, using an operating microscope, drains CSF from the undersurface of the brain to improve access, identifies the blood vessels leading up to and in the vicinity of the aneurysm, and then places a permanent titanium clip across the neck of the aneurysm to minimise the risk of further aneurysmal bleeding. Considerable debate existed over the investigation and treatment of poor grade patients and elderly patients especially with significant co-morbidities due to the very high risk of poor outcomes in these groups of patients. In addition, there was controversy about the timing of treatment, due to the risk of early treatment inducing delayed ischaemic deficits and delays in treatment exposing the patient to the risk of a fatal rebleed [see section m13.35].

13.41 In 1995, endovascular options for the treatments of aneurysms were emerging. Endovascular treatments are performed by interventional radiologists.

²⁴ The cranial cavity is lined with dura. The subdural space lies between the dura and the brain. The extradural space lies between the skull and the dura.

²⁵ The brain is invested in the arachnoid membranes. A subarachnoid haemorrhage occurs between the arachnoid and the brain.

In the UK around 5 or 6 surgeons have been trained to undertake endovascular aneurysm procedures. Endovascular treatments involve treatment from within the affected blood vessels. These were first adopted for aneurysms in the posterior circulation where surgical complications were particularly high. The posterior circulation comprises aneurysms of the vertebral and basilar arteries rather than the anterior circulation which is fed by the carotid arteries. In 2002, the ISAT²⁶ [ELJ00001-00023] study showed equivalence of endovascular and surgical treatments for anterior circulation aneurysms. Within a year of this publication a seismic shift towards endovascular treatment as the preferred option was adopted by all UK and Ireland neuroscience centres, mainly due to the perceived benefits of avoiding major “open” brain surgery. In the initial phases of this change interventional radiologists were not available in all neuroscience centres. As a result, a patient may have required transfer to another neuroscience centre where endovascular treatment could be provided in preference to open surgery. During the relevant period, Edinburgh provided endovascular treatments for Eastern Scotland. The endovascularly trained consultants comprised interventional neuroradiologists, and for some of the relevant period a neurosurgeon.

13.42 Spontaneous intraparenchymal or intracerebral haemorrhages can have a variety of causes. Hypertension is the most common underlying factor. In some very elderly patients fragile blood vessels due to a condition called amyloid microangiopathy is causative. In other patients, an underlying lesion such as an arteriovenous malformation, a dural arteriovenous fistula, a cavernoma or a tumour (e.g. metastatic tumour in a patient with melanoma or renal cancer) may have caused the haemorrhage. Angiograms may be required to identify, or rule out, such pathology.

13.43 A neurosurgeon might undertake surgery to evacuate a spontaneous intracerebral haematoma. This is to reduce intracranial pressure and protect the brain from secondary damage. Such an operation is performed through a craniotomy although a craniectomy (removal of skull bone) may reasonably be

²⁶ Molyneux AJ, Kerr RSC, Stratton I, et al. International Subarachnoid Aneurysm Trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomised trial. *Lancet* 2005; 366: 809-17

performed as a therapeutic or prophylactic manoeuvre to optimise intracranial pressure.

(o) Arterial dissection

13.44 Arterial dissections are infrequent in general neurosurgical practice. However, some cases of arterial dissection may be managed by stroke medicine, neurology or vascular surgery, largely due to local historical pathways of care. The commonest presentation of a patient with a dissection is after trauma affecting the skull base or the cervical spine. In such cases, any of the paired carotid or vertebral arteries can develop bleeding into the vessel wall. This strips the inner layer of the vessel wall causing vessel occlusion. Simultaneously, the outer wall of the vessel can be stretched by the blood attempting to flow within the layered vessel wall forming a pseudoaneurysm. These conditions would normally be recognised on imaging. Treatment is normally non-surgical and may include antiplatelet agents to minimise clot propagation. Endovascular options are sometimes deployed.

(p) Intracranial infection

13.45 Intracranial infections can occur as a complication of any cranial procedure. The risk of infection after a craniotomy or burr holes is less than 2% and was less than 2% during the relevant time period. Prophylactic antibiotics are, and were, given to minimise the risk of infection.

13.46 Post-operative intracranial infections are more common in patients who have had implants. These include VP shunts, LP shunts and Deep Brain Stimulation (DBS) electrodes.

13.47 Post-operative infections are normally treated with antibiotics targeted towards causative pathogens²⁷ identified in CSF.

13.48 Intracranial infection can develop as a complication of a head injury. This is particularly the case in a patient with a post-traumatic CSF leak from the ear or nose. Patients who have sustained open cranial trauma are also at increased risk of infection. The principles of management are to identify the causative organism,

²⁷ Pathogen = a causative organism

administer targeted antibiotic therapy and minimise the risk of future infection by attention to wound healing and obliteration of any CSF leak.

13.49 Serious intracranial infection can occur as a spontaneous event. Meningitis is normally managed by general physicians, neurologists or paediatricians. Surgeons have a limited role in the management of such cases, although CSF diversion with an EVD may be used in the acute phase of care.

13.50 Sometimes spontaneous intracranial infections cause brain abscess formation. This is a collection of pus and infective organisms in brain tissue. Patients with diabetes, infected paranasal sinuses, ear infections, congenital heart disease, a history of intravenous drug use and immunodeficiency are at risk of developing such infections. The principles of treatment are to drain the abscess by (i) aspiration, or (ii) widely opening the most accessible wall of the abscess [marsupialisation], or (iii) excision of the abscess. Treatment with targeted antibiotics ensues, normally for 4 to 6 weeks. Serial scans are performed post-operatively to monitor progress. The outcome of surgery for brain abscess is wide-ranging with life-changing disability as a common sequela. A related condition is a subdural empyema. This describes a collection of pus and infected material adjacent to the brain, in the subdural space, rather than within the brain. The principles of treatment are the same as those deployed for patients with an abscess.

(q) Parkinson's disease

13.51 None of the experts are specialists in the management of Parkinson's Disease.

13.52 Parkinson's Disease is a movement disorder characterised by a 4-7 Hz resting tremor, bradykinesia (slowness of movement) and rigidity (stiffness of muscles). The management of Parkinson's Disease is led by a neurologist or Medicine for the Elderly specialist. Prior to the introduction of L-DOPA in the 1960s, stereotactic thalamotomy was used to damage or ablate thalamic tissue: this often improved tremor. However, other disabling symptoms of Parkinson's Disease prevailed and complications of this lesioning approach were not infrequent. The treatment went out of favour.

13.53 In the 1990s tissue transplantation studies seemed to offer hope for a cure. However, the benefits of transplantation have not been sustained, and transplantation is confined to research studies.

13.54 During the relevant period, Deep Brain Stimulation (DBS) has evolved. This involves implantation of electrodes into specific well-defined brain regions. These include the subthalamic nucleus, the globus pallidus interna, the ventralis intermedius nucleus and the pedunculopontine nucleus. The electrode placement is guided by stereotactic techniques to ensure accuracy of placement. Often intraoperative neurophysiological stimulation is used as an adjunct to optimise electrode positioning. The patient has a battery powered electrical stimulator fitted that activates the electrodes and can successfully suppress some of the motor symptoms of Parkinson's Disease. Bilateral procedures are often performed, usually separated by an interval of time to evaluate response and side effects.

(r) Multiple sclerosis

13.55 None of the experts are specialists in the management of Multiple Sclerosis (MS). All Experts have experience of baclofen²⁸ pumps and MS-related trigeminal neuralgia.

13.56 The management of a patient with MS lies within the domain of a neurologist. Medical treatments have advanced during the relevant period.

13.57 Sometimes patients with MS experience trigeminal neuralgia. Radiofrequency lesions of the trigeminal nerve root(s) or stereotactic radiosurgery lesioning are sometimes utilised to manage these patients. Success rates are not as good as those seen in patients without MS.

13.58 MS can also cause severe spasticity²⁹. In responders to test doses, spasticity can be managed by use of a baclofen pump system. This requires surgical implantation of a catheter into the lumbar spine and connection to a pump implanted into the subcutaneous plane. The pump then delivers intrathecal³⁰ baclofen. The pump can be reprimed with baclofen by percutaneous injection without the need for subsequent surgery. The battery life on these pumps is

²⁸ Baclofen = an antispasticity medication. This can be delivered into the CSF.

²⁹ Spasticity = a medical term for increased tone or stiffness in muscles.

³⁰ Intrathecal = into the CSF space.

normally several years. Complications of pump implantation are infection, catheter displacement, catheter disconnection or fracture and sudden baclofen withdrawal, which can be a life-threatening emergency.

(s) Any other common brain or intracranial conditions or injuries with which a patient may present to a neurosurgeon.

Chiari Malformation

13.59 Chiari malformation is an abnormality at the base of the brain (the part of the brain consisting primarily of the brainstem, which connects to the spinal cord and the cerebellum, which regulates essential involuntary functions such as breathing, heart rate and body temperature). There are 4 types of abnormality. At the mild end of the spectrum a small amount of cerebellum may project below the foramen magnum³¹ of the skull base. In more severe cases a larger amount of cerebellum can project through the foramen magnum causing severe headaches, worse on coughing and straining. Brainstem compression can occur causing difficulties with swallowing and speech. Vision can be blurred and double [diplopia]. The spinal cord can develop fluid within it [syringomyelia]: this can cause loss of temperature and pain sensations in the hands, clumsiness in the hands, gait disturbance and in severe cases bladder and bowel dysfunction. Sometimes the patient can have associated hydrocephalus. Severe cases require surgical treatment.

13.60 The role of surgery in mild cases with headaches and medically unexplained symptoms is controversial. This is due to poor objective data on the benefits of surgery in these patients; the placebo effect magnifying any apparent beneficial effect of surgery, weighed against the serious risks of surgery including hydrocephalus, posterior fossa haemorrhage and severe brainstem oedema. The surgeon should determine whether hydrocephalus exists. If hydrocephalus is present, a VP shunt insertion is appropriate to reduce the forces compressing the lower part of the cerebellum down through the foramen magnum. In the absence of hydrocephalus, a Foramen Magnum Decompression (FMD) can be performed. This involves removing a 10-20mm rim of bone from the posterior half of the foramen magnum. The dural membrane is then normally (but not always) opened

³¹ Foramen magnum = the opening at the base of the skull through which the spinal cord projects.

to decompress the cranio-cervical junction. Some surgeons also remove the lowermost part of the cerebellum to be confident that decompression has been achieved. Although surgery is relatively straightforward, complications can be severe including death, CSF leak, infection and cranial nerve deficits. A sterile “chemical” meningitis can occur, and this can be a source of intractable headache.

Cerebral metastases

13.61 Cerebral metastases are malignant tumours that have spread to the brain from a primary source elsewhere in the body. They can be solitary [metastasis] or multiple [metastases]. They can present months or years after the diagnosis of a primary tumour, or present synchronously with a primary tumour. Occasionally a primary tumour cannot be identified at first presentation of a patient with a metastatic tumour.

13.62 Almost any primary tumour can cause cerebral metastases. The commonest primary tumours to cause cerebral metastases are lung, breast, melanoma and kidney.

13.63 Cerebral metastases can be identified as asymptomatic findings on a brain scan. More commonly they cause symptoms including those of raised intracranial pressure, focal neurological deficit or seizure.

13.64 The neurosurgeon may be requested to operate on metastases to (i) reduce mass effect, thereby reducing intracranial pressure and adverse compression of brain tissue; or (ii) achieve a tissue diagnosis in cases of uncertainty. Many patients with cerebral metastases harbour widespread disease throughout the body (e.g. lung, liver and lymph node metastases) and are not normally considered candidates for neurosurgery. Since approximately 2005, the use of stereotactic radiosurgery as a treatment for intracranial metastases has grown incrementally. Where time permits, the decision-making process requires multidisciplinary input, particularly from a neuroradiologist, an oncologist and a neurosurgeon.

Extracranial-Intracranial (EC-IC) By-pass Surgery

13.65 EC-IC by-pass is occasionally used to connect blood vessels from the neck or scalp to those of the brain, most commonly the middle cerebral artery (MCA). By-pass surgery is, and was performed during the relevant period, for select cases

of symptomatic cerebral ischaemia, a very small number of large skull base intracranial aneurysms and a small number of patients with neoplastic disease causing arterial compromise in the region of the skull base. The indications for surgery are few and are often controversial due to the lack of a strong evidence base showing efficacy and safety. By-pass can be direct from the superficial temporal artery on the scalp to the MCA or via an interposed graft harvested from the radial artery or great saphenous vein.

13.66 During the relevant period the procedure was deployed in the treatment of (i) symptomatic ischaemic carotid artery disease not amenable to endarterectomy or persistently symptomatic despite endarterectomy; (ii) large skull base arterial aneurysms and (iii) skull base tumours that involve the carotid artery. In all cases the by-pass is provided to augment blood flow to the brain by passing around an arterial obstruction. The commonest complications of this procedure are ischaemic stroke and intracranial haemorrhage.

14 Broadly how might the requirements placed on a neurosurgeon in the intracranial work be experienced in an emergency setting, as opposed to in more routine hospital setting?

14.1 Cranial neurosurgical patients can be considered in 3 categories:-

- Cases requiring immediate admission to a neurosurgical centre for assessment, investigation and treatment. Examples include head injury, brain haemorrhage and acute hydrocephalus cases. These cases are referred on-call from hospitals and GPs in the catchment area. Care for these patients normally displaces routine elective cases and urgent cases.
- Cases requiring urgent admission to a neurosurgical centre for assessment, investigation and treatment. These cases are often referred to the on-call team by hospitals and GPs in the catchment area. Sometimes they are referred through an “urgent” outpatient appointment request. Examples include urgent tumours (e.g., glioblastoma; metastatic tumours, tumours that might cause acute hydrocephalus). Such cases are normally investigated and treated on an expedited but planned basis. These cases displace routine, elective cases.
- Cases requiring outpatient, or inpatient care on a planned basis (e.g., slow growing benign tumours, some hydrocephalus cases, planned surgery for unruptured aneurysms or unruptured AVMs and most

functional neurosurgical cases). These patients are occasionally referred as “on-call” (emergency, including out of normal hours) cases, although usually the outpatient referral system is used.

14.2 The requirements placed on a neurosurgeon in an emergency setting are acutely demanding due to time constraints, limited preparation, and life-threatening patient conditions. This contrasts with the more controlled and planned routine (elective) hospital setting.

Feature	Emergency Setting	Routine Hospital (Elective) Setting
Urgency	Immediate, often life-threatening conditions (e.g., severe TBI, large brain haemorrhages) requiring rapid assessment and intervention.	Planned in advance, for conditions that are not immediately life-threatening but require treatment (e.g., many benign tumours).
Time Constraints	Decisions are made quickly, often under significant time pressure, with less time for extensive planning. Often there is insufficient time to optimise patients for emergency surgery.	Sufficient time for detailed pre-operative planning, discussion with other specialties where appropriate, and patient optimisation.
Resources	May involve out-of-hours surgery with potentially fewer specialty-specific personnel or full anaesthesia, nursing or radiology teams immediately available.	Procedures are scheduled during normal hours, normally with fully resourced, dedicated operating theatres and specialised staff.
Patient Condition	Patients are often unstable. Many have altered consciousness due to elevated intracranial pressure causing brain compression. Some have multiple associated injuries and systemic insults requiring intensive care management. Intensive care management aims to support organ function and restore normal physiology: this includes normal respiratory gas exchange, normal	Patients are generally stable and medically optimised before surgery.

	renal function and normalising cardiovascular function. In the brain treatment is normally focussed on ensuring satisfactory cerebral blood flow and, when measured, normal intracranial pressure. Sometimes this can entail the use of inotropic drugs to increase cardiac output in an attempt to better perfuse the brain.	
Outcomes & Risks	Associated with increased rates of complications and higher mortality rates due to the acute, severe nature of the pathology.	Lower risk of immediate complications and generally better patient outcomes due to controlled conditions and thorough preparation.
Logistics	Focus is on rapid stabilisation and transfer to a specialised neurosurgical centre; ethical dilemmas regarding appropriateness of care can arise.	Focus is on efficient patient flow, continuity of care, reduced infection risk, and shorter length of hospital stay.

14.3 The core difference between emergency and elective [routine] care is the shift from a highly reactive, time-critical environment in emergencies to a deliberate, methodical approach in routine cases, which fundamentally changes the demands on the neurosurgeon's decision-making and resource management.

14.4 Provision of emergency care is normally called “on-call” work. Throughout a week the consultant neurosurgeons in a unit would provide continuous on-call cover. This means that in the unit with three consultants, the consultants would, on average, be on-call every third day and night: a 1 in 3 rota. In addition, when a colleague, or colleagues, are on leave the remaining neurosurgeon(s) would work a 1:2 or even a 1:1 rota. On-call commitments are generally considered onerous. In a unit with a 1:3 rota, all three consultants probably work around 36-48 hours per week undertaking paid routine NHS work. On-call cover is in addition to these core activities: in a three-consultant unit each consultant would normally provide around 40 hours of on-call cover per week. In practice this normally means the Monday to Thursday on-call periods are divided equally amongst the consultants with Friday 08:00 – Monday 08:00 undertaken as a ‘weekend on-call’, with each consultant undertaking 17 weekends on-call per annum. During “on-

call” hours, one junior doctor (registrar level or above) would also be on call as a first point of call for referring doctors. During the relevant period there were very few specialist nurses. Those undertaking such a role would normally only work during normal office hours.

14.5 In a smaller unit, such as Tayside, the Consultant commitment would normally be for the on-call consultant to undertake their normal weekly timetable of planned NHS activities in addition to any period of on-call (e.g. clinics, operating sessions, MDTs, radiology meetings, training, administration). The majority of the time there would be a junior doctor (now called a resident doctor) to be the first point of call for any on-call referrals: the junior would be alerted by an on-call bleep. In the last decade, on-call referral platforms have developed to collate information about any on-call referrals, immediately alerting the receiving clinician to any new referrals. In the relevant period, the vast majority of on-call referrals would have been made to the receiving junior doctor via the bleep system.

14.6 Junior Doctors receiving neurosurgical calls vary in their capabilities to take a history, provide interpretations of scans and to offer advice. Most calls would be discussed with the on-call consultant to guide and support decision-making: either immediately, if necessary, or towards the end of the working day and again first thing in the morning.

14.7 The on-call consultant should be available to provide immediate advice about urgent cases. In cases where life-saving surgery is required, the consultant should be available to attend hospital within 30 minutes. Most NHS Trusts have a clause in a consultant contract stating that the consultant must live within 10 miles or 30 minutes’ drive from the hospital. Occasionally a contract may be less explicit stating “close enough to perform your clinical duties”.

14.8 In a smaller unit, on-call episodes can be very light with few referrals and little involvement of the consultant: in such quiet periods the consultant will be able to go home and sleep, with a bedside telephone available. However, sometimes an on-call period can be very busy with many hours of continuous consultant input required. A consultant may be required to make many decisions on new emergency referrals as well as oversee the management of all in-patients in the neurosurgical unit. In addition, the consultant may be required to undertake

emergency and urgent surgery on patients with brain and patients with spine conditions.

14.9 If, during a period of on-call time allocation, a consultant is not available for on-call duties (e.g. operating at a private hospital), a contingency plan should be made such that a consultant colleague can provide senior cover if necessary. The receiving junior doctor should be aware of the logistics of such contingencies.

15 Please explain the patients who would be suitable to undergo, the purposes and objectives of, main contraindications for and the broad operative procedures involved in the following surgeries:

(a) Craniotomy

15.1 This is an operation that involves drilling a window in the skull to access the intracranial cavity. A craniotomy may be any shape chosen by the surgeon: the shape and size is governed by the intracranial pathology and the access required. Typically, an ovoid shape is used with measurements ranging from 20-30mm across to well over 100mm across. Any intracranial pathology can be accessed via a craniotomy including brain tumours, aneurysms, AVMs, and trauma cases. After performing the intracranial surgery, the dura is usually repaired and the bone flap is replaced. It may be secured by miniplates and screws or using bone anchoring sutures. Glue is, and was used during the relevant period, for assisting with dural closure.

(b) Craniectomy

15.2 This is also an operation that involves drilling a window in the skull to access the intracranial cavity. Craniectomy differs from a craniotomy in that the bone flap is not replaced at the conclusion of the operation. A post-operative decision is then made on whether and when to repair the bone defect: reimplantation is commonly 3 to 12 months after the presenting, acute illness. A craniectomy was used to access most posterior fossa pathologies during the relevant period (i.e. those in the confined compartment of the base of the skull, housing the cerebellum, brainstem and fourth ventricle): any post-operative swelling in the posterior fossa can cause acute neurological deterioration. The craniectomy approach was popularised prior to the relevant period due to the tight

confines of the posterior fossa and the risk of serious adverse consequences should a small haematoma or swelling develop post-operatively. In the last 10 years of the relevant period many surgeons discarded craniectomy as a routine approach for posterior fossa pathology, favouring a craniotomy: both approaches normally afforded good outcomes and were reasonable. A large craniectomy is sometimes performed to decompress a very swollen brain, typically after a traumatic brain injury or after a middle cerebral artery infarct. These procedures were occasionally deployed during the relevant period.

(c) Cranioplasty

15.3 This operation describes using an implant to reconstitute the skull instead of the bone flap elevated to access the intracranial cavity. The aim of surgery is to afford brain protection, improve cosmesis and try and normalise intracranial physiology with relation to CSF flow and cerebral blood flow. Usually, a cranioplasty is performed weeks or months after the craniectomy using any of a variety of implant materials including titanium, acrylic, hydroxyapatite and others. An autologous cranioplasty was used in some units where the patient's own bone flap, which had been stored frozen or in the subcutaneous tissues of the patient, was reimplanted after recovery from the acute surgical procedure. This was considered a better fit for the bony defect and therefore offer a better cosmetic result. Occasionally in complex craniofacial operations a preformed cranioplasty might be implanted at the primary operation.

(d) Thrombectomy

15.4 This is normally a procedure performed by an interventional neuroradiologist to retrieve a blood clot from a blood vessel in a patient with a stroke. The procedure aims to restore blood flow. It would be a very rare occurrence for a neurosurgeon to undertake an open intracranial thrombectomy via a craniotomy due to the complexity of such a procedure and the high risks of causing a stroke due to technical factors.

(e) Stereotactic surgery

15.5 A highly precise minimally invasive method that uses 3D coordinates to locate and treat small, often deep-seated targets, with high accuracy. The procedure is suitable for patients undergoing DBS or lesioning for functional neurosurgical conditions or to access small brain tumours. During the relevant

period, stereotactic surgery evolved. The use of rigid frames affixed to the skull with 4 screws was a standard approach throughout. The use of a frame continues for functional neurosurgery including DBS electrode placement. During the 1990s and 2000s frameless systems using markers on the scalp, or anatomical landmarks attained wide utility, particularly in tumour biopsy and resection procedures.

(f) Trans-sphenoidal surgery

15.6 This approach is used to access the pituitary gland for the removal of a pituitary gland tumour. This necessitates an incision just beneath the upper lip or within the nostril. Surgery then proceeds through the nasal cavity to the sphenoid bone. This is then opened to reveal the sphenoid air sinus before the floor of the bone encasing the pituitary gland is opened. The tumour is then normally removed using a combination of suction and curettes. Nearby structures include the carotid arteries. To minimise risk, intra-operative image intensifier images (x-rays) were used during most of the relevant period to guide surgical access. In the last two decades, surgeons prefer the greater accuracy of image guided neuronavigational techniques that deploy stereotactic principles. In addition, most pituitary surgeons have adopted an endoscopic approach rather than a microsurgical approach. In the relevant period, either approach would be considered reasonable.

(g) Electrical stimulation including deep brain stimulation (DBS)

15.7 This is highly specialised surgery normally performed using a stereotactic frame. DBS is most commonly used for movement disorders including Parkinson's Disease, dystonia, and essential tremor. DBS is not commissioned within the NHS³² for use in chronic neuropathic pain, Tourette's syndrome or severe depression although there is some literature about the use of DBS in these conditions. The aim of surgery is to reduce symptom severity. During surgery a burr hole with a diameter of 9-14mm is made in a pre-planned location. Using a pre-planned trajectory, a probe or electrical wire is inserted deep into the brain to the targeted tissue. Some neurosurgeons rely on anatomical measurements for final placement, whereas others measure tissue impedance with a probe inserted

³² Commissioned for use. NHS Commissioners define which procedures are available to NHS patients. The medical literature and the National Institute for Health and Care Excellence help inform the commissioners about the benefits, risks and costs of treatments. Only a small number of centres are approved for highly specialised services.

into the brain and use this to guide wire placement. The DBS wires are then connected to a battery pack, which is normally implanted on the upper chest wall. The wires are then used to stimulate the targeted brain. This targeted deep brain stimulation acts as a neuromodulation technique that alters electrical, cellular and chemical dynamics of pathological neural circuits resulting in symptomatic improvement.

(h) Cerebrospinal fluid diversionary procedures/ shunt insertion.

15.8 In patients with hydrocephalus or Idiopathic Intracranial Hypertension, CSF diversion using a shunt may be performed. The aim is to reduce intracranial pressure and improve symptoms, including headaches, conscious level and visual disturbance. The most frequent CSF diversion procedure is a ventriculo-peritoneal shunt (VP Shunt). A burr hole is performed to enable a catheter with a diameter of approximately 1-1.5mm to be placed into a fluid space within the brain [ventricle]. The tube is connected to a pressure driven valve that determines the flow of fluid from the brain. The onward tubing from the valve is tunnelled from the head to the abdomen. It is then implanted into the peritoneal cavity, the space surrounding the bowel and abdominal organs. Normally, CSF is effectively removed from the peritoneal cavity by absorption. Sometimes the distal drainage of a shunt may be to the heart (a ventriculoatrial shunt) or the cavity investing the lungs (ventriculopleural shunt). Severe intrabdominal adhesions from multiple abdominal operations would be an example of when drainage to a different body cavity is chosen.

(i) Neuroendovascular interventions

15.9 Neuroendovascular procedures are normally undertaken by interventional neuroradiologists (INRs). Conditions treated are intracranial aneurysms and arteriovenous malformations. The aim of treatment is to minimise the risk of future haemorrhage. Occasionally treatment can also improve symptoms caused by aneurysmal compression of cranial nerves. In the 1990s the GDC coil technique was adopted by many units as a minimally invasive approach for the treatment of intracranial aneurysms. This technique involved coiling a platinum wire into an aneurysm until a point is reached when no blood flows into the aneurysm. Throughout most of the relevant period this technique and later developments have been the mainstay approach for aneurysms of the posterior circulation: vertebral artery, posterior inferior cerebellar artery and basilar artery. In 2002,

the ISAT trial publication³³ [ELJ0001-00023] was followed by a swing in the treatment away from open clipping operations for anterior circulation aneurysms to coiling procedures. Nowadays most units treat 80-95% of aneurysms using coils rather than open clipping operations. In a coiling procedure, the radiologist performs an angiogram by inserting a catheter into the arterial circulation via the groin, or more recently the forearm. This is advanced up to the aneurysm, whilst injecting contrast to map the position of the catheter. The catheter is then used as a channel to pass a platinum wire into the aneurysm. This soft wire forms a coil ball. Often several coils are deployed to obliterate an aneurysm. During the relevant period only one or perhaps two UK neurosurgeons were trained in this technique.

15.10 INRs also undertake minimally invasive embolic procedures. These are used to reduce the blood supply to vascular tumours or to reduce the blood supply to an arteriovenous malformation. An angiogram is performed and small particles or glue are then injected into the targeted vessel aiming to occlude the specific blood vessel and sometimes its tributaries. During the latter part of the relevant period, embolisation of aneurysms with a gluelike substance (onyx) was sometimes utilised. Tumour embolisation is normally performed as a precursor to a tumour resection craniotomy or craniectomy operation.

(j) Tumour resection

15.11 This means removal of tumour. Tumour resection is normally performed via a craniotomy or sometimes a craniectomy. The extent of tumour resection ranges from partial to complete, normally governed by the size and accessibility of the tumour. Many techniques are used to resect a tumour. These depend upon the size, consistency and precise location of the tumour. Techniques used in the relevant period include suction, cavitating ultrasonic aspiration³⁴ and thermal dissection (diathermy). A few centres also used LASER techniques in the relevant period.

³³ Molyneux AJ, Kerr RSC, Stratton I, et al. International Subarachnoid Aneurysm Trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomised trial. *Lancet* 2005; 366: 809-17

³⁴ Cavitating ultrasonic aspiration. A technique used where a very high frequency probe is applied to tumour. The ultrasound causes tumour cells to separate from each other. This enables them to be readily suctioned by an aspirator. The ultrasound and aspiration components of the process are incorporated into a single hand piece. The original machine for this technique was called a Cavitron machine.

(k) Aneurysm clipping and aneurysm coiling

15.12 Ruptured or unruptured aneurysms may be treated by open aneurysm clipping or interventional aneurysm coiling. The aim of treatment is to minimise the risk of haemorrhage from the aneurysm at a future time point. The risk of a further haemorrhage from a recently ruptured aneurysm is 20% in 2 weeks or 50% in 3 months. Ruptured aneurysms are therefore normally clipped (or coiled) soon after presentation, although factors such as patient condition, age and risk of vasospasm (delayed cerebral ischaemia) might lead to appropriate delays in clipping or coiling, particularly in the first 10 years of the relevant period. Coiling, performed by a radiologist, is described in the neurointerventional section above. Clipping is performed by a neurosurgeon via a craniotomy. The intricacies of the procedure are largely governed by anatomical factors. In principle a careful dissection is performed, using the operating microscope. The proximal artery is normally identified and dissected up to the aneurysm. Branches of the parent artery are identified and preserved where possible. A titanium clip is then placed, under direct vision across the aneurysm neck. Clipping aneurysms is one of the most challenging neurosurgical operations with the potential for life-endangering intra-operative rupture and a risk of causing ischaemic stroke.

(l) Functional neurosurgical procedures

15.13 Functional Neurosurgery is an umbrella term for procedures used in the treatment of disorders of neurological function rather than pathological disorders of structure (e.g. tumours, AVMs, aneurysms, hydrocephalus). Functional disorders include movement disorders (see DBS above), and pain conditions. During the first decade of the relevant period, the deployment of functional neurosurgical techniques was more dependent upon local referral pathways rather than national guidance. In the UK, functional neurosurgical procedures have always been undertaken by specialist neurosurgeons with training and expertise in this area. These surgeons normally work closely with neurologists, and where relevant, pain specialists, who have a special interest in this area of practice. During the latter part of the relevant time period, the recommendations for treatments became better defined: in 2003 NICE Guidelines for Deep Brain Stimulation for Parkinson's Disease were published [ELJ0001-00040]. Patients suitable for DBS in Parkinson's must have had the disease for 5 years or more, must have had a good response to L-dopa (a foundational medication used in the

treatment of Parkinson's disease), must have severe motor symptoms refractory to medical therapy: this includes involuntary movements (dyskinesias) or tremor, must have a life expectancy of >5 years and no evidence of dementia or severe cognitive impairment. The aim of treatment is to improve quality of life. Patients with dystonia include those with a primary dystonia that causes debilitating symptoms and is resistant to oral medications and botulinum toxin. DBS in secondary dystonias (e.g. cerebral palsy, stroke) is less effective. The aim of DBS is to improve quality of life by affording better control of movement. This targeted deep brain stimulation acts as a neuromodulation technique that alters electrical, cellular and chemical dynamics of pathological neural circuits resulting in symptomatic improvement.

15.14 The commonest pain management treatments include spinal cord stimulation for neuropathic back pain, failed back surgery syndrome and complex regional pain syndrome. These patients have normally had pain refractory to physiotherapy and medications. A multidisciplinary team is involved in the selection of patients for this treatment. The procedure involves electrical stimulation of the spinal cord, aiming to suppress the perception of severe pain, thereby improving quality of life.

15.15 Baclofen pump implantation is a technique used to improve lower limb spasticity. This is used in multiple sclerosis and aims to reduce painful spasms and improve access for personal care.

15.16 A morphine pump, with a catheter delivering opioid to the spinal cord is sometimes used to help manage intractable cancer pain. A percutaneous transection of spinal cord tracts is occasionally used to manage intractable cancer pain.

15.17 Interventions including radiofrequency lesioning, glycerol injection and microvascular decompression surgery are all options for the management of patients with Trigeminal neuralgia. These treatments are selected according to age, co-morbidity and symptom severity. The treatments aim to reduce or alleviate facial pain, thereby reducing the need for medications and improving quality of life.

(m) Open Vascular Neurosurgery

15.18 Vascular lesions are accessed via a craniotomy. The main pathologies encountered are: (i) ruptured or unruptured intracranial aneurysms. Open

aneurysm surgery comprises clipping, or in cases where clipping is not possible, wrapping with muslin gauze. The aim is to minimise the risk of future haemorrhage; (ii) arteriovenous malformations (AVMs) and arteriovenous fistulae (DAVF). Open surgery normally comprises excision of the AVM or disconnection of a DAVF from the arterial circulation. The aim of surgery is to minimise the risk of future haemorrhage and, in some cases, to alleviate symptoms such as pulsatile headache; (iii) EC-IC by-pass surgery. This was a rarely performed open vascular operation during the relevant period. The aim of surgery was to minimise the risk of ischaemic infarct [stroke] by providing an alternative route for blood flow around an occlusive segment of the internal carotid artery. Very rarely an EC-IC by-pass was performed to by-pass a large artery supplying the brain narrowed by a skull base tumour or enlarged to form a surgically untreatable aneurysm; and (iv) Craniotomy or craniectomy to evacuate an intracerebral haematoma [blood clot]. If a causative pathology such as a ruptured aneurysm, AVM or DAVF was identified, usually on pre-operative imaging, this would often be treated at the same time as removing the haematoma.

(n) Other types of intracranial surgery commonly carried out by neurosurgeons over the period in which the Inquiry is interested.

15.19 Foramen magnum decompression is an operation to decompress the cranio-cervical junction in symptomatic patients. Symptoms can be wide-ranging. The aim is to alleviate symptoms and improve quality of life.

15.20 Metastatic tumours. Metastatic brain tumours are common. Decisions regarding the role surgery are usually made in a multidisciplinary team setting. This has become the norm since around 2002/3. Prior to that a decision to operate was often made by a consultant neurosurgeon in the knowledge of the extent of cancer elsewhere in the body and the patient's clinical performance status (i.e. functional abilities). Metastases in the upper half of the cranium [supratentorial] were normally accessed via a craniotomy, often with the assistance of neuro-navigation image guidance. Metastases in the lower part of the brain [infratentorial] were normally accessed via a craniectomy alone. The aim of surgery is normally to achieve maximal resection, achieve a tissue diagnosis and alleviate symptoms due to raised intracranial pressure and often those due to focal neurological deficits.

15.21 Abscess Surgery. Brain abscesses and the related rare condition, subdural empyema, normally require surgery to drain or evacuate pus. This normally provides certainty about the diagnosis and the choice of the most effective antibiotic. Surgical options include excision of the abscess, stereotactic needle drainage of the abscess or laying open and washing out the abscess [marsupialisation].

16 What are the main risks, benefits and alternatives (in broad terms) of the surgeries listed above, as would have been generally understood and accepted over the relevant period.

These matters are discussed in the table below.

16.1 In general, any neurosurgical procedure can cause a long list of potential complications. The exact risk of complications is dependent upon the pathology being treated, the conduct of the operation and patient factors including co-morbidities: the risk for any patient is normally individualised. In general, the risk of death is between <1% and 10% for all but the most high-risk cases. Furthermore, the risk of complications that may cause disability is governed by the underlying anatomical location of the pathology. Typically, the risk of severe, disabling complications is between 1% and 10%.

16.2 The risk of intracranial bleeding is governed by the underlying pathology, the presence of uncontrolled post-operative hypertension, the medications taken by the patient and the difficulty of surgery. If intracranial bleeding occurs during an operation, and is recognised, the surgeon can normally obtain control. However, for some vascular conditions (e.g. cerebral aneurysm and AVM) and some vascular tumours (e.g. meningioma, haemangioblastoma) torrential intraoperative bleeding can occur resulting in fatality.

16.3 Post-operative bleeding can be detected by observing a decline in the patient's level of consciousness and is confirmed on a post-operative scan. This can cause severe disability, death and sometimes raises ethical questions about the continuance of potentially futile treatment.

16.4 Operations for tumours and vascular cases can cause brain swelling [oedema] and ischaemia [deprivation of blood flow] that may lead to a stroke. This can cause fatality or serious neurological disability. The risk is determined by the proximity of the pathology to important arteries, veins and the adherence of the lesion to adjacent brain.

16.5 Dissection of lesions in the vicinity of neural structures can cause disabling neurological problems e.g. weakness on one side of the body [hemiplegia], loss of ability to understand speech [receptive dysphasia], loss of ability to talk fluently [expressive dysphasia], eye closure, inability to move an eyeball, double vision [diplopia], facial weakness, hearing loss, balance and coordination impairments, difficulty with swallowing, vocalising and breathing. In some cases, a patient with severe disability may require a post-operative tracheostomy to facilitate airway management, a PEG or RIG feeding tube to provide nutrition and a urinary catheter. A hoist may be required to transfer a patient.

16.6 Operations in the supratentorial³⁵ compartment, in the upper parts of the brain where the cerebral cortex lies, are potentially epileptogenic and can cause post-operative seizures. Operations towards the base of the brain and in the posterior fossa can cause CSF leakage from the wound which can lead to infection. Infection is also more common in patients undergoing implants such as cranioplasty, shunt insertion or EVD insertion. In most elective neurosurgery cases the risk of infection is around 1%. Higher risk operations may carry a risk of 5-10%.

16.7 The risk of post-operative epilepsy is governed by the underlying nature and location of the pathology. The risk of seizures generally lies between around 1% to 30% for the highest risk pathologies.

³⁵ Supratentorial. A horizontally aligned fold of dura separates the brain into supratentorial and infratentorial compartments.

TYPE OF SURGERY	RISKS	BENEFITS	ALTERNATIVES	DEVELOPMENTS
Craniotomy	Bleeding, brain swelling, infection, seizures	Access to intracranial pathology	Craniectomy. Burr hole with limited access. Not operating	Improved drills and saws. Improved image guidance to localise the craniotomy
Craniectomy	Bleeding, brain swelling, infection, seizures	Access to intracranial pathology.	Craniotomy with bone flap replacement. Not operating	Improved drills and saws.
Cranioplasty	Bleeding, brain swelling, hydrocephalus, infection, seizures	Brain protection, cosmesis, restoration of CSF dynamics	There is a choice of materials. Not operating	Better 3D computer aided design. No high-quality evidence that materials differ in the risk of infection
Thrombectomy	Performed by INR ³⁶ . Stroke, haematoma at entry point. Arterial dissection, intracranial bleeding and seizures	Restoration of blood flow to threatened brain tissue	Medications to dissolve a thrombus (thrombolysis). No thrombectomy or thrombolytic treatment.	Mechanical thrombectomy has become a mainstay of treatment for a thrombotic stroke in the last decade
Stereotactic Surgery	Trajectory error leading to misplacement of a therapeutic lesion, DBS	Precise localisation of a functional surgery target or tumour	A less precise surgical approach. Or no surgery	Frameless stereotactic methodology has developed, replacing the use of a frame for

³⁶ INR = interventional neuroradiologist

	wire or biopsy/ craniotomy approach. Bleeding, infection and seizures			some patients. In most DBS centres a frame is still considered the gold standard.
Transsphenoidal Surgery	Bleeding, including carotid artery injury, eye movement disorders, CSF leak, intracranial infection, injury to nasal structures	Approach avoids the need to retract brain during most pituitary operations and is considered to be a minimal access approach	Trans cranial surgery (which is more invasive); fractionated radiotherapy. Medical treatment under the care of an ophthalmologist	The open microscopic approach was widely using in the first 10 years of the relevant period. Endoscopic approaches are now widely used as a less invasive approach that affords better visualisation of pituitary fossa contents
Electrical Stimulation inc DBS	Misplacement of leads, intracranial bleeding, infection, battery problems, failure to work, visual symptoms, other neurological deficits, seizures	Minimally invasive approach to effectively manage disabling symptoms (e.g. movement disorders)	Continued medical management	Improved computer aided planning software. Improved knowledge of targets for stimulation.
CSF diversion/ Shunt insertion	Bleeding, misplaced catheter with failure to work, infection, blockage,	Reduce intracranial pressure alleviating symptoms including	Surgery is the mainstay treatment for hydrocephalus with no satisfactory	Improvements in shunt design have occurred incrementally during the relevant period. These help

	overdrainage causing intracranial bleeding or fluid accumulation over the surface of the brain, disconnection	headache, visual impairment, impaired level of consciousness, and in older patients gait disturbance, urinary urgency and cognitive impairment.	alternatives. Sometimes suitability for shunt insertion can be assessed pre-operatively with CSF drainage tests. Idiopathic Intracranial Hypertension can be managed with weight loss and medication	avoid CSF over-drainage and reduce infection risk.
Neuroendovascular interventions	Stroke, bleeding, wound complications (haematoma and infection), need for monitoring and retreatment in first 2 years, delayed rebleed	Minimally invasive approach to treatment of an aneurysm and devascularisation of an AVM or DAVF. Avoidance of need for craniotomy/ craniectomy	Open surgery with aneurysm clipping. Very rarely EC/IC by-pass surgery	Vast improvements in endovascular equipment and implants have led to many neurovascular conditions being treated by this technique
Tumour resection	Bleeding, brain swelling, infection, hydrocephalus, seizures	Obtain a precise diagnosis. Removal of tumour. Sometimes improvement of presenting symptoms	Biopsy only. No surgical treatment. Monitoring of underlying pathology	Image guidance has enhanced access. Improved imaging enables the surgeon to better recognise potential hazards. Refinements in tools used to resect tumours e.g.

				cavitating ultrasonic aspirators. In the 2000s awake surgery for tumours in eloquent regions of the brain have increased in frequency. More widespread use of intra-operative ultrasound and in a very few centres, intraoperative MRI has refined tumour resection. Since 2006, 5-ALA has been utilised to enhance the extent of resection of malignant brain tumours.
Aneurysm clipping or coiling	Clipping: craniotomy complications and complications due to brain retraction, a risk of bleeding and risk of delayed ischaemic deficit and infarct (stroke). Coiling: Stroke, bleeding, wound complications (haematoma and	Clipping: minimise risk of rebleed: arguably more robust in the long term. Clipping: minimally invasive and avoidance of a craniotomy involving potentially traumatic dissections of brain and blood vessels	In the first 5 years of the relevant period clipping was widely undertaken for most supratentorial aneurysms. Around this time the unit in Edinburgh was developing an endovascular service and offering coiling treatments to suitable patients outside their catchment area. Since the	Refinement of endovascular techniques. More widespread availability of coiling procedures

	infection), risk of delayed ischaemic deficit; need for monitoring and retreatment in first 2 years, delayed rebleed		2002 publication, coiling has become the mainstay for intracranial aneurysm treatments, both elective and emergency. The alternative is no treatment.	
Functional Neurosurgery	See DBS above. Other treatments such as baclofen and morphine pumps delivering drugs into the CSF can cause infection, drug overdose, acute drug withdrawal, paralysis, pain	Alleviate disabling symptoms including movement disorders, pain and spasm	Medications, often in high dose with considerable side effects	Improved image guidance software. Improved DBS hardware. Improved drug delivery pump systems.
Open vascular neurosurgery	For aneurysm surgery please see above. AVM surgery remains worthy of consideration. Risks are those of a craniotomy, life-endangering bleeding from the AVM, post-	Aneurysm clipping and AVM resection minimise the risk of future haemorrhage. Evacuation of an intracerebral haematoma reduces	Endovascular options (e.g. coiling of an aneurysm; embolisation of an AVM). Gamma knife or stereotactic LINAC radiotherapy are non-invasive treatments that are	Improvements in microscope quality and clip applicator ergonomics. In the 2010s indocyanogreen (ICG) became a widely used adjunct in aneurysm clipping.

	operative intracranial haemorrhage, ischaemic stroke, epilepsy and infection. Evacuation of an intracerebral haematoma carries similar risks	intracranial pressure and may improve focal neurological deficits	in effective at obliterating the majority of small AVMs	
Other types of Intracranial surgery	Foramen magnum decompression (FMD): bleeding, swelling in the region of the craniocervical junction, acute hydrocephalus, infection, stroke. EC/IC by-pass surgery: bleeding, swelling, stroke, epilepsy, infection, occlusion of the graft Abscess Empyema: bleeding, brain swelling,	FMD: alleviate symptoms including headaches and limb symptoms caused by the build-up of fluid in the spinal cord [syringomyelia] EC/IC by-pass: reduction of risk of a stroke consequential to narrowing of the by-passed artery Abscess/ Empyema: reduction in mass	FMD: Medical management of symptoms. EC/IC by-pass: medical management of stroke risk Abscess/ Empyema: choice of operative approach.	FMD: Improved pre-operative imaging. Improved knowledge of effects of surgery. EC/IC by-pass: evidence before and during the relevant period has shown diminishing indications for performing this type of surgery Abscess/ Empyema: better imaging techniques to have more certainty

seizure; focal neurological deficit	effect, optimisation of antibiotic therapy, perhaps a reduction in extent and severity of neurological deficit	Medical treatment of condition. In most cases surgery is recommended.	about pre-operative diagnosis. Improved neuro navigation techniques to minimise risk of surgical approach
Metastatic tumours: Bleeding, brain swelling, infection, hydrocephalus, seizures, neurological deficit	Metastatic tumours: Obtain a precise diagnosis. Removal of tumour. Sometimes improvement of presenting symptoms	Metastatic tumours: radiotherapy or stereotactic radiosurgery are commonly used as non-invasive alternatives. Pharmacological treatments including immunotherapy	Metastatic tumours: the availability and utility of stereotactic radiosurgery has increased. Medical oncological treatments have improved alongside genetic profiling of tumours. Image guidance techniques have become more advanced throughout the whole of the relevant period

17 Please set out any key developments, in the period in which the Inquiry is interested, in the approach to the listed surgeries, including techniques generally used, approaches to determining suitability for the surgery.

17.1 For ease of clarity, developments in neurosurgery have been addressed in the table above. Key developments during the relevant period are listed below:

- Endovascular radiology techniques including the application of aneurysmal coiling (especially from 2002 onwards).
- Frameless stereotaxy (neuronavigation) principally for tumour resection – continuous developments from 1995 to 2025.
- Endoscopic surgery: this commenced with endoscopic transsphenoidal pituitary surgery but is now widely used for many skull base and intraventricular operations. Particularly in the 2000-2020 period.
- Refinements in VP shunt technology. Continuous throughout the relevant period.
- Widespread use of endoscopic third ventriculostomy for obstructive hydrocephalus: mainly in the paediatric population. Particularly from 2000 to 2010.
- Refinements in the planning and hardware used for DBS operations. Continuous throughout the relevant period.
- Evolution and development of multidisciplinary team working to guide decision making. MDTs developed particularly in the 2000-2010 period. Prior to 2005 many neurosurgeons made decisions independently or sometimes after discussion in radiology meetings. Decision-making was guided by published evidence but was also based upon personal experience and personal preference. Patient choice in decision-making was present throughout the relevant period, although clinician recommendations normally prevailed.

Other neurosurgery

18 What other main types of neurosurgery would have been expected to be carried out by neurosurgeons over the relevant period (including but not limited to functional neurosurgery)? Please explain the patients who would be suitable to undergo, the purposes and objectives of and the broad operative procedures involved in those surgeries.

18.1 Chronic subdural haematoma. In general, this condition occurs in older patients. About half of them recall sustaining a mild head injury a few weeks previously. Many of these patients require evacuation of the haematoma to alleviate symptoms of raised intracranial pressure and/or focal neurological deficit. Surgery is normally performed using one or two burr holes. This allows the fluid collection to be washed out. Sometimes a surgeon's preference is for a craniotomy or craniectomy operation to try achieve maximal evacuation on the premise that this may minimise the risk of recurrence. This operation is often appropriately delegated to trainee neurosurgeons.

18.2 VP shunt revision. In a shunted patient with hydrocephalus or IIH, a fairly common presentation as an emergency is a history of drowsiness and headache. Sometimes signs of infection (e.g. elevated temperature) are also present. Scans are normally performed to make a diagnosis of a blocked shunt. Symptoms include headache, impaired level of consciousness, visual blurring, nausea and vomiting. In the absence of infection, surgery is performed to identify the site of blockage and replace the offending component of the shunt system. If infection is present, the shunt is normally removed and an external ventricular drain inserted to temporarily restore CSF drainage and enable antibiotics to be given. Normally, an elective shunt re-insertion operation takes place once the infection has been eradicated.

18.3 Excision of lesion of skull. Lesions of the bone of the skull normally present as a lump on the skull. They are occasionally removed. Skull lesions are usually, but not always, benign. Sometimes a cranioplasty may be inserted to cover a bone defect at the same operation.

18.4 Skull base tumours that invade nearby structures e.g. orbit, infratemporal fossa, scalp. Many skull base tumours can erode adjacent bone and extend into adjacent regions such as the orbit, infratemporal fossa and pterygopalatine fossa. Such tumours include meningioma and several rare skull base tumours. If the lesion is symptomatic, or large, or if the lesion is growing on interval imaging, surgery is often the mainstay of treatment to obtain a diagnosis and remove tumour bulk. Depending upon the exact location, surgery may be performed with colleagues from ENT or maxillofacial surgery. Some lesions (e.g. skin cancers) can cause significant loss of scalp and facial tissues. A plastic surgeon would normally work with the surgical team to assist in providing skin closure, often with skin grafts.

18.5 CSF leak repair. CSF leakage can occur spontaneously, after trauma or after surgery (e.g. vestibular schwannoma, pituitary surgery). CSF leakage can cause meningitis. If a CSF

leak is suspected, biochemical tests are normally performed to confirm any fluid is CSF. CT and MRI scans are undertaken to establish the site of leakage. Surgery to repair the leak is then performed: there are many variations on the exact technique, and most surgeons use a dural sealant (e.g. tissue glue). Surgery may be transsphenoidal (through the sphenoid sinus), or via a craniotomy or craniectomy. Tissues harvested from the leg (muscle and fascia) may be used to help repair the defect. Tissue glue was often used as an adjunct and has been widely used in neurosurgery in the UK throughout the relevant period. Tisseel glue and Evicel glue are both formulated from pooled -plasma blood products. They both form fibrin, which constitute a natural barrier to CSF. Surgeons must be cautious about use in confined spaces such as the spinal canal due to the risk of the glue causing compression due to mass effect.

18.6 Psychosurgery. In the first decade of the relevant period, psychosurgery was performed in a few UK centres. This is better described as Neurosurgery for Mental Disorders and is a type of functional neurosurgery. Dundee and Cardiff are centres that the authors are aware performed such cases. Conditions such as severe depression, obsessive compulsive disorder and anorexia nervosa were treated with ablative procedures to specific intracranial targets such as the cingulum, subcaudate white matter and the anterior limb of the internal capsule. The operations aimed to disconnect structures in the limbic system, such as connections to the amygdala, hypothalamus, insula, orbitofrontal cortex, prefrontal cortex, cingulate cortex and thalamus, aiming to alleviate distressing symptoms. The ablative procedures were undertaken by stereotactic placement of a radiofrequency probe to heat, and thereby damage tissue, or use of a cryo-ablative probe, designed to damage tissue by freezing. By the late 1990s, DBS started to be used *in lieu* of ablative procedures. The decision to undertake such procedures would require input from psychiatry.

19 What are the main risks, benefits and alternatives (in broad terms) of these other surgeries, as would have been generally understood and accepted over the relevant period.

19.1 Chronic subdural haematoma (CSDH). For a reasonable sized CSDH, surgery is the mainstay of treatment. The main alternative treatment option was conservative management with follow-up scans and intervention if symptomatic enlargement occurs. A non-operative approach would normally only be adopted for very frail patients with a pre-existing poor quality of life or for a small CSDH.

19.2 The care of a patient with a blocked or infected shunt requires urgent treatment. Surgery is the mainstay of treatment with no alternative medical options.

19.3 **Lesion of skull.** Surgery would be appropriate where the diagnosis might include a cancerous or infective pathology, or for a patient with cosmetic or anxiety symptoms caused by the lesion. Other patients can normally be reassured and, if necessary, rescanned at future time points to monitor the lesion.

19.4 **CSF leak repair.** A proven leak may be managed conservatively for 7-10 days if there is a good prospect of resolution e.g. after trauma. Pneumovax (a vaccine designed to protect against a number of serotypes of bacteria) has been used by many neurosurgeons as a prophylactic vaccine for most of the relevant period. Persistent CSF leak requires careful investigation and surgery to minimise the risk of meningitis at a future time point.

19.5 **Psychosurgery.** This field of surgery is beyond the scope of the Experts. Such surgery was considered a “last resort” and was used in patients with severe depression, including those self-harming with suicide attempts and for very severe eating disorders.

20 Please set out any key developments in the period in which the Inquiry is interested on the approach to of these other surgeries, including techniques generally used, approaches to determining suitability for the surgery.

20.1 **Chronic Subdural Haematoma.** The surgery for this condition has not changed over the relevant period. However, in the last decade embolisation of the middle meningeal artery has been adopted by some centres in patients with recurrent CSDHs to minimise recurrence rates. Research continues to better understand the selection of patients for this procedure.

20.2 **VP shunt revision.** In the last decade, antibiotic impregnated catheters have significantly reduced the risk of shunt infection. In the last 2 decades, image guidance techniques have been utilised in selected cases, particularly in patients with small ventricles, to minimise the risk of shunt misplacement.

20.3 **Lesion of skull.** In the last 5-10 years improvements in computing technology have enabled complex shaped, preformed cranioplasty plates to be manufactured prior to excision of lesions involving the skull.

20.4 **CSF leak repair.** The evolution of endoscopic surgery has significantly reduced the need to perform a craniotomy when repairing a CSF leak.

20.5 **Psychosurgery.** This field remains highly regulated and low volume on a national basis. DBS techniques, rather than ablative techniques that damage tissue, are more likely to be used.

Part C - Qualifications and training

21 What is the route / are the routes by which neurosurgeons can become qualified to practise in the field of neurosurgery in the UK? Has that route/ have those routes changed since the 1980s and, if so, how?

21.1 Traditionally, pursuing a surgical career in the UK in the 1980s would have entailed a trainee undertaking an initial period, typically for 2-4 years, comprising several 6-month duration Senior House Officer (SHO) and registrar posts in a variety of different specialties, usually surgical although some trainees would undertake a period of training in other disciplines including general medicine &/or anaesthetics. During this time, they would have to pass first a primary examination (basic surgical sciences), and then a final examination (clinical and operative skills) in order to obtain a Fellowship (FRCS) of one of the four UK Colleges of Surgeons (London, Edinburgh, Glasgow, or Ireland (Dublin)). Although some trainees from overseas did come to the UK to train for a specific period – bringing with them a wealth of ‘different’ knowledge which resulted in a great cross fertilisation of ideas – others, intending to remain in the UK permanently found that their qualifications were not acceptable for career-progression to consultant status and therefore had to find the time (and the financial resources) to sit the UK-based qualifications (FRCS from one of the Royal Colleges). Those that did not succeed in this would either return to their homeland (often disillusioned) or remain permanently in the UK in various sub-consultant posts such as Staff Grade or Associate Specialist. During the pre-fellowship period of training, assessments were entirely informal. Often, the sole mechanism of formal feedback was a reference letter written when a trainee applied for their next post - frequently at a geographically distant hospital. This absolute power could be wielded as a vicious stick, allowing consultants to completely block career progression if a trainee failed to comply to the letter with their demands. Conversely, this old hierarchical model offered a true apprentice-like environment. Regular, direct observation allowed a consultant to gauge a trainee’s progress in real-time, rewarding them with operating opportunities tailored strictly to their evolving ability. The system thus contained the potential for severe institutional abuse, but also for fortunate trainees to receive an incredibly rich tutelage from a dedicated mentor. Only after passing the FRCS examination would they commence continuous training in their chosen specialty. Such trainees were thus by the stage of obtaining a Fellowship generally technically capable hands-on surgeons, with a broad base

of generic surgical knowledge. It should be noted, too, that the primary and final examinations which had been undertaken were an assessment of knowledge of surgery in general and not of the particular specialty that the trainee would pursue.

21.2 In 1991, the FRCS (NS) – an examination based on neurosurgical knowledge - was introduced. In contrast to the FRCS examination (which was a pre-requisite for pursuit of a specialist surgical career) this new examination was an ‘exit’ requirement, essential³⁷ for appointment to a consultant post. This new qualification came about as part of the general trend towards driving up standards. The new examinations (other surgical specialties developed their own qualification) was now based on a requirement to be examined in one’s chosen specialty with an assessment of relevant basic science (anatomy and physiology) together with appropriate clinical and diagnostic understanding and surgical practice. It also managed to eliminate the rather subjective practice of the surgical ‘viva’ at which one could fall on the whim of a cantankerous examiner. This new examination thus helped to ensure that, towards the end of their training, surgical trainees were equipped with a sufficient knowledge base to fulfil their role as consultant upon appointment to their chosen specialty.

21.3 A further significant change occurred in 1993 with the Calman Report [ELJ0001-00053] which, in brief, led to the replacement of Registrar and Senior Registrar grades (often undertaken at widely separated geographic locations) by a single SpR (Specialist Registrar) grade (usually within one neurosurgical unit, or at least within one geographic region). This change had additional significance in terms of longer-term governance issues as the potential ‘hurdle’ between Registrar and Senior Registrar grades was lost, and with it the potential opportunity for weeding out trainees who may have been deemed unsuitable for continued training in their chosen specialty. Whilst that hurdle was potentially open to abuse (with subjective assessment of trainees by senior consultants) it was, nonetheless, a safety net at which potentially unsuitable trainees could be filtered out. There was no formal, structured assessment of this hurdle so that occasionally suitable trainees would fail to progress – and vice versa. Despite (or, perhaps, as a result of) the subsequent introduction, in 1996, of the RITA (Record of In-Training Assessment) it became much more difficult thereafter to remove from further training trainees who had achieved SpR status, even when significant and repeated adverse assessments arose. (Such trainees would have been those included in the ‘vice versa’ category above). The RITA assessments would be attended by a small group of

³⁷ There was, in fact, a small cohort of trainees for whom an exemption was made as they were already at an advanced stage of training when this additional ‘hurdle’ was introduced

surgeons from that specialty representing the various training units within a region, and also attended by a senior member of the Deanery staff. [The Deanery is the regional body responsible for managing, funding, and quality-assuring postgraduate surgical training]. Individual trainees would attend annually and would present written evidence of clinical and surgical activity, and evidence of training and research involvement. Discussion would revolve around their training opportunities or concerns, with the opportunity for some pastoral care and similar matters. Also of relevance in the current context would be discussion of any matters of concern (complications, behaviour, probity etc) which may have been brought to the attention of the committee by a trainer or other interested party (e.g. hospital manager). The presence of trainers from other units and the attendance of a Deanery representative ensured that the trainee was treated fairly and reduced the potential risk of 'in house' bias. It thus had a fairly robust dual purpose to act as an assessment of educational progression and at the same time provide clinical governance to promote current and future safe patient care. Ultimately, the RITA process successfully regulated the safety, uniformity, and professional governance of UK neurosurgeons, ensuring that no overtly unsafe surgeon could easily progress. However, by regulating a time-compressed system focused heavily on numbers and retrospective paper signatures, it inadvertently pressured the specialty to accept a lower threshold of raw, autonomous technical experience at the point of progression to a consultant post.

21.4 Another significant change in the pattern of surgical training arose in the wake of the implementation in the UK in 1998 of the EWTD (the European Working Time Directive).³⁸ This is a key piece of health and safety legislation which set limits on working hours, rest breaks, and annual leave for workers, particularly impacting junior doctors by imposing with its 48-hour week average and rest period rules, though an opt-out allows working longer hours if agreed. The effect of this was that, in order to achieve compliance, there was a further need for medical work-force expansion and as a consequence a reduction in individual training opportunities. Such has been the longer-term effect of this that it is estimated that there has been a loss of nearly 1,400 training hours over a typical five-year higher training period with an estimated 13.5% to 15.5% reduction in the total number of operations performed by trainees. The EWTD has had two unintended but significant consequences for neurosurgical training. Firstly, by reducing the practical experience of surgical trainees *prior* to their commencement of formal neurosurgical training the specialty has been populated by a new

³⁸ Incorporated into UK law via the Working Time Regulations 1990 which came into force on 1st October 1998

generation that, unlike their predecessors, do not hit the ground running. This results in them needing a longer early period of neurosurgical training to hone their operative skills. This lack of practical skills may then be further compounded by their overall reduction in operative exposure which is an inevitable consequence of the combination of a shorter duration of training and increased numbers of trainees required to run an EWTD-compliant rota. Consider the operative experience of a trainee in the 1980s undertaking a 1:3 rota in a unit with a catchment population of 3 million. That should generate an averaged experience of 1 million population for each on call session. If the catchment population remained the same and the trainee was now on a 1:6 (or even a 1:8) rota the figure falls to 500,000 (or to 375,000 for a 1 in 8 rota). The loss of experience is further compounded by the fact that these trainees will then not witness (and be involved in the assessment of or management of) the post-operative neurological changes or complications in their cohort of patients to the same degree. This situation has to be balanced, however, by the more structured and rigorous approach to training that now prevails. Nonetheless it is of concern that there is a tendency for trainees to progress to consultant status with a significant shortfall in both neurosurgical and general surgical experience than was formerly the case. The other mitigating factor against the potential adverse effect on patient care – which should be the main driver in all such considerations – is that the introduction of MDT meetings, regular neuroradiology meetings, mandatory audit and the requirements for CME (continuing medical education) as part of annual appraisal, ensure an educational discipline that persists throughout a surgeon's entire career.

21.5 Another change resulting from the Calman report [ELJ0001-00053] was the introduction of a mandatory end to training within a set period from receipt of a CCST (Certificate of Completion of Surgical Training). This period was usually 6 months. This meant that training could no longer be used as an open-ended post. Some trainees thus became 'time-expired'. This 'lost generation' had a hard time. If they did not find a suitable career post as a consultant in their own unit, or elsewhere, they would have to take on a permanent sub-consultant role such as Staff Grade, Trust Grade, or Associate Specialist. Some left the specialty and endeavoured to train in an alternative field while many emigrated. Others left medicine altogether, often after completing many years of rigorous training, resulting in a tragic waste of their potential expertise to the NHS. The use of the CCST ran from 1995-2005 when it was replaced by the CCT (Certificate of Completion of Training) but with the same grace period. This new nomenclature came about as a result of another sea-change in training regulations (Modernising Medical Careers, 2005) [ELJ0001-00062] in which a new nomenclature and structure was imposed upon all medical training rather than just surgical

training. MMC was introduced to address this "lost generation" and the chaotic bottlenecks of the Calman era, where hundreds of Senior House Officers (SHOs) were trapped in unstructured, permanent middle-grade posts. The government sought to create a seamless, centrally managed pipeline that automated a doctor's path from graduation to consultant status, eliminating service-provision dead ends and accelerating the production of specialists for a consultant-led NHS. MMC shifted the definition of quality from a surgeon's raw operative capability to their holistic, documented compliance. Because it replaced the competitive registrar application with early, unproven recruitment at the ST1 level, it was heavily criticized for prioritising academic "box-ticking" (audits, teaching degrees, and portfolio structure) over a candidate's innate technical aptitude, physical dexterity, and resilience under pressure in the operating theatre. By replacing the flexible, multi-year SHO grade with the generic two-year Foundation Programme (FY1/FY2), trainees spent their formative early years rotating through completely unrelated specialties like psychiatry or geriatrics. When they finally entered run-through neurosurgical training, they had far less exposure to basic surgical anatomy, general trauma, and tissue handling than any previous generation. MMC explicitly mandated the use of **Workplace-Based Assessments (WPBAs)**—such as Case-Based Discussions (CBDs) and Direct Observation of Procedural Skills (DOPS). Rather than judging a trainee by the sheer volume of their logbook, training success was measured by generating synthetic assessment metrics. This flooded the system with paperwork and checklist outcomes, which critics argued masked a lack of actual, hands-on surgical experience. Because MMC launched in lockstep with the EWTD shift-work patterns, on-call competence suffered significantly. Trainees became shift workers who arrived at night to cross-cover patients they did not know, only to hand them over to another team in the morning. This lack of continuity meant MMC trainees rarely managed acute post-operative neurosurgical deterioration from start to finish, eroding the independent clinical judgment and risk-management confidence required for lone, high-stakes consultant on-call duties.

21.6 Neurosurgical trainees no longer undertake the extended pre-specialty surgical rotations but now apply for a training post through a National Selection process, run by the SAC (Specialists Advisory Committee) Chair and the National Neurosurgery Selection Board Secretary. This process commenced in 2007 in neurosurgery as part of the wider implementation of the MMC initiative³⁹. Neurosurgical trainees now tend to enter specialist

³⁹ Two of the authors have been involved in the Neurosurgery National Selection process for 5 years or more. Some 20 or so neurosurgeons would meet in Sheffield for 2 days each January and sift through approximately 200 applications applying a rigorous scoring system. Assessors worked in pairs with each scoring the same applications individually and independently, with scores of 1-5 for each domain within the structured application form. If there was more than a 1-point discrepancy between the two

training within 2-3 years after qualification. They will then enter a period of run-through neurosurgical training which is for a minimum of 8 years (ST1- ST8, Specialist Trainee year 1-8). In the early part of this training, they will sit a two-part examination (written, then Objective Structured Clinical Examination) in order to obtain the MRCS (Member of the Royal College of Surgeons) exam. Towards the end of training (after ST6) they will sit the FRCS (SN) examination. Later, at the end of training, and following receipt of a CCT, many will elect to undertake a period of further training the form of a Fellowship in their chosen area of specialist interest which they would then hope to pursue during their consultant career. In spinal neurosurgery for example fellowships in the UK are delivered by NHS Teaching Hospitals and Major Trauma Centres, but are strictly governed by external bodies. National Interface Fellowships are run centrally by the Spinal Training Interface Group (STIG) on behalf of NHS England. Local Fellowships are run independently by individual NHS Hospital Trusts. Educational Standards of these programmes are regulated by the Joint Committee on Surgical Training (JCST) and accredited by the Royal Colleges of Surgeons. Other specialist fellowships undertaken at this stage of training include Skull Base and Pituitary Surgery, Paediatric Neurosurgery, Functional Neurosurgery, and Neurovascular. Some of these programmes may be undertaken overseas. Under those circumstances such activity (OOPT - Out Of Programme Training) must have prospective training approval by various regulatory bodies which may include the GMC (General Medical Council), the JCST and the Regional Postgraduate Deanery. For **neurosurgeons from overseas** wishing to work as a consultant in the UK two possible routes are available: (a) **The Portfolio Pathway (formerly CESR (Certificate of Eligibility for Specialist Registration))**: The surgeon must submit an extensive portfolio of evidence to the GMC. This evidence is reviewed alongside the JCST to demonstrate that their knowledge, skills, and surgical numbers match the high-level learning

assessors they would be asked to consult and try to reach agreement. If this could not happen the final score for that domain would be determined by the Neurosurgery Specialty Advisory Committee chairman. By this means, with all reasonable attempts to eliminate bias having been undertaken, the 200 applications would be reduced to approximately 100. These candidates would then be selected for interview. The assessors would reconvene 4 weeks later, and over 2 days interviews would take place with each candidate rotating through a series of 6-8 stations at which identical questions were asked of each, with the assessors regularly rotating and resting, again with the intention of minimising fatigue and the elimination of bias. As with the first stage, a rigorous scoring system was employed. At the end of this process a cohort of 18-20 candidates were selected for that year's intake to the available national neurosurgical training posts. Prior to the process the candidates would have indicated their preference for which region they would wish to apply. The highest-ranking candidate would be offered their first choice of Deanery, and the subsequent candidates likewise in order of ranking through the interview process. The early indications from this system were that it was robust, effective and unbiased. Around the country it was widely appreciated by units and by trainees since overnight it eliminated the burdensome task of trainees travelling the length and breadth of the country to attend interviews for individually advertised posts, and the administrative burden placed upon busy surgeons having to wade through numerous applications and then interview several candidates for just one training post. It also helped to ensure that the best candidates each year were able to achieve training status.

outcomes of a UK-trained neurosurgeon; (b) Alternatively they may opt for Interim **SAS posts**. Because the Portfolio Pathway takes time to evaluate, many overseas neurosurgeons initially take a Specialty Associate Specialist (SAS) or Senior Clinical Fellow post in an NHS Trust. This allows them to work under supervision while compiling their GMC evidence portfolio.

22 What experience and qualifications require to be demonstrated when a neurosurgeon is appointed to a consultant post? How have these requirements changed over the period in which the Inquiry is interested?

22.1 During the period of interest to the Inquiry the following would have been required for appointment to a UK- based consultant neurosurgery post:

- A primary medical degree
- Full GMC registration
- FRCS (SN)
- CCST
- Evidence of research, audit, and teaching activity

22.2 The award of a CCST was contingent upon approval by the Neurosurgery SAC (Specialist Advisory Committee). The SAC is a sub-committee of the Joint Committee on Surgical Training (JCST), which acts as an advisory body to the four surgical Royal Colleges of the UK and Ireland. It consisted of a Chairman and approximately 8-10 members drawn from the general neurosurgical consultant pool (approximately 150 at that time). The SAC would meet regularly (in a committee room within the Royal College of Surgeons of England building located at Lincoln's Inn Field, London) to consider matters relating to training both at a unit level and at an individual level. This would entail unit inspections (generally 5 yearly) and scrutiny of trainees' logbooks of surgical activity. The SAC would also recommend the minimum numbers of each type of operation performed by trainees which would be necessary for the award of a CCST.

22.3 Prior to appointment it was also a general requirement that trainees had attended a management training course. There were a number of organisations which arranged such recognised courses for trainees. These included the Royal College of Surgeons of England, various Regional Postgraduate Medical Deaneries, The King's Fund (an influential, independent health and care think tank and charity in England), The Health Services Management Centre (HSMC) at the University of Birmingham, The British Association of

Medical Managers (BAMM), and Templeton College, Oxford (Oxford University's specialist postgraduate college for business, leadership, and management studies).

22.4 In consideration of applicants who had undertaken specialist training outside the UK there were separate pathways available for them to be considered for consultant appointment posts. These differed according to whether the applicant came from within the EU or EEA (extended European area), or from further afield. During the 1990–1995 period, the entry routes for foreign-trained specialists to be considered for NHS consultant posts were heavily dictated by free movement laws and international reciprocity. As indicated above, the rules were strictly split between doctors arriving from the EU or EEA, and those arriving from outside these areas (International Medical Graduates, or IMGs).

22.4.1 **Doctors from within the EU or EEA** benefited from European law - specifically Directive 93/16/EEC - which mandated the mutual recognition of medical qualifications across member states. **The Principle of Mutual Recognition:** If an applicant held a recognised specialist qualification from an EU or EEA member state that matched the criteria of the Directive, the UK was legally obligated to accept it as equivalent. **The Registration Process:** These applicants could bypass many of the clinical assessments required of other foreign doctors. The GMC would grant them Full Registration based on their European credentials. **Consultant Appointment Eligibility:** Following the transition toward the Certificate of Completion of Specialist Training (CCST) framework in the mid-1990s (for details refer to para 21e, above), an EU / EEA specialist certificate allowed the holder to be directly entered onto the UK Specialist Register. This made them immediately eligible to apply for substantive NHS consultant posts without undergoing further mandatory training in the UK.

22.4.2 **The "Further Afield" / Non-EEA Pathway (The Equivalence Route).** Doctors who trained outside the EU / EEA (such as in the Commonwealth, the USA, or other international regions) did not have automatic recognition. They had to prove their skills met British standards through a rigorous process of verification and top-up training. **GMC Registration Assessment (PLAB or Exemptions):** To practice at all, these doctors first had to secure GMC registration. This typically required passing the Professional and Linguistic Assessments Board (PLAB) test to verify their medical knowledge and English language proficiency. Some senior clinicians could achieve registration via a sponsorship scheme from a Royal College if they were already highly distinguished. **The**

"Equivalence" Assessment: Holding a foreign residency certificate or board qualification (e.g. from India, Australia, or the US) did not automatically qualify a doctor for a consultant interview. The relevant Specialty Advisory Committee (SAC) or Royal College had to scrutinise their overseas portfolio logbooks, curriculum, and exam history. **The Requirement for "Top-Up" UK Training:** Most non-EEA doctors in the early 1990s were required to enter the UK system at a lower level - often as a Senior House Officer (SHO) or Registrar - to spend a mandatory period observing and working within the NHS framework. They had to pass the relevant UK fellowship exams (such as the FRCS for surgery) to prove their competence met the benchmark required for a local consultant appointment.

Comparison of the Rules (1990–1995)

Requirement / Rule	EU / EEA Applicants	"Further Afield" (Non-EEA) Applicants
Legal Basis	Directive 93/16/EEC (Mutual Recognition)	Medical Act 1983 (Individual Assessment) [ELJ0001-00078]
Entry Examinations	Exempt from standard clinical entry exams.	Must pass PLAB or secure an official Royal College sponsorship.
Portfolio Assessment	Automatic entry onto the Specialist Register if qualification was recognized.	Manual portfolio review by the SAC / Royal College to check syllabus matching.
Mandatory UK Hospital Time	Not legally required; could apply directly for consultant posts.	Frequently required to work in sub-consultant grades to log NHS-specific experience.

22.5 At the time of appointment, a consultant neurosurgeon would have been expected to be a safe, independent operator across the full breadth of emergency and general neurosurgical practice. A degree of subspecialisation (e.g., in skull base or functional surgery) would have been desirable but not essential for appointment. Essential emergency competencies would have included:

- Proficiency in neuro-trauma, particularly performing life-saving craniotomies for extradural and subdural haematomas and managing penetrating head injuries;
- Management of acutely raised ICP (intracranial pressure) with proficiency in insertion of ICP monitors, EVDs (external ventricular drains), and burr hole drainage for acute hydrocephalus;
- Management of acute vascular emergencies including spontaneous ICH (intracranial haemorrhages) and, in many units at the time, performing microsurgical clipping of aneurysms.

22.6 A number of core (essential) elective competencies were required in order to be appointed to any neurosurgical unit. These would have included:

- Operative management of degenerative lumbar and cervical disc prolapse causing radiculopathy or cauda equina syndrome.
- Excision of cortical and subcortical tumours
- Management of hydrocephalus by insertion of shunts including VP (ventriculo-peritoneal), VA (ventriculo-atrial), and LP (lumbo-peritoneal); and revision shunt procedures.

22.7 During the period in which the Inquiry is interested the core skill requirements would have remained the same but there would have been an increasing expectation that newly appointed consultants would bring a subspecialty interest which would complement departmental or regional activities.

23 What induction would normally be provided when a neurosurgeon is appointed as a consultant and to other key positions such as: (a) head of department / section for surgical neurology or (b) lead clinician for neurosurgery and pain?

23.1 In 1995, the induction process for a newly appointed Consultant Neurosurgeon, or for a role such as Lead Clinician or Clinical Director, would have been significantly less regimented than that which would be expected now. It would have been principally involved with meeting key staff, both in management roles (hospital and medical) and also consultant colleagues from anaesthetics, neurology, radiology, neuropathology and related disciplines, and theatre and senior nursing staff. A geographic tour around the hospital site, including to Emergency Department and the Central Sterile Supplies Department, might be included, together with a trip to the administration offices. At the time the post would almost invariably have attracted a personalised and individual office, with a secretary in an adjacent room.

23.2 That somewhat *ad hoc* introduction to a consultant post has now been supplanted by a more extended and formal induction process which may last for several days. The shift from an ad hoc "handshake and a bleep" introduction to a formal, multi-day induction process began with the 1993 Calman Reforms [ELJ0001-00053] and was formalised between 1996 and 2003. **The Starting Point (1994–1996):** In 1994, the NHS Management Executive issued directives making structured, paid inductions legally compulsory for junior doctors. While the **NHS Consultant Contract (2003)** introduced formalised job planning and annual appraisals, it did not explicitly mandate an initial induction framework other than for re-induction for staff

returning from extended leave (see Regulation 15 of Terms and Conditions Consultants 2003) [ELJ0001-00067]. Instead, the transition from the introductions of 1995 to today's rigorous, multi-day induction processes, was driven by statutory healthcare regulations and local clinical governance requirements. Under **Regulation 18 of the Health and Social Care Act Regulations**, the **Care Quality Commission (CQC)** legally requires NHS trusts to provide comprehensive induction and training to ensure patient safety. Consequently, individual hospital trusts enforce mandatory multi-day onboarding frameworks as a strict pre-employment condition. This process formally signs off on a new consultant's training in local clinical pathways, electronic patient records (EPR), and corporate risk management before they are permitted to assume ultimate clinical responsibility. In Scotland there have been a different set of requirements with local differences. The first formal requirement for induction in Tayside, for example, did not come about until June 2012*. (*Please refer to Tayside Human Resources Recruitment and Selection Policy, 2012, Section 23.1: *NHS Tayside's 'Induction & Orientation Policy' reinforces the organisational commitment to the induction process for new employees to the organisation and existing employees who may be changing their role*). [ELJ0001-00065] Prior to this the need for induction for consultant staff could only be inferred from the stated need (by the GMC and others) to promote 'patient safety' with induction being deemed to be include within this remit.

24 What responsibilities did consultant surgeons have or ought they to have had over the relevant period relating to the training of junior surgeons?

24.1 By 1995, the training responsibilities of consultant surgeons were undergoing a significant transition, moving away from the traditional and unstructured "master-apprentice" model towards a more structured, competency-based system following the Calman Report [ELJ0001-00053] reforms. Thereafter training involved a unified Specialist Registrar grade and a fixed-duration curriculum. Progress within this new methodology was determined by explicit educational objectives and objective appraisals, culminating in a mandatory Certificate of Completion of Specialist Training (CCST).

24.2 Consultant responsibilities, however, would still have included supervision of trainees in the operating theatre, the outpatient clinic, and on the ward. In theatres, in particular, there would have been a gradual progression by the trainee from observation, to assisting, and eventually performing procedures, initially under supervision and ultimately with no direct supervision. Following the Calman reforms this progression of increasing responsibility by trainees was assisted by the RITA process, in addition to individual consultant assessment. The reforms also placed upon employers a greater pastoral responsibility than had hitherto

been in place. This was the period during which there was a transition to mentoring of trainees and ensuring that competency-based progression took place. It should also be recalled that the formal firm structure⁴⁰ was being lost so that trainees would no longer be attached to a single consultant, but rather, in many instances, to a unit or to a surgical team within the unit, so that the importance of the regular RITA assessments became increasingly evident. Since there would inevitably have been subjective variations (amongst consultant staff) in the perceived ability of individual trainees, the role of the RITA assessments was a major safeguard in the training process. Whilst the degree of responsibility apportioned to a particular trainee would vary between different consultants – according to their individual perception of the trainee's progress and ability – the structured, and more robust, nature of the RITA assessments ensured that the progress of a particular trainee could be monitored and, when indicated, feedback given to supervising consultants regarding the need for targeted training or, perhaps, being given more clinical responsibility. The former would generally tend to have been a more formal process, with supplementary documentation; the latter perhaps by informal discussion between consultant colleagues in the base unit. Particularly in the case of concerns about the underperformance of a trainee managerial or HR input might be invoked.

25 How would / should decisions be taken about the allocation of surgical work to surgeons in training, including the requirements of supervision of such junior colleagues by consultants?

25.1 Prior to the Calman reforms, cases allocated to trainees were largely dependent upon the supervising consultant's subjective view of the trainee. Whilst this situation also prevailed post-Calman, there was now a more structured approach to training with increasing emphasis upon the operative logbook (in which details of the operations undertaken or participated in by the trainee were noted), the opinion of consultant colleagues across the department, and evidence adduced from the annual RITA process. The logbooks were filled in by individual trainees and then, periodically, signed as being accurate by a member of consultant staff. They provided evidence of opportunity to train. This was done particularly at times when the trainee was due to attend a RITA meeting or when the Neurosurgery SAC made one of its quinquennial visits (as it did to each of the neurosurgical departments around the UK) and at which each trainee would be interviewed and would also have an opportunity to report candidly (and *in camera*) about training opportunities and pitfalls that they may have encountered. Following such visits the SAC would then provide structured feedback about the unit's training

⁴⁰ A firm comprised a consultant, senior registrar, registrar and senior house officer

performance. Their feedback was often scathing and, in some instances, the threat of withdrawal of training recognition by the SAC (acting on behalf of the JCST) from a particular unit would lead to positive change. (Since the visits were quinquennial – occurring every 5 years – these visits ensured that most trainees had the opportunity to provide feedback at some stage during their training. However, with the changes that occurred in the wake of the introduction of more robust surgical and medical training regulations – referred to elsewhere in this document – these SAC visits to individual units ceased to be of relevance and were phased out in around 2005-2007).

25.2 Additionally, the GMC's "Good Medical Practice" (1995) [ELJ0001-00019] mandated that doctors ensure that those they managed had "appropriate supervision," whether through close personal oversight or managed reporting structures. Similarly, the JCST (Joint Committee on Surgical Training) [ELJ0001-00009_40] mandated that trainees should have a nominated consultant supervisor for emergency work and be able to discuss emergency cases with them pre-operatively. (The JCST is formed by representatives of surgeons from each of the 4 UK Royal Colleges. The Neurosurgical SAC reports to it administratively). The discussion would usually commence with a telephone call, with subsequent consultant involvement being determined by two main factors – the complexity of the case and the perceived competency of the particular trainee (as perceived by the consultant supervisor receiving the call). Such considerations would then determine whether or not the consultant would attend the operative procedure, if such was indicated.

25.3 Within all surgical departments, not just in neurosurgery, good working relationships between consultant colleagues would also have involved regular discussion about the progress and capabilities of their trainees, and thus the amount of responsibility to be given and also the current degree of supervision required.

26 What responsibility would a neurosurgeon be expected to have or have had in the period between around 1990 to date for the following:

- (a) Continuing professional development, including the maintenance of technical proficiency in different types of neurosurgery;**
- (b) Maintenance of training and standards of ethical practice, including patient care and communication; and**
- (c) Engagement and compliance with medical re-validation and appraisal.**

(a) Continuing Professional Development (CPD) including the maintenance of technical proficiency in different types of neurosurgery.

26.1 In the early 1990s CPD was often informal and self-directed but, over time, (from 1998 to 2012) transformed into what is now a mandatory, documented requirement for remaining on the GMC specialist register through annual appraisal and 5-yearly revalidation. GMC specialist registration appears on the GMC website as the name of the individual, with confirmation that they are on the specialist register, the nature of their specialty, and the date when this specialist registration was granted. As a consequence of high-profile cases where things had gone wrong such as at the paediatric cardiac surgery department of Bristol Royal Infirmary in the 1990s, and then the conviction in January 2000 of GP Dr Harold Shipman for the murder of at least 215 patients, the GMC was galvanised into bringing in measures to assess the competence and trustworthiness of doctors in order to reassure the public. Medical revalidation is a mandatory process by which licensed doctors demonstrate to the medical regulator (the GMC) that their knowledge and skills are up to date, ultimately, that they are fit to practise. It requires regular appraisal and the maintenance of a portfolio of supporting evidence. It had first been proposed by the GMC in 1998, but these publicly reported events triggered action. Thus, in 2006, the report of Sir Liam Donaldson (Chief Medical Officer) "Good Doctors, Safer Patients" [ELJ0001-00016] strongly recommended its implementation. Formal annual appraisal became mandatory in 2012. It might be asked why it took so long for annual appraisal to be implemented when its contractual foundations were laid as early as 2001. A primary hurdle was cultural resistance within the medical profession, where many senior clinicians viewed top-down managerial tracking as an infringement on their professional autonomy and dismissed it as a bureaucratic, "tick-box" exercise. Furthermore, the early NHS lacked the unified digital infrastructure needed to manage complex portfolios, causing years of localised, inconsistent development. Crucially, early appraisal systems lacked any real regulatory enforcement mechanism; it was not until December 2012, when the General Medical Council legally linked five consecutive annual appraisals to a doctor's statutory licence to practise under the new Revalidation framework, that universal compliance was finally achieved.

26.2 In parallel with the introduction of the new GMC regulations, the surgical Royal Colleges were also moving towards a formal process of personal assessment and professional development. Whilst this was regarded (by some surgeons, at least) as a move in the right direction there has never been any mandatory assessment of continuing technical proficiency. Indeed, it would be hard to perceive how this could be undertaken and regulated on a mass

scale. The loss of manpower to resource such an undertaking would be disproportionate to the efficacy (in terms of patient outcomes) so as to justify such an endeavour. The best that can currently be reasonably implemented is a requirement to report outcomes, such as the BSR database (see para 2d, below).

26.3 Prior to 2004, some form of recording of annual continuing medical education (CME) activity had been undertaken on a voluntary basis but, thereafter, this was increasingly recognised as an obligatory educational activity. This position was formalised in 2011 by the Academy of Medical Royal Colleges [ELJ00001-00025] which mandated a minimum of 50 hours of documented CPD per annum. These changes came about largely in the wake of the Shipman scandal, and in anticipation of the resultant imminent introduction of mandatory annual appraisal, which itself was being driven by a perception (by the GMC and others) of a loss of faith in the medical profession by the general public and its belief that doctors were insufficiently regulated.

26.4 Additionally, many surgeons maintain a logbook of operative cases and complications for varied reasons: as a means of personal reflection; with a view to later publications since they will then have a permanent source of base data upon which to draw for a personal series; as personal proof of their surgical experience in the event of accusations to the contrary; and as an ingrained professional habit. Data normally included in a surgical logbook comprises patient hospital number, age, date of operation, title of operation, role in operation (e.g. performed independently; performed under supervision; assisted; observed) and complications. Additionally, there is now a necessity to keep such data for the purpose of annual appraisal so that the practice is now the norm. There are disease-specific national databases to assist with this process. In spinal practice one of the databases more widely used by neurosurgeons is the BSR (British Spine Registry) administered by BASS (the British Association of Spine Surgeons). The main purpose of these registers is to improve patient safety and to track outcomes across the UK. Some specialties - particularly cardiac surgery, vascular surgery and spinal surgery - lend themselves to such activity since they have a patient cohort with disease-specific data which can be readily tabulated pre-operatively and relatively clear outcomes, which can also be documented objectively. Such specialties thus lend themselves rather more to performance data analysis of this type. Nonetheless, there have been attempts to produce outcome data more widely but such activity is time-consuming and the potential benefits have to be weighed against the loss of clinical activity that might follow.

(b) Maintenance of training and standards of ethical practice, and communication.

26.5 In parallel with this transformation in educational requirements and documentation there has been a commensurate shift in the dissemination of information given to patients. This is perhaps most simply expressed by the suggestion that there has been a dramatic shift, within the medical profession away from *Medical Paternalism* (the doctor knows best) to *Patient Autonomy* (shared decision-making).

26.6 The legal benchmark rulings of Bolam (*"If a doctor reaches the standard of a responsible body of medical opinion, he is not negligent"*) and Bolitho (*"The professional opinion relied upon must have a logical basis and be capable of withstanding logical analysis"*) have served as long-standing guides to medical practice. In 2015, the Montgomery ruling [ELJ0001-00077] shifted the legal requirement for informed consent further in the direction of the patient. The focus was now shifted from what a *"reasonable doctor"* would disclose (the Bolam test) to what a *"reasonable person in the patient's position"* would consider significant in terms of information which required to be shared about the risks of treatment, surgical or otherwise and reasonable alternatives.

26.7 Such ethical considerations marked a significant change in the doctor-patient relationship – particularly in relation to informed consent – and would come to form a significant part of training and of daily practice on the wards. Whereas, for example, it had been possible for an inexperienced trainee to undertake the consent process preoperatively, it was now required that this task be undertaken by a more experienced clinician, perhaps even by one capable of performing the procedure. Thus, following the Montgomery ruling the responsibility for communication changed and neurosurgeons must now ensure that patients understand not just the "standard" risks, but any risk that a *particular* patient would find significant. Between 1985 and 2015, there was a famous disconnect in the UK. The **law** (*Sidaway v Bethlem Royal Hospital Governors* (1985)) allowed doctors to be paternalistic and withhold small risks if a body of surgeons agreed. However, **medical ethics** (GMC guidance - GMC 1998 *'Seeking patients' consent - The ethical considerations* [ELJ0001-00004] and GMC 2008 *'Consent - patients and doctors making decisions together'* [ELJ0001-00051]) explicitly told doctors that they *must* respect autonomy and share material risks.

26.8 Another significant shift in the Doctor-Patient relationship is that since 2014 there has been a formal legal and ethical responsibility to be open and honest with patients when something goes wrong (The Statutory Duty of Candour) [ELJ0001-00050]. Prior to 2014 the

Duty of Candour was an **ethical responsibility**, determined by the GMC (and as set out in the preceding paragraph). However, from 2014 onwards, and as a direct consequence of legislation arising from the Francis report which detailed systemic failures in services in Mid-Staffordshire (The Francis Report 2013 - *'The Mid-Staffordshire NHS Foundation Trust Public Inquiry'*), [ELJ0001-00069] this became a statutory legal requirement. Thereafter, concealment became a criminal offense for healthcare organisations.

26.9 With regards to trainees, consultant neurosurgeons now have a continuous responsibility to act as Educational Supervisors. This responsibility involves not just teaching technical skills but assessing the "non-technical" skills (leadership, stress management etc) of trainees. This came about initially as a consequence of changes from the introduction of MMC (Modernising Medical Careers, 2005) [ELJ0001-00062]; was supplemented by NOTSS (Non-Technical Skills for Surgeons, 2007 – an initiative pioneered by The Royal College of Surgeons of Edinburgh which categorised these behaviours into situational awareness, decision-making, communication/teamwork and leadership [ELJ0001-00066] [ELJ0001-00068]; and became embedded in practice with the 2012 GMC publication *'Recognition and Approval of Trainers framework'* [ELJ0001-00059] which made it a strict statutory requirement that by July 2016 any consultant acting as an Educational Supervisor had to be formally trained, appraised, and certified against specific educational standards - including the ability to assess holistic professional capabilities. The GMC tied the supervisor role to a consultant's legal license to teach. To be an Educational Supervisor, a consultant must demonstrate proficiency across 7 areas defined by the Academy of Medical Educators (AoME), which include ensuring safe clinical practice through effective supervision; evaluating a trainee's holistic professional development (not just technical metrics); and undergoing dedicated Equality, Diversity, and Educational Governance training.

26.10 There is now an expectation that decisions about patient care will be undertaken through regular and formal MDTs. This is no longer aspirational. Surgeons now have an ethical responsibility to present complex cases to an MDT to ensure the best consensus-based care. Furthermore, this became mandatory from 2013 as indicated by para 22 of the GMC Good Medical Practice booklet (2013) which states that: *'You must take part in systems of quality assurance and quality improvement to promote patient safety. This includes: (a) taking part in regular reviews and audits of your work and that of your team, responding constructively to the outcomes, taking steps to address any problems and carrying out further training where necessary (b) regularly reflecting on your standards of practice and the care you provide and*

(c) *reviewing patient feedback where it is available*'. [ELJ0001-00014] The change in accountability is summarised in the table below:

Summary Table: Then vs. Now

Responsibility	circa 1990-95	2024 - Present
Accountability	Primarily to peers/self	To the Regulator (GMC), Employer, and individual patient
CPD	Voluntary/Self-certified	Mandatory/Evidence-based
Patient Role	Passive recipient of care	Partner in shared decision-making
Data	Private surgical records	Publicly available outcome data

Publicly available outcome data is available from COP (The Consultant Outcomes Publication) which was introduced to publish quality measures at the level of individual consultant doctor using National Clinical Audit and administrative data. Consultant Outcomes Publication began with 10 National Clinical Audits in 2013 and the information published is available on the NHS Choices website. For neurosurgery such data is obtained by the NNAP (National Neurosurgery Audit Programme) which was established by the SBNS in 2013.

(c) Engagement and compliance with medical re-validation and appraisal.

26.11 When annual appraisal was introduced initially informally but subsequently as a mandatory requirement by the GMC in 2012, the type of format was that of a paper collection containing details of job plan, CME activity, complications, a list of compliments / complaints, and a short section containing personal reflection. Additionally, a neurosurgeon's professional obligations have evolved significantly beyond technical proficiency and transactional informed consent. Aligned with the GMC's Good Medical Practice framework, contemporary clinical governance mandates the continuous maintenance of competency in good patient communication, specifically open and continuous dialogue required for shared decision-making. Beyond basic consent protocols, surgeons must actively navigate complex ethical terrains mapped by GMC guidance, including the uncertainty of prognosis, the safe

introduction of innovative surgical procedures, and the ethical allocation of finite resources with daily constraint upon availability, the supply-demand deficit.

26.12 Soon after its introduction the Royal Colleges also included a template for submission of a mandatory 50 hours of CME per annum on average (thus 250 hours in the 5-year revalidation cycle). This led to meetings, seminars, conferences etc all being advertised as attracting so many CPD points (or hours of CME).

26.13 The folder containing the details would be presented annually to the departmental Clinical Director who, after a discussion about its contents, would sign off the appraisal for that year. The main factor to be considered was that the appraisee had *complied* with the process and shown that they had made some effort to complete the various domains.

26.14 As time passed, the process moved from a paper-based process (circa 2007-2012) to an online version with inherent IT glitches causing innumerable problems. The domains themselves became more numerous and complex, but still compliance with the process was essential. Other domains would include mandatory training, evidence of 360-degree feedback (to be completed within each 5-year cycle), statements with confirmation of probity, physical and mental health, and an action plan for the next year's PDP (personal development plan).

26.15 Much of this activity was (and is) regarded throughout the medical profession as being largely a box-ticking exercise without any clear evidence of benefit. It should here be recalled that it was introduced in response to at least two high profile medical scandals which had been widely reported in the media.

26.16 This being said, most doctors agree that the reflective content is of some benefit but also that the process does not necessarily protect the general public from poor practice. Furthermore, there have been concerns raised that whilst patient details have to be redacted (for reasons of patient confidentiality) the sensitive information entered into in the personal reflections of appraisal folders by doctors themselves, may perversely be used against them. This possibility came into sharp focus during the course of legal proceedings in the case of Dr Hadiza Bawa-Garba, a trainee paediatrician convicted of gross negligence manslaughter in 2015. In the aftermath of this case, it was alleged that many doctors had been reticent to enter personal reflections in their appraisal portfolio. In respect of the **aims and deficiencies of appraisal** they can be summarised as follows: **Aims:** (a) **Professional Development:** to provide a protected, structured space for a doctor to reflect on their clinical practice, identify

learning needs, and plan their continuing professional development (CPD); (b) **Quality and Safety Assurance**: to confirm that a doctor is practicing in accordance with the GMC's *Good Medical Practice* framework, ensuring that clinical performance, safety records, and patient feedback are regularly audited; and (c) **The Foundation for Revalidation**: to act as the mandatory vehicle for GMC Medical Revalidation, serving as the cumulative evidence (across five consecutive annual appraisals) required to maintain a license to practice. **Deficiencies**: (a) **Bureaucratic and "Tick-Box" Burden**: clinicians frequently criticise the appraisal process for prioritising administrative box-ticking over genuine quality improvement. Doctors must spend dozens of hours uploading granular evidence, certificates, and reflective logs into digital portfolios; (b) **The Revalidation Conflict**: Appraisal is intended to be a supportive, developmental discussion. However, because it is directly tied to a doctor's legal licence to practice (revalidation), it can be perceived as being of a punitive, judgmental character. This may prevent doctors from being completely open about their mistakes, stressors, or areas where they lack confidence; (c) **Inconsistent Quality of Appraisers**: for example, a neurosurgeon appraised by a professional from an entirely different medical discipline may find that the appraiser lacks an understanding of the specific operational challenges, clinical risks, and stress environments of theatre work; (d) **Lack of Organisational Support**: a consultant may use their appraisal to identify a clear clinical development need or a safety issue in their department, but the health board may lack the funding, staff, or SPA (Supporting Professional Activities) time to help them to address it; and (e) **Ineffectiveness at Catching Serious Underperformance**: High-profile medical inquiries have noted that poorly performing or rogue doctors can often successfully navigate the appraisal process by presenting compliant paperwork, meaning that the process does not always successfully identify severe behavioural or clinical risks.

26.17 In summary, engagement with annual appraisal – as part of the 5-year GMC revalidation process – has become a part of professional life but does not necessarily achieve its intended aims. Many doctors feel that there may be more cost- and time-effective ways of promoting better patient care and safety.

27 How would the relationship of a clinical neurosurgical service be expected to liaise and interact with services providing education and training such as universities, Royal Colleges and other governmental bodies such as NHS Education for Scotland or its predecessor bodies? What roles would consultant neurosurgeons be expected to play in the operation of such relationships?

27.1 Clinical services, including neurosurgery, should have structured interactions with educational, professional, and governmental bodies. Such relationships should ensure that standards are maintained throughout the general medical workforce and that all trainees receive appropriate supervision and educational opportunity.

27.2 In neurosurgical services in Scotland this is now facilitated through the **National Managed Service Network (MSN) for Neurosurgery**.⁴¹ [ELJ0001-00057] This organisation was set up in 2009 to ensure that patients have equal access to high-quality Neurosurgical care in Scotland. It supports the delivery and audit of services in the four neurosurgical units (Aberdeen, Dundee, Glasgow, and Edinburgh). The **MSN for Neurosurgery** reports operationally to **NHS National Services Scotland (NSS)** via the National Services Division, while maintaining its strategic accountability link to the **Chief Medical Officer (CMO) for Scotland** [Link: nss.nhs.scot nhs.scot]. These governance updates and comprehensive clinical audit reports are compiled following the close of the financial year on **31 March**, with formal submissions moving through the national review process during the subsequent spring and summer reporting windows [Link: nss.nhs.scot nhs.scot].

27.3 In terms of how it promotes good quality education the MSN organises how complex brain and spine care is run across Scotland. By doing this, they make sure that trainees can work regularly inside team meetings (MDTs) with other experts. In these meetings trainees learn, and demonstrate, that they can handle the important interpersonal skills needed to function as a surgeon. Instead of just learning how (and when) to operate they also become proficient in **paying attention** to everything happening around them, in **making good choices** together as a team, and **staying calm and leading** during a medical emergency. The MSN promotes the educational standards of Scotland's neurosurgical trainees by a variety of activities which include: (a) **joint anatomy courses for Scottish trainees**, in which registrars from all four regional units are brought together to practice advanced cadaveric dissection and operative approaches in a centralised, highly focused environment; (b) **providing equitable access to sub-specialties** since not every neurosurgical unit in Scotland performs every highly complex procedure (for example, paediatric epilepsy surgery is centred in Edinburgh, while functional stereotactic surgery is centred in Glasgow). The MSN coordinates the rotational structure and cross-board referral pathways so that trainees have equal, structured exposure to these low-volume, high-complexity cases, broadening their operative capability; (c) **sponsoring high-fidelity simulation days** to build the "non-technical skills" (mentioned

⁴¹ Details of the network in its current form can be found online at www.msn-neuro.nhs.scot

above). To achieve this the MSN funds and runs specialised **surgical simulation events** at which trainees are placed into simulated, high-stress operating room scenarios - such as dealing with a sudden, catastrophic intraoperative aneurysm rupture - allowing them to practice leadership, communication, and fast decision-making safely before touching a real patient; and (d) **democratising audit and clinical research data**: Rather than forcing trainees to spend lengthy periods chasing scattered medical records for mandatory quality improvement projects, the MSN's embedded **National Audit Facilitators** provide trainees with pre-compiled, highly accurate nationwide data registries. This allows trainees to perform high-impact clinical research, publish in major journals, and confidently learn data-driven risk management - a key benchmark required to pass the exit exam (FRCS (SN)) and thereby to progress to independent consultant practice. Additionally, the MSN for Neurosurgery promotes standardised clinical pathways to reduce regional variation and ensure consistent, high-quality care across Scotland. These pathways aim to streamline patient referrals, define multi-professional boundaries, and provide an auditable framework for measuring outcomes, while also serving as a practical, consensus-driven blueprint for trainees. In order to achieve this it relies upon a board of advisers comprising a variety of clinical staff (medical directors and neurosurgeons), specialist working subgroups, and patient and carer representatives, supplemented by documented clinical evidence such as publications from national bodies including the Scottish Intercollegiate Guidelines Network (SIGN), NICE guidance, and the Royal Surgical Colleges, adapting them specifically into localised Scottish guidance.

27.4 Neurosurgery is a lower volume specialty service, with an estimated 10,000 inpatient hospital stays per year for neurosurgical patients in Scotland according to the home page of the MSN website. The MSN endeavours to improve the quality of care (and thus outcomes) for all patients, irrespective of their age (adult or child) or geographical location. In addition, it aims to facilitate collaboration and clinical research.

27.5 In addition to having accountability through the MSN, neurosurgery units will also liaise with:

- **Universities**, thereby providing a platform for undergraduate medical education and high-level academic research;
- **Royal Colleges** which define the National Neurosurgery Curriculum, set professional standards, and oversee the Intercollegiate Surgical Training Programme (ISCP) which tracks trainee progression through competency assessments and exams;

- **NHS Education for Scotland (NES)**, established in 2002, which acts as the regional postgraduate deanery, managing the national selection process for trainees and approving out-of-programme experiences (OOP); and
- **General Medical Council (GMC)**, which provides the final accreditation of the curriculum and maintains the specialist register that graduates must join to practice as consultants.

27.6 The role of consultant neurosurgeons in this process is to provide the primary link between clinical services and these various bodies. They thus help to uphold clinical standards, particularly through clinical governance and audit initiatives (such as those recommended by the SBNS (Society of British Neurological Surgeons)) and, at the same time, have direct responsibility for daily supervision of trainees, and for the delivery of the curriculum mandated by the Royal Colleges. In consideration of the role that the **SBNS** has in **clinical governance** there are several notable initiatives which it delivers: (a) **The National Neurosurgical Audit Programme (NNAP)**: Managed under a dedicated SBNS committee chair, the NNAP is a major national quality assurance initiative. It benchmarks unit-level and consultant-level surgical data across the country, evaluating mortality, morbidity, and complication rates to ensure transparent quality of care; (b) **Mandating the Surgical eLogbook**: To support appraisals, validate training progression, and fuel clinical governance loops, the SBNS officially adopted and mandates the electronic **eLogbook**. This system forces all neurosurgical doctors to strictly document surgical workloads, operative autonomy levels (which are: Observed (O), Assisted (A), Supervised with Trainer Scrubbed (S-S/STS), Supervised with Trainer Unscrubbed (S-U/S-TU, Performed (P), and Training a Junior (T/UC)), and CPD actions; (c) **The "Safe Neurosurgery" Quality Standards**: Originating from landmark consensus papers like *Safe Neurosurgery 2000* (ELJ0001-00010), this initiative defines the mandatory structural criteria a hospital must provide to deliver safe care. It explicitly rules that a safe unit must have 24/7 access to critical care beds, dedicated neuroradiology, neuro-anaesthesia, and formal local clinical governance leads; (d) **National Care Pathway Specifications**: In tandem with national teams, the SBNS authors critical guidelines to protect patient safety. Recent key initiatives include the unified **Cauda Equina Syndrome Pathway** (now available online as the GIRFT* National Suspected CES Pathway) and the national guidelines for managing emergency vascular injury during spinal operations. [*GIRFT – **Getting It Right First Time**]; and (e) **Royal College Invited Reviews**: The SBNS provides specialised independent clinical expertise required when a hospital's neurosurgical unit undergoes an internal or external review due to a perceived compromise in patient safety, behavioural issues, or standard-of-care failures.

27.7 Additionally, most units will have an academic lead who may hold an honorary university title and whose role will include supervision of academic pathways, including PhD research and peer-reviewed publications.

27.8 More senior consultants may also take up additional responsibility, outside their base unit, in order serve as Clinical Directors or National Clinical Directors for the MSN, thereby directly influencing national policy and service redesign.

27.9 The current role of a consultant contrasts markedly with that which would have prevailed 30 years ago. In 1995, the landscape of education and service coordination in Scotland was significantly more fragmented and localised than the current integrated model so that a neurosurgical unit would have dealt with multiple different regulatory and educational bodies for its multidisciplinary staff, rather than the central coordination currently provided by NES and the coordinated approach offered (since 1998) by the MSN for Neurosurgery. There were at that time various educational bodies which worked independently of each other:

- Postgraduate medical training was managed by the **Scottish Council for Postgraduate Medical and Dental Education (SCPMDE)**.
- Nursing and Midwifery were overseen by the National Board for Nursing, Midwifery and Health Visiting for Scotland.
- Pharmacy was managed by the **Post Qualification Education Board for Pharmacists**.

27.10 Furthermore, whilst the SBNS provided UK-wide guidance, there were no Scottish-specific "National Clinical Standards" for neurosurgical units until 2010. They were introduced at this time to address unwarranted regional variation in Scotland and to resolve the structural mismatch between generic UK-wide guidelines and Scotland's unique geography and health service layout (NHS Grampian 2010 '*Clinical standards for neurosurgery in Scotland*' [ELJ0001-00055]).

27.11 In terms of training posts themselves, the effects of the Calman reforms, which introduced the Specialist Registrar grade to create more structured training, were only just being implemented in 1993–1995. Additionally, selection for training posts was still being handled locally by individual units rather than by the centralised UK-wide National Selection and Scottish Training Committee system used today. Trainees would have worked much longer shifts (in the pre-EWTD era) and the digital, competency-based Intercollegiate Surgical Curriculum Programme (ISCP) did not launch until 2007.

Comparison Summary: 1995 vs. Present

Feature	1995 Landscape	Current (Post-2002/2009)
Education Board	SCPMDE*	NHS Education for Scotland (NES)
Service Oversight	Local Health Boards	Managed Service Network (MSN and HIS**)
National Standards	Advisory (SBNS)	Mandatory National Clinical Standards set by <i>[MSN and HIS*]</i>
Training Grade	Senior Registrar/Registrar	Specialist Trainee (ST1–ST8)
Appointment Process for Trainees	Regional/Unit-based	UK National Selection

[*SCPDME - Scottish Council for Postgraduate Medical and Dental Education]

[**HIS – Health Improvement Scotland]

27.12 The **Specialty Training Committee (STC) in Neurosurgery** - frequently referred to as the Scottish Training Committee - is the official regional governance panel operating under the **Scotland Deanery** within **NHS Education for Scotland (NES)**. Functioning under strict statutory mandates from the General Medical Council (GMC), the STC serves as the operational body responsible for managing postgraduate medical training, monitoring educational quality, and enforcing curriculum progression guidelines across Scotland's four neurosurgical units. The STC framework evolved through two distinct structural reorganisations to achieve its current centralised configuration: (1) **August 2007 (Initial Formation)**: The STC system was formally established across the UK as a direct result of the **BuMedical Careers (MMC)** initiative and the publication of the first UK **Gold Guide**. This structural reform replaced the legacy of informal "Regional Hospital Training Committees" (which comprised *ad hoc* local arrangements for recruitment and training, paper-based subjective references, and end-of-appointment consultant 'sign-off') with formal, regulated

Specialty Training Committees tasked with managing the newly introduced run-through Specialty Registrar (ST1–ST8) training tracks. (2) **1 April 2014 (The "Once for Scotland" Centralisation):** Prior to 2014, Scotland's neurosurgical training was managed by fragmented, regional committees divided across separate local deaneries (West, South East, East, and North). On this date, NES abolished these regional boundaries to establish a single, unified **Scotland Deanery**. This reform integrated the separate groups into one centralised, pan-Scotland Training Committee, ensuring uniform educational standards, equitable rotational allocation, and consistent quality management across the entire country.

27.13 The National Selection process for Neurosurgical trainees (outlined in section 21f) underwent a transformation following the Covid epidemic and is now performed remotely. Furthermore, whilst centred in England it also undertakes selection for Scottish trainees. In practice, the Scottish Specialist Training Committee (STC) validates units in the four Scottish regions for suitability for training (educational resources and infrastructure, clinical caseload and educational supervisors), and also coordinates workforce numbers and availability of training posts. Following advertising available posts, senior Scotland-based neurosurgeons then screen the applications and select potential appointees for the English-based National Selection process. These surgeons will also be included in the interview process itself which is now performed entirely remotely via secure video link. This saves the expense and time involved in attending a distant location. Candidates are graded on technical knowledge, clinical judgment, and the "non-technical skills" (communication and stress management) required for run-through training. Successful candidates are then assigned to the Scotland Deanery based on their performance ranking. Neurosurgical training is delivered within Scotland's four accredited units: The Institute of Neurological Sciences (Glasgow), the Western General Hospital (Edinburgh), Ninewells Hospital (Dundee), and Aberdeen Royal Infirmary.

28. In what circumstances would it be normal for a consultant neurosurgeon be placed under clinical supervision or suspended from practice? What rules exist around the types of restrictions which it would be normal to impose in such circumstances and the obligations of neurosurgeons to comply with supervision and suspension regimes?

28.1 A consultant neurosurgeon would be placed under clinical supervision or suspended primarily to protect patient safety or to maintain public confidence during investigations into their fitness to practise. Suspension would normally be undertaken by the employing Trust, who might then report concerns to the Regulator i.e. GMC. The GMC can place restrictions on a doctor's practice and can suspend or remove a doctor from the medical register.

Examples of the reasons for such a course of action to be imposed would include one or more of the following:

- **Patient Safety Risks:** Serious concerns that a surgeon's performance or health poses an immediate threat to patients.
- **Allegations of Misconduct:** Investigation into professional behaviour or criminal activity. This could also include allegations of adverse behaviour to other staff. Under the General Medical Council's (GMC) Good Medical Practice standards, a doctor's fitness to practice can be deemed impaired just as severely by how they treat their team as by their technical surgical skills. In the 2013 GMC Guidance [ELJ0001-00014] para 36 stated that "*You must treat colleagues fairly and with respect.*" To do otherwise would thus risk censure and sanctions, including suspension.
- Additionally, and in respect of the period from 1995-2012, severe or persistent bullying of trainees by a consultant could legally and contractually result in the consultant being placed under strict clinical supervision or barred from clinical independence. The primary tools that enabled clinical supervision to be enforced for bullying at that time relied on distinct regulatory mechanisms:

1. **The Pre-2005 Era: Misconduct vs. Patient Safety Risk.** Before 2005, disciplinary matters for doctors in Scotland were governed by NHS Circular 1990(PCS)8 (the "Annex C" regulations) [ELJ0001-00070]. While bullying was often labelled as "personal misconduct," if the bullying behaviour began to affect a trainee's confidence or decision-making in theatre, local managers could declare it a professional performance risk. Under the 1990 rules, the Chief Administrative Medical Officer (CAMO) could intervene immediately to mandate that the consultant only operate or conduct clinics with a peer present—effectively implementing **interim clinical supervision**—while an independent legal inquiry panel evaluated the behaviour. **Clinical Competence:** Significant deviation from generally-accepted standard neurosurgical care or evidence of recurring adverse events. **Health Issues:** Deterioration in physical or mental health impacting the ability to perform complex surgery.

2. The Post-2005 Era: Defining "Overbearing Supervision"

In 2005, Scotland introduced **NHS Circular: PCS(DD)2005/7 (Maintaining Professional Standards)**. This modern framework made it significantly easier to impose immediate restrictions. Under this policy, rather than issuing a full suspension, a Medical Director could order an immediate **Restriction of Practice**. This mechanism was routinely used to mandate that a consultant work under the supervision of a clinical lead or clinical director, specifically

to monitor their professional interactions and ensure they were not left alone with junior staff. This was reinforced by the national **2001 NHS Scotland Partnership Information Network (PIN) Guidelines on Preventing Bullying and Harassment**. The PIN policy explicitly defined bullying to include "*overbearing supervision or other misuse of power or position*" and "*deliberately undermining a competent worker*". Once a formal grievance was raised under this framework, the board had a duty of care to protect the trainee, which frequently required placing the consultant under immediate clinical oversight.

- As an interim measure the GMC or MPTS (Medical Practitioners Tribunal Service) may impose *interim suspension* whilst the facts are being established. The GMC defines three specific levels of clinical supervision for doctors with restrictions:
- **Direct Supervision:** The supervisor must be present in person for all patient contact, including consultations and neurosurgical procedures.
- **Close Supervision:** The supervisor must be on-site and available to the surgeon at all times.
- **General Supervision:** The supervisor may be off-site but must be available via telephone to provide immediate advice or assistance.

During the period of clinical supervision various obligations are placed upon the consultant:

- **To adhere to the level of supervision:** Direct, Close or General
- **To work with a named supervisor:** They must work with a GMC-approved clinical supervisor, and in some cases, a medical supervisor (for health issues) or educational supervisor (for performance issues).
- **To work within procedure limits:** They must not perform specific, prohibited surgical procedures unless directly supervised by an approved supervisor.
- **To maintain a logbook:** They must maintain a detailed log of all procedures performed, which must be signed by their supervisor and provided to the GMC upon request.
- According to NHS Scotland's **Workforce Policies**, interim suspension is a measure of last resort used instead of clinical supervision only when an employee presents an unmanageable risk to patient safety, staff wellbeing, or the integrity of an investigation. Clinical supervision or workplace adjustments are preferred, with suspension utilised only when risks cannot be mitigated while the individual remains in the workplace. For

detailed guidance on when this applies, refer to the **Conduct Policy Guide to Suspension at NHS Scotland** (ELJ0001-00060)

- **Interim suspension and clinical supervision are completely different mechanisms** with distinct purposes, legal implications, and outcomes. **Interim suspension** is a protective*, non-punitive management action that completely removes an employee from the workplace, while **clinical supervision** is a supportive, developmental practice that keeps the clinician at work under structured oversight. [*Protective of patients and the public, staff members, potential witnesses, and the individual clinician facing allegations]

28.2 On their return to work following a period of suspension, a surgeon may be required to undertake a clinical attachment as part of an Educational and Remediation Process. During this phase they may be required to function at a level similar to that of a medical student, with no independent decision-making authority.

28.3 [The above gives a summarised account of the main responsibilities of the nominated supervising consultant and of the consultant undergoing supervision. For a more detailed account of the requirements please refer to the 2012 [ELJ00001-00017] and 2021 [ELJ0001-00020] versions of “The GMC Undertakings and Conditions” which are appended to this document.

Part D - Neurosurgical practice

General

29. What are the respective roles and responsibilities of different levels of neurosurgeons, including consultant neurosurgeons and neurosurgeons in training and what broad responsibilities would be expected at each level of a surgeon's professional development?

29.1 In the period 1995-2006, those wishing to pursue training in neurosurgery in the UK applied to regional training programmes for a specialist registrar post when a vacancy became available. Specialist registrar training then took place over several years before eligibility to attain specialist registration. From 2007 onwards, application for neurosurgical training has been undertaken annually in a national training application process. Since then, training has been more structured with a minimum 8-year training programme. Trainees are now called Specialist Trainees suffixed by a number representing the year of their training e.g. ST1

through to ST8. To be successful in the national application process, junior doctors have always undertaken work as a pre-registration doctor or a Trust Doctor in a neurosurgical unit. Typically, this would be for 6-18 months. This level was generally called an SHO; Senior House Officer or junior fellow. At the end of successful training, the trainee is awarded a Certificate of Completion of Specialist Training signifying that the trainee had attained the knowledge, experience and skills to perform at a consultant level. In addition to trainees, most UK units have a parallel stream of internationally trained doctors working in neurosurgery. These “locally employed doctors” (LED), previously known as “locum appointment for training” (LAT) doctors, often harbour ambitions to develop their neurosurgical skills aiming to achieve a Certificate of Equivalence of Specialist Registration (CESR). LED doctors can be at a level equivalent to any of the ST 1-8 levels or SHO level described above.

29.2 Within a unit there are usually several consultants. While there is no formal difference in their status, older, more experienced consultants are often considered to be “senior” consultants. Many neurosurgical units are allied to a university. Many consultants hold honorary contracts recognising the consultant’s contributions to education and research. Honorary contracts are unpaid and can be at a Clinical Lecturer, Senior Lecturer, Associate Professor, Affiliate Professor or Full Professor levels. The exact terminology varies dependent upon university. Those with paid university roles, normally have a University Contract and an NHS Honorary Contract. Such personnel are often called “academics” and have major research commitments.

29.3 The table below outlines the roles of these various levels of neurosurgeon.

SHO	Assessment of inpatients. Ward based role. Supervised for most aspects of their work
ST1 – ST3 (equivalent to a Senior SHO)	The Early stage of training. Often spend one year in neurosurgery and two years attaining experience in allied specialities e.g. intensive care, emergency department, other surgical specialities, radiology. While in neurosurgery these trainees develop increasing experience at managing on-call referrals and discussing with more senior trainees and consultants. While much of the work is ward based, ST1-3 trainees start to undertake simple neurosurgical procedures e.g. burr holes, ICP monitors, EVDs, initially under considerable senior supervision. Undertake training courses appropriate to level of training and may conduct supervised audits and start to attend conferences.
ST4-6 (equivalent to previous term Specialist Registrar)	The Intermediate stage of training. Increased exposure to operative surgery. Participating in >200 operations per annum. Lead operator for many operations, particularly in the on-call setting: burr holes, trauma craniotomy. Undertake daily ward rounds, overseeing the care of in-patients. Holds complex discussions with patients and their families. Normally participate in clinics ⁴² to develop clinical skills and decision-making skills for elective patients. Will require considerable supervision from trainers in many aspects of work. Undertake audit and quality improvement projects. Participate in appropriate CPD including attendance at conferences.
ST7-8 (equivalent to previous term)	Final stage of training. Learning microsurgical techniques under supervision. Tackling more difficult operations with a degree of independence, although a consultant always remains responsible for the care. Provides senior oversight of ward

⁴² In UK medical practice a Clinic is a session of time (usually 4 hours) dedicated to seeing new and / or follow-up patients in the outpatient setting. The Clinician can review the history, undertake appropriate examination, evaluate results of investigations, formulate a diagnosis and provide advice on further management. Management includes further investigation and treatment. Consent information is normally discussed in clinic for those patients in whom surgery is proposed.

“Senior Registrar)	care. Holds complex discussions with patients and their families. Competent to see and manage the majority of outpatients. Competent at nearly all emergency workload: decision making and operating. Normally develops areas of specialist interest. May undertake a “fellowship” ⁴³ for 1-2 years, often after completion of training, to further develop skills. Develops experience of working in multidisciplinary teams. Undertake audit and quality improvement projects. Participate in appropriate CPD.
Consultant Neurosurgeon	Completed training. NHS appointment to the consultant level is made by competitive interview. ⁴⁴ Responsible for all patients admitted to the unit when on-call: in the relevant period this included brain and spine conditions. Responsible for all neurosurgical inpatients when on-call: this ensures 24/7 consultant cover is available 365 days a year. Responsible for all patients reviewed in own out-patient clinic. Responsible for all hospital in-patients under own care. Recognises when appropriate to discuss cases with colleagues, particularly if a patient is admitted with a condition that a colleague has a specialist interest in (e.g. pituitary tumour; vestibular schwannoma). Works in multidisciplinary teams to optimise decision making and delivery of care. Regularly holds complex discussions with patients and their families. Leads and supervises audit and quality improvement projects. Participates in appropriate CPD. Participates in organisation of the delivery of services within the NHS hospital: e.g. working with colleagues to develop multidisciplinary approaches to patient

⁴³ Fellowship. A fellowship is a period of concentrated work in a specific area of practice e.g. oncology, skull base surgery, neurovascular surgery, spinal surgery, paediatric surgery, functional neurosurgery. Fellowships can be applied for in the UK and overseas. Some fellowships provide excellent training and are highly sought after posts. A minority of fellowships in the UK have been approved by Royal Colleges. The fees charged by the Colleges to approve fellowships disincentivise some hospitals from attempting to attain Royal College approval.

⁴⁴ Interview for a consultant post is conducted by an Advisory Appointment Committee. This is normally chaired by an Executive or Non-Executive Director of the Hospital. For a neurosurgical consultant post other members of the panel usually include a senior hospital manager (e.g. medical director), neurosurgeons from the local department, often an academic representative and an independent Royal College of Surgeons representative. Any proposed appointment is subject to satisfactory references.

	care. The allocation of work to a consultant is based on the timing of emergency referrals (a consultant is initially responsible for all emergency referrals when on-call); triage of elective referrals so that cases are streamlined to those surgeons with a specialist interest where relevant. The triage processes are normally led by consultant neurosurgeons but may be delegated to other clinical or administrative staff provided a support mechanism is available for advice. General (non-specialised) cases are usually directly to a pool so that patients can be seen by the first available surgeon.
LED or LAT Doctors	The professional expectation for these doctors is governed by their level of experience and engagement in learning and the delivery of care. The experience of LED and LAT doctors is variable and can lie somewhere in the spectrum between SHO and ST8.

30. What respective roles are normally played by all staff who work in the field of hospital-based neurosurgery, including those played by trainee surgeons, nurses and other ancillary staff involved in the care of surgical patients?

30.1 The **Team Working** report (SBNS, 2002) stated that: *“The organisation of teams within the Neurosurgical department has to be flexible and is largely dictated by the size and nature of activity within the department. Because of the diversity of the Neurosurgical departments team working will by necessity have to be tailored to meet the needs of individual departments. In a number of units the whole department could work as a single team but within this there will be several small teams, which would work in parallel rather than in competition. It is essential that these teams be based on clinical and not managerial requirements.”* [ELJ0001-00006_6]. Additionally, whilst it was acknowledged that they would play a pivotal role on surgical management within the team, it was also stated that: *“Individual consultants can no longer claim to have complete autocratic control of the care that is provided to their patients and have to recognise the role and responsibility of other clinicians and professionals.”*. [ELJ0001-00006_6]

30.2 The **Neurosurgical team** includes the following members:

- Consultant neurosurgeons:** They are ultimately responsible for patients admitted to the unit under their care. They see patients referred to outpatient clinics, or as inpatients referred by other specialties, in addition to urgent and emergency cases admitted whilst on call. They are responsible for the investigation and management of these patients including arranging, and undertaking or supervising, surgical procedures when indicated. They offer advice to patients and make clinical decisions on the basis of a combination of personal experience, EBM (evidence-based medicine), *ad hoc* discussion with colleagues, and formally-structured MDT meetings. They oversee the training of other staff, predominantly neurosurgeons but also from other medical and allied healthcare disciplines. They are also responsible, with consultant colleagues, for departmental management and for liaising with other medical specialities, and with medical and hospital managers. It is important to understand that whilst there will be team-working within a department – so that some conditions may be managed by a shared-care approach (e.g. complex skull base or spinal conditions) - every individual patient should have a named consultant who is ultimately responsible for their care. Although not mandatory, consultants, often through invitation by the Chair of a committee, or through an application process, may be appointed to sit on and contribute to working groups such as Ethics Committee, Medical Workforce Planning Committee, Theatre Efficiency, Clinical Governance Committee etc. This is by no means an exhaustive list and historically the roles may or may not have been remunerated (more commonly not remunerated) but the examples indicate how hospital consultants may be involved in the working practices of a hospital beyond just the delivery of direct clinical care. Some of these activities may nowadays be classified as Supporting Professional Activities and recognised in a formal job plan rather than being an activity delivered over and above a clinician's contract with their employer.
- Trainee surgeons (STs, registrars and residents):** They work under supervision with their activity being largely involved in assisting consultants on the ward and in the operating theatre, managing emergency intakes, performing ward rounds, and attending outpatient clinics where they undertake consultations with new and follow-up patients. As they gain experience (typically over the course of an 8-year training programme) they acquire increasing responsibility for clinical matters on the ward, in the outpatient department, and for the performance of surgical procedures. They will also gradually take on responsibility in the education of less experienced trainees. Other activities may involve assisting with clinical administration (arranging and chasing up investigations, assisting in the preparation of theatre lists, and preparation

of discharge summaries) and educational requirements, including contributing to MDT and audit meetings, and involvement in case reviews, publications and research projects. Ultimate responsibility for preparing a theatre list rests with the consultant although in the 1980s, 1990s and 2000s, sometimes a very senior registrar would identify patients suitable for specific operating lists. In many hospitals theatre lists are constructed taking into account, clinical priority, waiting times, mix of complexity and availability of specialist equipment.

- **Foundation doctors:** These are relatively newly qualified doctors who are involved in the initial assessment, history-taking and documentation of patients at the time of admission; general ward duties including arranging investigations and documentation on ward rounds; and assist with minor surgical procedures under close supervision.

30.3 Other medical disciplines who often work closely with neurosurgeons:

- ***Intensive care and neuro-anaesthetics**
- ***Neuroradiologists and interventional neuroradiologists**
- **Maxillo-facial surgery**
- **Orthopaedic surgery**
- **ENT surgery**
- **Plastic surgery**
- ***Neurology**
- **Paediatrics**
- **Endocrinology**
- **Neurorehabilitation medicine**
- ***Neuropathology**
- ***Neuro-oncology**
- **Microbiology**
- **Chemical pathology**
- **Neuropsychology**

30.4 These disciplines, alone or in combination, are among the many that may have a role to play in the management of some neurosurgical patients. Some (particularly those with an * in the list above) will have an almost weekly (sometimes daily) interaction with neurosurgical staff and patients, so that strong working relationships will be forged. These interactions and collaborations are essential for the smooth running of a department and thus, ultimately, for the safe delivery of patient care.

30.5 It is important that good communication is maintained between these specialties. For example, a neuroradiologist will be in a much stronger position to be able to choose the most suitable investigation – and assist with diagnosis - if clear clinical details have been provided on the request form. Similar principles will apply in the case of neuropathology, or when referring a patient to another specialty such as neurology.

30.6 With urgent or emergency surgical procedures requiring related disciplines (e.g. orthopaedics, Maxillo-facial, ENT or plastic surgery) joint pre-operative assessment, discussion and planning will facilitate intra-operative decision-making and progress. For example, where two possible course of treatment exists – such as in compound depressed skull fracture with frontal sinus involvement – the discussion with the maxillo-facial surgeons about intra-operative factors determining to whether to obliterate the sinus or to leave it patent should preferably take place in advance, with a final decision being made in the light of the operative findings. In that case the operating surgeons from the two disciplines will be able to make a swift and rational decision in a calm and efficient manner. Again, good communication and respecting the expertise of other disciplines will facilitate patient safety.

30.7 **Specialised nursing roles**

- **Neurosurgical ward nurses:** These nurses have been generally trained but develop special expertise in the assessment of the needs of neurosurgical patients. Such expertise will include:
 - an understanding of the assessment of level of consciousness (using the Glasgow Coma Score) and the significance of, and action to be taken, when this falls;
 - the general care of unconscious patients and of those with spinal injuries. In addition to standard nursing requirements, management of these patients will need attention to various other functions including nutritional needs, pressure area care, elimination (bladder and bowel), chest management, tracheostomy care, reduction of risk of thrombo-embolism.
 - the ability to deal calmly with sudden changes that can occur in neurosurgical patients (such as rapid change in vital signs (including breathing), altered conscious level, and seizures) and have an understanding of when continued observation is appropriate and when to summon urgent medical assistance.
 - empathy and an understanding of the emotional needs of patients and their families, and personal emotional resilience to be able to deal with the high incidence of seriously ill or injured patients for whom they care. It should be remembered that whereas clinical medical staff spend much of their time away from the wards, neurosurgical nursing

staff may be caring for patients with serious and distressing illness throughout their shift.

- **Neurosurgical theatre nurses:** These nurses have also been generally trained in general theatre routine but, by virtue of the essence of the complexity and intensity of some neurosurgical procedures, learn to perform their work in an atmosphere which may require strict concentration over prolonged periods. They will become skilled in the different protocols of a neurosurgical theatre and will develop skill in the various specialised equipment used in modern neurosurgical procedures (operating microscope, neuro-navigation, intraoperative monitoring etc). Additionally, the importance of their contribution to the theatre ambience cannot be overestimated – the operating surgeon needs a dependable scrub nurse (nurses who work in the sterile field, assisting the operating surgeon directly) at their side, who can be relied upon to anticipate and hand over the correct instrument at the correct time, and with minimal prompting.
- **Circulating theatre nurses:** These nurses manage the operating room environment outside the sterile field, ensuring all equipment is available, maintaining safety checklists, and supporting the scrub nurse. They also have an important role as part of the theatre team in ensuring the smooth running of the procedure, often by deflecting any potential distractions to the operating surgeon.
- **Nurse practitioners:** These nurses, who will have often already spent time working as neurosurgical nurses, take on specific roles within the team such as assisting individual consultants with the running of a spinal service. In this capacity they might assist (under supervision) with pre-operative outpatient clinic assessments, including history-taking, arranging for diagnostic tests such as blood samples, ECG and chest radiographs, and providing some degree of explanation as a prelude to the formal consent process subsequently undertaken by the operating surgeon. They will also assist on the ward by performing some of the routine daily tasks usually performed by trainee medical staff, thereby freeing up these trainees for other activities. They often also serve as the primary point of contact for patients and families.

30.8 Ancillary and Support Staff

- **Operating Department Practitioners (ODPs):** These staff take on practical roles in theatres where they tend to assist anaesthetists in the three phases of surgery, namely anaesthesia, surgery, and recovery.

- **Surgical Care Practitioners (SCPs):** These specialised staff, often having previously worked as operating theatre nurses, assist in surgery, manage preoperative clinics, and help formulate postoperative care plans. Occasionally they have sufficient training to enable them to take on some limited surgical activity such as wound closure. At a time when trainee staff availability has been reduced due to, for example, EWTD or fixed rota patterns, these staff are a valued resource in facilitating the smooth running of departmental operating lists.

- **Rehabilitation specialists:**

PT (Physiotherapy)

OT (Occupational Therapy)

SALT (Speech and Language Therapy)

These specialist healthcare professionals bring particular areas of expertise to neurosurgical patients, and often, in collaboration with clinical neuropsychology, provide specialist rehabilitation for head injured patients (TBIS, traumatic brain injury services) both in hospital and in the community.

- **Physiotherapists** assess, diagnose, and treat physical dysfunction, injuries, and illnesses to improve patient mobility, strength, and overall functional independence. They employ a variety of manual therapy, personalised exercise programs, and patient education to manage pain and promote rehabilitation. In the acute setting they also have an important role in airway management.
- **Occupational therapists** help patients overcome physical, mental, or developmental challenges to perform everyday tasks. They achieve this by evaluating the patient's needs, modifying their environment, and teaching practical, personalised techniques to promote independence. OTs often work in close collaboration with physiotherapists in the ward setting but may also undertake home visits with patients as part of the discharge planning process.
- **Speech and language therapists** assist patients with difficulties in communication, speech, voice, and language, as well as those with eating or swallowing dysfunction.

30.9 Physician associates (PAs): PAs in neurosurgery are healthcare professionals who work under the supervision of a consultant neurosurgeon to assist in the provision of care for patients with brain and spinal conditions. Whilst they are not medically qualified, they do perform a wide range of clinical and surgical tasks to enhance department efficiency.

Unverified sources indicate that there are at least six neurosurgical units in the UK (including at least one in Scotland) that employ PAs as part of their core team.

30.10 As of early 2026 the future of this grade of healthcare worker remains uncertain. Following intense public and professional controversy surrounding the safety, role, and rapid expansion of Physician Associates (PAs) and Anaesthesia Associates (AAs) their role was subject to a review commissioned in November 2024 by the UK Secretary of State for Health and Social Care, Wes Streeting. The resultant Leng Review [ELJ0001-00013] (officially the *Independent review of physician associates and anaesthesia associates*) was published in July 2025 and concluded that there was no convincing evidence to abolish the roles, but that significant number of changes were needed to ensure safety, clarity, and effective integration into the workforce. Controversy remains about their potential role within the medical profession, which generally feels that it is inappropriate that they should be regulated by the General Medical Council – the regulatory body for doctors. This position is supported by the British Medical Association. The position of the PAs themselves is, as they state, that they are highly trained and their clinical responsibility should not be curtailed. The trade unions for PAs are still endeavouring to appeal these decisions, particularly the recommendations of the Leng review, in court.

30.11 **Secretaries and Administrative Staff:** Secretaries typically work closely with consultants particularly during the years between 1995-2015. They would help manage the diary and schedule appointments, outpatient clinic lists, answer administrative queries from patients and relay clinical questions on to consultants. In many hospitals secretaries would type clinic letters while in others, typing administrative assistants might type the letters. It was not uncommon for NHS secretaries to also manage the private practice bookings for consultants with a separate remuneration pathway.

31 **What working patterns (in terms of routine and on-call commitments) might a neurosurgeon at different levels of experience and responsibility usually have been expected to undertake over the relevant period and more recently?**

31.1 Neurosurgical working patterns have evolved from historically unrestricted "firm-based" models (see footnote 37 at end of Section 24) to structured, regulation-compliant systems. Modern routines in the UK are shaped primarily by the European Working Time Directive (EWTD). They are also fashioned around staffing numbers and sub-specialisation within individual departments. Whilst the main thrust of this review has been focussed upon medical staff it should also be noted that in addition to nursing and allied professions (including

physiotherapy, occupational therapy, SALT (speech and language therapy), dietetics and pharmacy) the running of a unit was also dependent upon administrative and clerical staff. Of particular note is the role of the secretary. Each consultant would have an individual medical secretary as an integral part of their team. The secretary would generally have a separate (and individual) office close to that of the consultant and would be responsible for record keeping. Traditionally, and certainly before the arrival of computer-based record keeping, documents would be filed in Oxford ring binders in which would be stored in systematic fashion medical records which might include copies of outpatient letters, miscellaneous correspondence, operation notes and discharge summaries, these records being separate from the patient hospital folder (stored separately and often at a distant location, such as in a neighbouring building or tucked away in the hospital basement). The Oxford ring binders would be stored in a systematic fashion (alphabetically / chronologically) and each category (discharge summaries, operation notes etc) would generally be supplemented on an annual basis. Thus, in addition to inheriting such records of those patients who had been cared for by their predecessor, a new consultant would soon accumulate a large collection of their own documents. These records formed an essential part of neurosurgical practice, particularly prior to later IT developments and electronic record keeping, since if an 'old patient' re-presented with an acute problem access to information about their previous history, investigation, diagnosis and management could be a critical factor in the understanding and management of their new presentation. (Access to such matters is still, of course, critical in safe patient care but prior to modern IT – when such information can be accessed readily - it could sometimes take days for the records to be located. Responsibility for the safe and systematic storage of these documents rested largely with the medical secretary. It was also their role to type up correspondence - often from shorthand notes which they would take down in clinics, later from correspondence recorded onto magnetic tape using Dictaphones, and latterly often replaced (in this context at least) by voice text or speech typing. Their role also extended to being the first port of call for patients and their relatives and, as a consequence, often built up a strong rapport with them. Their role extended to keeping a written diary of the consultant's forthcoming schedule including such things as management meetings, operating lists, annual and study leave, postgraduate education commitments, and in many cases personal activities which extended way beyond their clinical responsibilities. Some consultants would also employ their secretary for non-NHS activity including medico-legal and private practice. This was a very useful state of affairs which was mutually beneficial since the secretary would already be familiar with the consultant's ways and what to include in correspondence, and already had experience of their record-keeping expectations, and would benefit from the extra income that would result from such activity. There was a danger that the boundary between

NHS and non-NHS activity could be crossed, but in general time dedicated to the two roles was honourably followed. As a consequence of all these interactions the medical secretary became an important and integral part of the neurosurgical unit, not just at consultant level but amongst junior medical staff and others working on a unit. This often led to close bonds, based upon work, friendship and often the shared experience of the emotional consequences of dealing with seriously ill patients (and their families). Loyalty and respect became the norm and many consultants derived much emotional sustenance from these close working relationships. In more recent times, however, there has been a loss of consultant autonomy in this regard, with secretarial support being provided from a 'pool' with loss of these relationships perhaps to the detriment of both medical and secretarial, and especially to patients for whom this contact helped them to develop and maintain confidence in the treating team. Other staff would also play an important role, including ward receptionists, again a point of contact and a source of information (albeit limited and in lay terms) for relatives visiting the wards. All such staff served to cement the bond amongst staff in the unit, and helped to provide useful emotional support.

31.2 A further matter is worthy of consideration, specifically the question of the integration of demanding NHS commitments with university, research, and private obligations. This required strict adherence to formal institutional frameworks. Under the standard NHS contract, a consultant's working pattern was explicitly segmented into Programmed Activities (PAs); typically, 7.5 to 8 PAs were locked for Direct Clinical Care (DCC), while 2 to 2.5 PAs were dedicated to Supporting Professional Activities (SPA) to fulfil teaching and research duties. For clinical academics, this was formalised via a Joint Contract split directly between the University and the Trust. Private commitments were contractually restricted to a surgeon's spare time - such as evenings or weekends, or at other times during the working week with utilisation of a flexible PA arrangement following a job plan review - and remained legally subservient to primary NHS duties and emergency on-call responsibilities. Control over these competing timelines was maintained centrally by the unit's Clinical Director through a mandatory annual Job Planning process. Within the unit, the daily management of these complex, multi-site schedules relied entirely on specialised administrative buffers - such as medical secretaries and diary managers - who insulated clinical blocks, mapped rota cover, and ensured that out-of-hours activities never compromised the continuity or safety of the core NHS service.

Historical patterns (Pre-2003 / Pre-EWTD)

31.3 Smaller units (in Scotland, those in Dundee and Aberdeen) would typically have had fewer consultant staff and trainees. Thus, at the start of the period of interest for the Inquiry there would have been 2 to 4 consultants in the two smaller units. This would have resulted in them being on call on a 1:2, 1:3 or 1:4 rota. There would have been a similar number of trainees, or locally employed doctors, who would thus have had a similar rota pattern. At that time neurosurgical units typically followed a 24-hour on-call system during the week, and a 3-day shift for weekends on call. Typically a 3 day weekend would have resulted in the individual being on call from 09.00h on a Friday morning for the next 72 hours continuously until 09.00h on the Monday morning. This pattern would have applied both to the consultant staff and to the trainees. Additionally, whereas the consultant would be on call from home, the trainees were usually expected to remain in the hospital when on call, and to continue working throughout the next day without mandated rest. For the consultant staff in smaller units, and particularly when supported by relatively inexperienced trainees, there would have been a necessity to attend theatre (or at least to attend the unit to provide senior clinical input) out of hours on a fairly regular basis. This requirement would also have been present in larger units but, with a generally less onerous rota requirement and with more experienced trainees, this on call burden would have tended to be somewhat less than in the smaller units.

31.4 Following the introduction of the EWTD (introduced for the general UK workforce in 1998, but junior doctors were excluded until 2004) there was a significant reduction in the working week of trainees. The current work pattern is now typically as follows:

Current patterns by experience level

31.5 Junior Trainees (Interns / Postgraduate (PG)Y-1 / ST1-2)

- **Routine:** A standard week is often 40–48 hours, but actual work frequently exceeds this, reaching 60–80 hours in some contexts. Duties include ward rounds, administrative tasks (average 9 hours per call on electronic records), and assisting in theatre.
- **On-Call:** Shift-based patterns (e.g., "night float") are common to comply with rest requirements. Shifts are capped at 12–13 hours, with mandated rest periods (e.g., 11 hours between shifts).

31.6 Middle Grade / Registrars (PGY-3 to CCT / Senior Residents)

- **Routine:** High operative volume is expected. Registrars may stay late (2–4 nights per week) to ensure they meet surgical case targets for their logbooks.

- **On-Call:** Often 1-in-6 to 1-in-8 rotas. These staff handle the bulk of emergency referrals, receiving high volumes of calls during on-call periods.

31.7 Consultants

- **Routine:** Typically based on "Programmed Activities" (PAs), with a full-time contract being 10 PAs (approx. 40 hours). A typical week includes 2–3 theatre sessions, 1–2 clinics, and MDT meetings. Many consultants undertake a further 4–8 hours working in the NHS. Private practice and other commitments can extend the week to 60+ hours.
- **On-Call:** Usually non-resident (on-call from home) but must be available to return for emergencies. Frequencies vary but are often around 1 in 6 to 1-in-15, but this will be very much determined by the skill sets within individual departments.

31.8 Recent changes and challenges

- **Shift from 24-Hour Call:** Many programmes have transitioned to "night float" systems (a dedicated night team) to reduce fatigue, though some return to 24-hour calls to improve operative exposure.
- **Flexibility:** Modern job plans increasingly require "prospective cover" (covering colleagues' leave) and "Supporting Professional Activities" (SPAs) for research and appraisal.
- **Experience gap:** Modern neurosurgical trainees face a significant experience gap compared with those who completed training around 1995, primarily resulting from the change in work pattern summarised in the preceding paragraphs. Thus, whilst modern trainees often have better theoretical knowledge and access to simulated surgical training, they typically graduate with lower operative volumes and reduced hands-on exposure to key procedures. It is estimated that a 1990s trainee might have worked 20,000+ hours, whereas a modern counterpart may have closer to 10,000 hours. Furthermore, the traditional model of "see one, do one, teach one" has been replaced by shift work, which disrupts the trainee-trainer relationship and reduces the ability to follow patients from pre-op to post-op, hindering continuity of care. This change to shift work rather than the 24 hour (and longer) on-call rotas means that trainees miss out on overnight emergency cases, such as trauma craniotomies and CSF diversion procedures, which used to be the staples of training.
- **Subspecialty evolution:** Whilst 1995 training was heavily focused on broad, open, general neurosurgery, modern practice - and thus training - has moved towards endovascular techniques, minimally invasive spine operations, and functional neurosurgery.

- **Reduced autonomy:** Increased scrutiny on "health-care market" outcomes and a zero-tolerance attitude toward complications have led to reduced autonomy in key aspects of cases, and particularly training, compared to previous generations.

31.9 Factors mitigating the experience gap

- **Simulation technologies:** Modern training may incorporate virtual reality (VR), augmented reality (XR), and high-fidelity simulators to compensate for less operating experience, allowing for safe, repetitive practice.
- **Standardisation:** Modern training is more structured, with standardised curricula, national simulation training courses and milestone-based assessments (e.g., ARCP in the UK) ensuring a baseline level of competence, even if total experience is lower.
- **Enhanced safety culture:** The focus on reducing fatigue-related errors may improve safety, although it may come at the cost of reduced training volume.

31.10 Summary of differences

A 1995 graduate was likely more prepared for independent neurosurgical practice immediately upon completion than current trainees. A 2025 graduate is likely to be more tech-savvy, well-versed in subspecialised, minimally invasive techniques, but also likely to require further fellowship training to reach the stage of fully independent consultant status.

32 What numbers of patients in a medical catchment area would normally have been expected to be covered per neurosurgeon in a hospital unit over the relevant period and more recently? How would the size of the patient community covered alter the surgeon's experience and capabilities?

32.1 The UK population was approximately 56.5 million in the mid-1980s, 58.6 million in 1995, and 67.1 million in 2020. In 1990 there were 150 whole time equivalent consultant neurosurgeons, a figure which had risen to approximately 450 by 2020. Thus, the ratio of consultants to population fell from approximately 1:380,000 in 1990, to 1:148,000 by 2020. With further expansion of the workforce this ratio has now fallen to 1:144,000 as shown in the table below utilising data from the UK Neurosurgical census [ELJ0001-00007] developed in the last decade (supplied by Miss K Whitehouse).

32.2 The actual numbers are relevant for a variety of reasons but predominantly relating to maintaining consultants' skills in the management of particular conditions, and also for training purposes - the more cases with a specific pathology that pass through a unit, the greater the educational potential.

32.3 **Table: Ratio of consultant neurosurgeons to UK population (1990-2024).**

While the UK population grew from roughly 56.3 million in 1980 to 69.3 million in 2024, the expansion of the neurosurgical workforce has outpaced general population growth.

Era	Estimated Consultants	UK Population	Density (Surgeon: Population)
~1990	~150	~57.2 million	1 per ~381,000
2020	~450	~66.7 million	1 per ~148,000
2025	~-480	~69.3 million	1 per ~144,000

Catchment area population standards

32.4 **Current standards:** The NHS England Service Specifications [ELJ0001-000024] are detailed documents defining the required standards, scope, and quality of care for providers of specialised services. Developed by clinicians and experts, they outline core and developmental standards to ensure consistent, safe, and effective care across England. These documents cover clinical, operational, and performance requirements. They define the minimum requirement for a 24-hour consultant-led service as one neurosurgeon per 200,000 population.

32.5 **Historical benchmarks:** In the late 1990s and early 2000s, the ratio was significantly lower, with roughly one surgeon per 378,000 population recorded in some periods.

32.6 **Unit catchment sizes:** Modern neurosurgical units typically serve populations between 1.0 to 3.5 million (sometimes up to 4 million). Small units (1.0 - 1.2 million people) are expected to have a minimum of six consultant neurosurgeons to maintain safe rotas.

32.7 **Impact of community size on surgeon experience**

32.8 The size and density of the patient community directly influence a surgeon's proficiency and the unit's operational safety:

- **Surgical Volume & Proficiency:** Higher patient volumes generally correlate with improved clinical outcomes, including lower mortality and complication rates. This

is due to the "volume-outcome relationship," where surgeons in larger catchment areas encounter a higher frequency of complex cases, maintaining their technical skills. There is, however, a paradox here. With increasing intensity of work comes greater experience and diagnostic and technical expertise but at the expense of emotional stress, burnout, and the risk of operational fatigue. Without administrative buffers, this high-stakes environment reaches a tipping point where fatigue-induced errors reverse the patient safety benefits of high-volume care. The administrative buffers include other staff who take up some of the consultant's administrative workload such as medical secretaries (who may act as gatekeepers for relatives and families, triage GP phone calls particularly at stressful times, and maintain a clear diary schedule of planned events), MDT co-ordinators and rota coordinators (who reduce the onus of responsibility for the consultant of organising MDT sessions or departmental rotas, including annual and study leave requirements, and unscheduled absences from work amongst colleagues), and the consultant's peers (who may be able to offer emotional support and a sympathetic ear when unexpected clinical or surgical complications arise). Despite the mitigating effects of such other staff, however, the risk of burnout remains. In one neurosurgical meta-analysis study (Neurosurgical Review 2026 [ELJ0001-00063]) the pooled prevalence of burnout was reported to be 45% although it was noted that worldwide prevalence rates varied widely. The resultant loss of staff from this cause may have a further knock-on effect on residual staff – with lower staff numbers there will be increased demand placed upon those who remain. Whilst replacements may be found it can be some time before these new colleagues are 'up to speed' which increases the pressure upon existing staff members.

- **Sub-specialisation:** Units with larger catchment populations have more opportunity for sub-specialisation. In smaller units, however, surgeons must remain generalists so as to be able to cover a wider variety of emergencies, and this requirement may limit their depth of experience in rarer procedures.
- **Operational resilience:** Larger units (serving >2 million people) are required to have more infrastructure, such as at least four dedicated operating theatres, compared to one or two for smaller units. This reduces the risk of elective procedures being cancelled due to emergency cases.
- **Training and audit:** Centres with larger catchment areas often serve as Major Trauma Centres, providing a richer training environment. Furthermore, larger centres will also tend to present more opportunities for research and audit which are important factors not only in the maintenance of clinical standards and service development, but also in the educational development of trainees.

32.9 Current state of workforce and future concerns

- **Current situation (2020s):** As of 2023, there were >400 consultant neurosurgeons in the UK. While this is a significant increase, the ratio of one surgeon to 151,000 – 170,000 population remains below the European average of one surgeon per 125,000 population.
- **Employment uncertainty:** Despite the expansion, a 2020 report [ELJ0001-00007] identified that more trainees were completing training than there were consultant posts available, with a projected, persistent oversupply of trained, non-consultant neurosurgeons. This is an ongoing situation, although, due to the long duration of training, prediction of the balance of future workforce demand and supply are difficult to estimate with certainty.
- **Future outlook:** While numbers have grown, the SBNS projects that, if current trends continue, there will probably be a substantial surplus of neurosurgeons who have completed training but not attained a consultant post.

Best practice

33. Please outline the main sources of clinical guidance or best practice in relation to neurosurgery in the period since around 1990, with particular regard to the procedures set out above, setting out how and whether, how and why such guidance or best practice has changed materially over that period.

33.1 Clinical guidance and best practice in neurosurgery have shifted significantly since 1990, moving from a reliance on expert opinion toward a rigorous evidence-based medicine (EBM) framework. This evolution has been driven by rapid technological advances, including the widespread adoption of high-resolution MRI, neuronavigation (frameless stereotaxy) and minimally invasive techniques.

33.2 Main sources of clinical guidance

Since the early 1990s, neurosurgical guidance has been formalised through several key national and international bodies:

33.3 National Institute for Health and Care Excellence (NICE) and Scottish Intercollegiate Guidelines (SIGN): NICE Guidelines are a primary source of evidence-based guidance in the UK, providing clinical guidelines for a range of neurosurgical conditions. In

Scotland, The Scottish Intercollegiate Guidelines Network (SIGN) provided evidence based best clinical practice guidelines for the NHS: these included guidelines related to the early management of patients with head injury; rehabilitation of brain injured patients; the management of patients with chronic pain; the prevention and management of venous thromboembolism and clinical standards for neurosurgery. The NICE Guidelines have been widely used in the UK over the past 2 decades.

33.3.1 The guidance has been revised periodically, particularly in relation to the management of head injuries. Thus, the NICE guideline CG56 (published in 2007) provided evidence-based recommendations for the triage, assessment, investigation, and early management of head injuries in infants, children, and adults. It focused on identifying patients needing urgent CT scans or specialist referral, including specific criteria for paediatric imaging. This guideline was updated and replaced by NICE guideline CG176 (in 2014) which was itself replaced more recently (in May 2023) by NG232 [ELJ0001-00032].

33.3.2 Other conditions covered by NICE guidelines include:

[NG99] [ELJ0001-00033] Brain tumours and brain metastases (primary) in over 16s
Covers investigation, management (including chemical dyes for tumour removal), and follow-up.

[CG75] Metastatic spinal cord compression: Risk assessment, diagnosis, and management. This guideline was updated and replaced by NICE Guideline NG234 [ELJ0001-00034].

[NG41] [ELJ0001-00035] Spinal injury: Covers assessment and initial management for traumatic spinal column and cord injuries.

[NG127] [ELJ0001-00036] Suspected neurological conditions: Provides recognition and referral criteria for non-specialists.

[NG59] [ELJ0001-00037] Low back pain and sciatica: Early management and criteria for invasive treatments.

[NG252] [ELJ0001-00038] Rehabilitation for chronic neurological disorders: Covers person-centred rehabilitation for conditions including acquired brain and spinal cord injuries.

[NG217] [ELJ0001-00039] Epilepsy: Management of epilepsies in children, young people, and adults.

33.3.3 Interventional Procedures Guidance (IPG) has been published for various specific surgical techniques following NICE evaluation for safety and efficacy:

[IPG19] Deep brain stimulation for Parkinson's disease (now HealthTech guidance HTG7). [ELJ0001-00040].

[IPG32] Endoscopic transsphenoidal resection of pituitary adenoma (now HealthTech guidance HTG14) [ELJ0001-00041].

[IPG84] Supraorbital mini-craniotomy for intracranial aneurysm (now HealthTech guidance HTG52) [ELJ0001-00042].

[IPG12] Percutaneous vertebroplasty for spinal fractures (now HealthTech guidance HTG3) [ELJ0001-00043].

[IPG341] Prosthetic intervertebral disc replacement (cervical spine) (now HealthTech guidance HTG217) [ELJ0001-00044].

[IPG165] Interspinous distraction for lumbar spinal stenosis (now HealthTech guidance HTG238) [ELJ0001-00045].

[IPG574] Lateral interbody fusion in the lumbar spine (now HealthTech guidance 431) [ELJ0001-00046].

33.4 Specialist societies: The Society of British Neurological Surgeons (SBNS) provides clinical leadership, expert advice, and consensus guidelines. The following list serves to illustrate some of the range of available material and guidance from the SBNS:

Safe Neurosurgery – 2000 [ELJ0001-00010].

British Neurosurgical Workforce Plan (2000-2015) - 2000 [ELJ0001-00015].

Teamworking – 2002 [ELJ0001-00006].

Standards for Patients requiring Neurosurgical Care - 2002 [ELJ0001-00011].

Wrong Site Surgery - October 2015 [ELJ0001-00008].

Low Volume Surgery – 2018 [ELJ0001-00028].

Cauda Equina Syndrome – 2018 [ELJ0001-00031].

Site Infection – 2019 [ELJ0001-00012].

UK Neurosurgery Workforce Report - 2020 [ELJ0001-00007].

33.5 NHS England Clinical Reference Groups (CRGs): These groups provide national strategic leadership and clinical governance, particularly for transforming neurosurgery and spinal surgery services.

33.6 Quality improvement programmes: Initiatives like **Getting It Right First Time (GIRFT)** and the **National Neurosurgical Audit Programme (NNAP)** use national datasets to drive quality improvement and standardise care.

33.6.1 The **GIRFT** programme aims to bring about higher-quality care in hospitals, at lower cost, by reducing unwanted variations in services and practices. It uses national data to identify the variations and outcomes, shares that data with all those concerned with a service – not only clinicians, but also clinical and medical directors, managers and chief executives – and monitors the changes that are implemented. For neurosurgery there have been GIRFT reports on **Cranial Neurosurgery** (June 2018) [ELJ0001-00026], **Spinal Surgery** (January 2019) [ELJ0001-00003] and **Paediatric Neurosurgery** (January 2024). [ELJ0001-00005]

33.6.2 The **NNAP** was established by the SBNS in 2013 as part of a major quality improvement initiative. The programme aims to support neurosurgical units in the UK and Ireland to improve patient care outcomes, safety, and experience by providing high quality, robust audit data that is analysed and presented in a consistent and clinically relevant way.

33.7 Standardised textbooks and journals: Major reference works (e.g. *Schmidek and Sweet: Operative Neurosurgical Techniques* and *Youmans and Winn Neurological Surgery*) and several general and specialist neurosurgical and neurological journals continue to serve as fundamental sources for recognised practice and evolving techniques through peer-reviewed research publications.

Material Changes in Guidance and Practice (1990–Present)

33.8 The core principles of neurosurgical practice have changed due to an increasing reliance on objective medical evidence (EBM) over "eminence-based" expert opinion.

1. Shift Toward Minimally Invasive Approaches

Best practice has moved away from large, open exposures toward minimal access.

- **Neuro-oncology:** Current guidance favours minimal access to target areas where possible through stereotactic localisation, image-guided surgery, and endoscopy. The evolution of high-magnification surgical microscopes and of intraoperative imaging in facilitates safer and more extensive tumour resection.
- **Vascular neurosurgery:** Following the publication of the findings of the **International Subarachnoid Aneurysm Trial (ISAT)** [ELJ0001-00023] there has been a dramatic shift from surgical clipping of aneurysms (performed by neurosurgeons) to endovascular coil embolisation (performed by interventional radiologists). In terms of the surgical treatment of aneurysms this shift towards interventional radiology has had implications for skill retention by consultants and for training.

2. Evolution in Functional Neurosurgery

Treatment for movement disorders has undergone a complete paradigm shift.

- **1990s practice:** Surgical treatment of movement disorders generally involved through lesioning (permanent destruction) of specific brain regions.
- **Current practice:** The preferred procedure is now Deep Brain Stimulation (DBS), which uses implanted electrode stimulation, rather than the performance of a destructive lesion.

3. Advances in spinal surgery

Spinal surgery has always accounted for a significant proportion of neurosurgical activity in terms of numbers but over the last two decades the demand for spinal surgery (in part related to an aging population) and its complexity has increased.

- **Instrumentation:** There has been a significant increase in the performance of instrumented fusion (with a variety of screws, rods, cages, and bone graft) by neurosurgeons, formerly largely the province of orthopaedics.
- **Specialisation:** Increasing numbers of neurosurgeons undertake a spinal fellowship towards the end of their training, and this has further contributed to the shift in the volume and complexity of spinal procedures undertaken within neurosurgical units.

4. Systemic and multidisciplinary changes

- **Evidence-Based Medicine (EBM):** Although EBM became accepted as being the "gold standard" for clinical practice in the 1990s it is estimated that even now only 10% to 25% of clinical decisions are currently based on high-quality (Level I or II) evidence.

- **Multidisciplinary Teams (MDT):** Modern guidance mandates a networked approach to clinical decision-making. Discussions should not just involve other specialties but also clinicians within the *same* specialty. This helps to ensure consistent adherence to evidence-based standards. This process of intradisciplinary teamwork provides a supportive environment for shared responsibility for complex cases.

34. What would best practice have been over the relevant period relating to/ what principles ought to have guided the following aspects of neurosurgical practice:

(a) Diagnosing a patient and the explanation of the diagnosis to the patient

34.1 The General Medical Council (GMC) publications clearly state the duties of a doctor. The core content describing interactions with patients in the 1995 [ELJ0001-00019], 2006 [ELJ0001-00018], 2013 [ELJ0001-00014] and 2024 iterations of Good Medical Practice [ELJ0001-00052] are similar. In this section the 1995 edition is referenced.

34.2 Good Medical Practice (1995)⁴⁵ [ELJ0001-00019] stated that a doctor must take suitable and prompt action when necessary, including making an adequate assessment of the patient's condition based on the history and clinical signs, including where necessary an appropriate examination. The doctor must provide or arrange investigations or treatment where necessary. The doctor must refer the patient to another practitioner, when indicated. The doctor must recognise the limits of his/ her professional competence and be willing to consult colleagues. The doctor must be competent when making diagnosis and when giving or arranging treatment.

34.3 The GMC stated that the doctor must listen to patients and respect their views; treat patients politely and considerately; respect patient privacy and dignity; give patients the information they ask for or need about their condition, its treatment and prognosis; give information to patients in a way they can understand; respect the right of patients to be fully involved in decisions about their care; and respect the right of patients to refuse treatment or take part in teaching or research.

34.4 The GMC guidance therefore instructs the doctor to be competent at taking a history and performing an appropriate examination. The doctor must then arrange relevant tests to enable a diagnosis to be made. The diagnosis, treatment and prognosis must be discussed

⁴⁵ Good Medical Practice, GMC Publications, 1995

with the patient in a way in which the patient can understand. The doctor should involve the patient in decision making. In elective patients the above processes normally take place in an outpatient clinic. During the latter half of the relevant period, nurse specialists were often available to support a patient when bad news was being delivered. For emergency cases the above steps may appropriately be delegated to junior members of the medical team, under the direct, or indirect supervision of the consultant.

(b) Patient safety

34.5 Several aspects of Good Medical Practice (1995) [ELJ0001-00019] are directed at ensuring patient safety.

34.6 A doctor's duty is "to protect all patients". This includes taking action when a doctor's own health may put patients at risk and taking appropriate action when a colleague's conduct, performance or health may put patients at risk.

34.7 The guidance states that the doctor must "be competent, when making diagnoses and when giving or arranging treatment". This, and the requirement to be "willing to consult colleagues", is directed at recognising "the limits of your professional competence".

34.8 The Guidance states that the doctor "must maintain the standard of your performance by keeping your knowledge and skills up to date throughout your working life. In particular you should take part regularly in educational activities which relate to your branch of medicine". In addition, doctors were told that they "must work with colleagues to monitor and improve the quality of healthcare. In particular you should take part in regular and systematic clinical audit".

34.9 To support patient safety, "all doctors should be prepared to supervise less experienced colleagues".

34.10 Since healthcare was increasingly provided by multi-disciplinary teams, the 1995 Good Medical Practice [ELJ0001-00019] stated that "you are expected to work constructively within such teams." Doctors were instructed that if they disagreed with a team decision and were unable to persuade other team members to change their minds, and believed that a decision would harm the patient, they should "tell someone who can take action. As a last resort, take action yourself to protect the patient's safety and health."

(c) The taking of informed consent.

34.11 Good Medical Practice (1995) [ELJ0001-00019] does not specifically discuss consent. The consent process is directed by law and enacted by the application of medical professionalism. In 1998 the GMC first published guidance entitled “Seeking patients’ consent: the ethical considerations”⁴⁶. [ELJ0001-00004]. This publication considered the legalities and ethical aspects of consent, emphasising the importance of honesty and trustworthiness.

34.12 The discussion below is restricted to adult practice.

34.13 Where an adult is competent, only that adult can provide consent.

34.14 When an adult is incompetent, the doctor must act in the patient’s best interests. When clinical circumstances permit, it is normal practice to discuss treatment with the next-of-kin.

34.15 A competent adult (Person A) may give an enduring power of attorney to a named person (Person B). In such circumstances, if Person A becomes incompetent, Person B is enabled to make decisions regarding health matters on behalf of Person A.

34.16 For effective consent to treatment the patient must be competent, sufficiently informed and not subject to coercion or undue influence. For a person to be incompetent they must be unable to make a decision for him/herself due to (i) an inability to understand the information relevant to the decision, or (ii) an inability to retain that information, or (iii) an inability to weigh that information up as part of the process of making the decision, or (iv) unable to communicate his/her decision.

34.17 Obtaining consent is generally regarded as a process. For most interventional procedures or operations this culminates in completion of written consent. Throughout the relevant period, for elective patients, the process begins in the outpatient setting and was typically confirmed by signing written consent in the day or hours preceding the planned operation. For emergency patients, the process begins once a management plan is formulated.

⁴⁶ Seeking patients’ consent: the ethical considerations. GMC Publication. November 1998

34.18 The key steps that must be taken by the doctor are (i) assessment of patient capacity. If the patient is competent, the doctor then (ii) explains the nature of the proposed treatment, the likely benefits of the treatment, the common risks associated with the treatment, the potentially life changing risks of the treatment (which may be rare) and the prognosis for the outcome including recovery time range, if known. The surgeon must also discuss alternative treatment options, including a non-operative approach. The patient is assured that a competent person will perform the procedure. The information provided by the surgeon must be delivered in a way in which the patient understands. The patient must be given the opportunity to ask questions and given sufficient time to consider this information before making a decision: consent, particularly for elective procedures, should not be rushed. No coercion can be applied to pressurise the patient into making a decision in a short time period.

34.19 The doctor must recognise the paramount importance of patient autonomy: “a patient of adult years and sound mind has a right to determine what shall be done with his own body; and a surgeon who performs an operation without his patient’s consent, commits an assault.”⁴⁷

34.20 The information provided by the surgeon must be accurate. If inaccurate information is provided, a decision to consent is built upon unsound foundations and is invalid.

34.21 Consent discussions often involve the consultant surgeon. However, obtaining written consent can be delegated to more junior members of the medical team provided the discussant is well-informed regarding the factors that must be covered in the consent discussion.

34.22 During the latter half of the relevant period, the use of written materials to help provide information for patients has become popularised.

34.23 Throughout the relevant period, there has been controversy about how much information must be disclosed to a patient concerning the risk of a procedure. The *Chester v Afshar* case (2004) was well known in neurosurgical circles when Mr Afshar, a Consultant Neurosurgeon in London did not adequately inform a patient about the risks of a spinal operation. Ms Chester argued that if she had been fully informed about the risks of surgery she would have sought a second or even third opinion and that the competently performed surgery that caused a neurosurgical deficit would have been performed on a different

⁴⁷ Cardozo J. In *Schloendorff v New York Hospital* (1914) 105 NE 92

occasion, perhaps without causing a neurological deficit. In light of this case, and others, the majority of neurosurgeons pay scrupulous attention to conducting a thorough consent process.

(d) Patient communication generally.

34.24 Good Medical Practice 1995 [ELJ0001-00019] states that “good relationships” with patients is an essential element in providing good standards of practice and care. This is reiterated in all editions of Good Medical Practice. The doctor-patient relationship is built on trust and doctors have a special responsibility to make the relationship work. Doctors “must be honest and trustworthy”. Doctors must “listen to patients and respect their views; treat patients politely and considerately; respect the right of patients to be fully involved in decisions about their care; respect the rights of patients to refuse treatment or take part in teaching or research; respect the right of patients to a second opinion; ask patients’ permission, if possible, before sharing information with their spouses, partners or relatives; be accessible to patients when you are on duty; respond to criticisms and complaints promptly and constructively.” Doctors must not “improperly disclose or misuse confidential information about patients”.

(e) The referral of patients to private care.

34.25 The GMC are not explicit in the information given to doctors about self-referring to private care. The general understanding is that the GMC require doctors to act with honesty and probity at all times. A conflict of interest arises if a doctor suggests referral of a patient to private care: a doctor is paid for consultations and operations in the private sector. Recommending a patient is referred for private care (including self-referral) may therefore be construed as a conflict of interest due to the financial benefits that accrue for the surgeon. However, if a patient seeks information about “going private”, the doctor must be open and honest. The availability of private care should be explained to the patient. The availability of care in the NHS sector should be given as a comparator. The doctor must be honest in these discussions and answer any questions about time-frame for delivery of care and cost of care honestly.

35. What would best practice have been over the relevant period with regard to recording information in medical or other records relating to neurosurgical practice? In particular:

(a) What would the main means of recording information have been (e.g. patient records, theatre logs etc)?

(b) What types of information would normally be recorded in which area and why – eg, diagnosis, treatment options, discussions with patients, the taking of informed consent, events in theatre, surgical outcomes etc?

35.1 The GMC state that doctors must “keep clear, accurate, and contemporaneous patient records which report the relevant clinical findings, the decisions made, information given to patients and any drugs or other treatment prescribed.”⁴⁸ [ELJ0001-00019] Records should be dated and signed. Doctors must also “keep colleagues well informed when sharing the care of patients”.

35.2 For outpatients, the main means of recording information during the relevant period would be handwritten contemporaneous clinic notes filed in the hospital medical records (NHS or private). Provided contemporaneous dictation of correspondence to the patient or a medical colleague is undertaken, it is not mandatory to write additional handwritten notes, although for most clinicians, recording notes in addition to dictation is normal practice.

35.3 For hospital inpatients, handwritten medical records were the norm over most of the relevant period. In the last decade many Hospital Trusts have adopted full electronic patient records (EPR). I do not know whether Tayside University Hospitals NHS Trust use an EPR or whether paper records are still utilised. Inpatient records were commonly written by junior medical staff under the indirect supervision of the consultant. In addition, copies of typed correspondence would normally be filed in the patient record. Due to the huge volume of medical records held by a large NHS Trust, storage is often off-site, meaning that there is a delay in obtaining previous hospital records for emergency admissions. In the last decade, many hospitals have migrated to maintaining Electronic Patient Records (EPR) in lieu of handwritten records. The availability and compatibility of EPRs across hospitals and general practice is a challenge to better integrate patient care in the future.

35.4 The content of medical records is highly variable. It is normal practice for medical and nursing records to be integrated into one patient file. The records should be sufficiently detailed to document details of the history, findings on examination, investigations undertaken, a diagnosis or differential diagnosis, a management plan, a summary of issues discussed with the patient (and their chosen representatives) and a summary of issues discussed during consent (these may be listed on the consent form). Post-operative records should include regular assessments of the patient's condition, notes of specific assessments in the event of

⁴⁸ See Good Medical Practice, 1995 – Section 3. GMC Publications

deterioration, management plans and information concerning the content of communications with the patient and/or family. Post-operative clinic records should detail the patient condition, the ongoing management plan and, where relevant, the prognosis.

35.5 During the relevant period, operation notes were commonly handwritten or typed. Operation notes should have been written immediately on completion of surgery. They should state the name of the surgeon(s) and anaesthetist(s), the procedure performed, the position of the patient, the incision and approach used, the operative findings, the procedure undertaken, any difficulties incurred during surgery, the closure of the wound and detailed post-operative instructions. A separate record should have been kept by the anaesthetic team and filed in the patient's notes. While operations are normally listed in an Operating Theatre Logbook, the Operation Note should be filed in the hospital medical records. Operating Theatres also keep a log of implanted products (e.g. VP shunts, screws and plates used to secure a craniotomy). The details normally kept in an Operating Department Logbook therefore include: Date, elective or emergency case, start and finish times, patient name, ID number (e.g. Hospital Number and or NHS Number), responsible consultant, operating surgeon, anaesthetist, title of operation, implants used. While all this information is, and was during the relevant period, kept in the patient notes, it provides a useful resource for checking theatre throughput and identifying patients operated upon on any given date. With the proliferation of data collection in the NHS a paper logbook seems to be superfluous in the modern era.

Surgical competence

36. What requirements existed on neurosurgeons during the relevant period and has the position materially changed since then with regard to:

- (a) acquiring the ability to safely and competently to undertake particular neurosurgical procedures in particular new or experimental procedures: and**
- (b) maintaining the necessary skills safely and competently to undertake particular neurosurgical procedures.**

36.1 (a & b)

1995 saw the first publication of *Good Medical Practice* produced by the General Medical Council [ELJ0001-00019]. This document has been updated on several occasions

subsequently. The original document was brief at no more than 13 pages excluding the index. Three brief paragraphs might be interpreted as relevant to the above question⁴⁹. *Good Medical Practice* was revised in 1998 and 2001. In 2002 *Good Surgical Practice* [ELJ0001-00022] was published designed as a surgical specific companion to *Good Medical Practice*. The guidance stated that surgeons should develop and maintain their personal performance. Surgeons were responsible for keeping themselves up to date and that they should undertake continuous professional development (CPD) and educational activities relevant to all aspects of their work. CPD activities should be relevant to the clinical practice, support current skills, knowledge and career development. This guidance made a connection to appraisal in stating CPD should be planned with an appraiser and reflected in the annual personal development plan. Where relevant the surgeon should make appropriate use of simulation to support learning of new procedures. An indicative amount of CPD was 50 hours per year or 250 hours over 5 years. The surgeon should engage in quality assessment and quality improvement activities such as national and local audit, peer review, multidisciplinary team meetings and morbidity and mortality meetings.

36.2 (a & b)

Specifically in relation to new introducing surgical techniques, *Good Surgical Practice* 2002 [ELJ0001-00022] defined new techniques and provided the following guidance:

New techniques include: a new or personally developed operation, any major modifications to an established procedure; and the introduction of a procedure not previously performed in the Trust. When a new technique is to be used, the patient's interests should be considered paramount. Therefore, surgeons must:

- First discuss the technique with colleagues who have relevant specialist experience and the medical/clinical director;
- Follow local protocols with regard to local ethics committee approval; and

⁴⁹ Keeping up to date

5. *You must maintain the standard of your performance by keeping your knowledge and skills up to date throughout your working life. In particular, you should take part regularly in educational activities which relate to your branch of medicine.*
6. *You must work with colleagues to monitor and improve the quality of health care. In particular, you should take part in regular and systematic clinical audit.*
7. *Some parts of medical practice are governed by law. You must observe and keep up to date with the laws which affect your practice.*

- Contact the Safety and Efficacy Register of New Interventional Procedures (SERNIP) at the National Institute for Clinical Excellence (NICE) to learn the status of the procedure and/or to register it.

The surgeon should also:

- Liaise with the relevant specialist association if appropriate;
- Ensure that patients and their supporters know when a technique is new before seeking consent;
- Explain that all the established alternatives are described prior to recording their agreement to proceed;
- Be open and transparent regarding the sources of funding for the development of any new technique;
- Audit outcomes and review progress with a peer group;
- Where possible, obtain necessary training in the new technique;
- Enable the training of other surgeons in this new technique; and
- Ensure that any new device complies with European standards and is certified by the competent body (Competent Authority in the UK is the MHRA)

36.3 (a & b)

The above guidance from both *Good Medical Practice* and *Good Surgical Practice* in the early years of relevant interest 1995 – 2015, imply that the desired and necessary actions are self-directed and essentially self-regulated albeit with some degree of external assessment, although not oversight, from the appraisal process.

36.4 (a & b)

By 2014, both *Good Medical Practice* [ELJ0001-00014] and *Good Surgical Practice* [ELJ0001-00030] had been revised and the relevant domains outlining good practice were more closely aligned. There are four domains:

1. Knowledge, Skills and Performance
2. Safety and Quality
3. Communication, Partnership & Teamwork
4. Maintaining Trust

In Domain 1 at the very beginning, it is stated: “*Surgeons are responsible for keeping themselves up to date and maintaining competence in all areas of their practice*”.

By 2014 within Domain 1 under knowledge, skills and performance there was a specific section relevant to the introduction of new techniques:

“Good Surgical Practice 1.2.4: Introduction of new techniques Introduction of new clinical interventions and surgical techniques (including equipment) that deviate significantly from established practice and are not part of an NHS local ethics committee research programme must be underpinned by rigorous clinical governance processes, having the patient's interests as the paramount consideration. If you are introducing new surgical techniques and technologies you should:

- *Discuss the technique with colleagues who have relevant specialist experience and seek formal approval from your medical director.*
- *Follow local protocols with regard to obtaining approval by the local ethics committee or the local clinical governance committee. These should include the provision of evidence that the new technique is safe and that all clinical staff who plan to use the new technique will undertake relevant training, mentorship and assessment.*
- *Contact the Interventional Procedures Programme at the National Institute for Health and Care Excellence (NICE) to learn the status of the procedure and/or register it and liaise with the relevant surgical specialty association.*
- *Obtain appropriate training in the new technique, take part in regular educational activities that maintain and develop competence and performance, and enable the training of other surgeons.*
- *Ensure that any new device complies with European standards and is certified by the competent body.*
- *Ensure that patients and their supporters know that a technique is new before seeking consent and that all the established alternatives are fully explained prior to recording their agreement to proceed.*
- *Be open and transparent about the sources of funding for the development of any new technique*
- *Contribute to the evaluation of the new procedure by auditing outcomes and reviewing progress with a peer group, and by complying with guidelines by NICE or by the Scottish Intercollegiate Guidelines Network (SIGN)”. [ELJ0001-00030_19-20]*

36.5 The above demonstrate that responsibility for assessing ability, competency, maintaining skills and the necessary requirements to introduce new techniques originated with the individual surgeon through a process of self-assessment, reflection and self-regulation, gradually evolving into a practice with a surrounding scaffold of guidelines and indicators of

good practice, interfacing with an appraisal process but lacking in independent oversight, intervention or external regulation in the absence of any indicators of poor surgical practice.

36.6 Introducing a new surgical procedure may be an innovation, introduction of established clinical care but in a new environment or it may be research. Innovation in surgery has some aspects of clinical care and research but it may be distinct. An innovation may be a minor modification of well-established technology (WET), a major modification of WET, or a radically new intervention. Challenges associated with surgical innovation and research include: addressing informed consent when some risks are unknown or yet to be identified, safety of the procedure, the necessary learning curve, identifying appropriate oversight, potentially vulnerable patient groups, or small population sizes where potential benefits or risks are not identified early on.

36.7 Since 2015, surgical research and new innovations have attempted to follow the IDEAL framework of: Idea, Development, Exploration, Assessment & Long-term follow-up. This provides a structured and assessable approach to the introduction of new techniques. Evaluation of new surgical innovations is complex and variably regulated. The Baroness Cumberlege Report *First Do No Harm, The Independent Medicines and Medical Devices Safety Review* [ELJ0001-00027] was released in March 2020: beyond the relevant time period of 1995 – 2015. It makes recommendations pertinent to the future.

Imaging

37 What were the main types of imaging which were used in or in conjunction with neurosurgical practice over the relevant period and for what purposes would they routinely have been used?

37.1 Prior to the 1970's the main imaging modality in neurosurgery relied on plain x-rays either in isolation to assess dense structures, mainly bones, or in combination with contrast materials introduced into blood vessels or CSF spaces to help distinguish different structures of anatomical or pathological relevance. Contrast agents could be radio-opaque water or oil-based compounds or even air introduced into ventricular spaces for air ventriculograms. The advent of Computerised Tomography (CT) scans from the 1970's onwards introduced the concept of cross-sectional, or axial imaging with the capability of distinguishing tissues of different densities to produce images of anatomy and relevant pathology. Subsequent Magnetic Resonance Imaging (MRI) allowed greater resolution of soft tissues and characterisation of pathological processes. The relevant time period of 1995 – 2015 saw

significant improvements in computational power associated with these imaging modalities resulting in faster image acquisition times, a growth in applications, improved resolution of images and reconstruction of images into multiple planes or even 3-D for enhanced appreciation of pathology and its relations to relevant structures. This period also saw integration of these imaging modalities into computer navigation systems to aid surgical planning and intra-operative orientation.

37.2 Beyond illustrating core structural features, imaging modalities were applied to specific structures for either diagnosis, monitoring, screening or assessment of a range of pathologies. Vascular imaging would be under the umbrella term of angiography looking at blood vessels. Functional and physiologic imaging modalities can provide information on activity within regions of the brain. These are Positron Emission Tomography (PET), Single Photon Emission CT (SPECT), and functional MRI (fMRI). More advanced MRI sequences such as diffusion weighted imaging (DWI) and diffusion tensor imaging (DTI) were introduced in the late 1990s and mid 2000's. The relevant time period saw an increase in developments in intra-operative imaging and included intra-operative ultrasound, intra-operative fluoroscopy (x-rays or CT scanning) as well as intra-operative MRI scanning in a few neurosurgical centres.

37.3 The following are brief descriptions of neurosurgical imaging modalities that were present or evolved during the relevant period of 1995 – 2015.

Computed Tomography (CT)

A rapid X-ray–based scan that produces detailed cross-sectional images, particularly good for detecting acute bleeding, fractures, and changes requiring urgent treatment.

Magnetic Resonance Imaging (MRI)

A scan that uses strong magnetic fields to create highly detailed images of soft tissues such as the brain, spinal cord, and nerves, forming the mainstay of neurosurgical diagnosis and planning.

Digital Subtraction Angiography (DSA)

An invasive imaging technique using contrast injected into blood vessels to provide highly detailed images of cerebral circulation; considered the reference standard for vascular abnormalities.

CT Angiography (CTA)

A CT scan performed with intravenous contrast to visualise blood vessels non-invasively, commonly used to assess aneurysms, vascular injury, and arterial narrowing.

MR Angiography (MRA)

An MRI-based method for imaging blood vessels, often without contrast, used for screening and follow-up of vascular conditions.

Diffusion-Weighted Imaging (DWI)

An MRI technique that detects microscopic water movement in tissue, allowing very early identification of stroke and helping distinguish between different types of brain lesions.

Functional MRI (fMRI)

An MRI technique that maps brain activity by detecting blood-flow changes, used to identify critical functional areas (such as speech or movement) before surgery.

Diffusion Tensor Imaging (DTI) / Tractography

An advanced MRI method that visualises white-matter nerve pathways, helping surgeons plan operations while avoiding damage to critical neural connections.

Positron Emission Tomography (PET)

A nuclear medicine scan that shows tissue metabolism rather than structure, commonly used to assess tumour activity or localise epileptic foci.

Single Photon Emission Computed Tomography (SPECT)

A nuclear imaging technique that maps blood flow in the brain, mainly used as an adjunct in epilepsy and perfusion studies.

Intraoperative Ultrasound

Real-time ultrasound imaging used during surgery to locate lesions and assess progress of tumour removal.

Intraoperative MRI (iMRI)

MRI performed during surgery to assess how much of a lesion has been removed and to update surgical guidance as anatomy shifts.

Intraoperative CT / Fluoroscopy

X-ray-based imaging used during surgery, particularly in spinal procedures, to guide instrument placement and confirm alignment.

Image-Guided Neuronavigation Systems

Computer-assisted systems that use pre-operative imaging to guide the surgeon in real time, improving precision and safety during neurosurgical procedures.

37.4 The following table outlines the main purposes the above listed imaging modalities would have been used for during the relevant period of 1995 – 2015 and beyond to the present day. It should be appreciated that not all neurosurgical units in the United Kingdom would have necessarily had access to all the resources to use or deploy the imaging modalities. In addition, technological advances will have resulted in higher resolution and potentially improved quality images in the latter part of the time frame compared to the mid 1990's.

Imaging Modalities Used in Neurosurgical Practice (1995–2015)

Imaging Modality	Approx. Year of Introduction as Common Neurosurgical Use	Primary Routine Purposes in Neurosurgical Practice (1995–2015)
Computed Tomography (CT)	Late 1970s–1980s (fully standard by 1995)	Acute head trauma; detection of intracranial haemorrhage; skull and spinal bone detail; hydrocephalus assessment; rapid post-operative evaluation
Magnetic Resonance Imaging (MRI)	Early–mid 1990s	Brain and spinal tumour characterisation; soft tissue contrast; spinal cord and disc pathology; infection and inflammatory disease; pre-operative planning
Digital Subtraction Angiography (DSA)	1980s (gold standard by 1995)	Detailed cerebral vascular anatomy; aneurysm and AVM evaluation; pre-operative and endovascular planning; embolisation guidance
MR Angiography (MRA)	Mid–late 1990s	Screening and follow-up of aneurysms; assessment of carotid and intracranial circulation; non-invasive vascular evaluation
Diffusion-Weighted Imaging (DWI)	Early 2000s	Early detection of acute cerebral infarction; tumour cellularity assessment; differentiation of abscess vs tumour
Functional MRI (fMRI)	2005-2010	Pre-operative functional mapping (motor, sensory, language cortex); planning tumour

		resections near eloquent brain regions
Diffusion Tensor Imaging (DTI) / Tractography	2010	White matter tract mapping; surgical planning to preserve critical neural pathways; assessment of traumatic axonal injury
Positron Emission Tomography (PET)	1990s (specialist centres)	Tumour grading; differentiation of tumour recurrence from radiation necrosis; epilepsy focus localisation
Single Photon Emission Computed Tomography (SPECT)	1990s	Cerebral perfusion assessment; epilepsy evaluation; adjunct functional imaging in selected cases
Intraoperative Ultrasound	1980s–1990s (routine by 1995)	Real-time localisation of tumours and cysts; guidance during tumour resection; confirmation of lesion removal
Intraoperative MRI (iMRI)	Early–mid 2000s	Assessment of extent of tumour resection; updating neuronavigation after brain shift; maximising safe resection
Intraoperative CT / Fluoroscopy	1990s	Spinal instrumentation guidance; confirmation of hardware placement; minimally invasive spinal procedures
Image-Guided Neuronavigation Systems	Late 1990s	Surgical planning and intraoperative guidance; targeted biopsies; minimally invasive cranial and spinal surgery

Pre-operative practice

38. Who is responsible for diagnosing a patient and providing them with information about risks, benefits and alternatives in a neurosurgical unit?

38.1 A clinical diagnosis is achieved through taking a history of the symptoms or presenting circumstances of a patient, combined with appropriate examination and the observation or eliciting of physical signs and where necessary supported by targeted investigations or tests. These three principles underpin the diagnostic process in all clinical specialties, neurosurgery being no exception. Many patients present to a neurosurgical service either in an elective or

emergency capacity with a diagnosis already established by a referring clinician or clinical team and the neurosurgical emphasis is either on whether or not the patient is suitable for surgery, whether there are appropriate beneficial neurosurgical interventions or if clinical management in a neurosurgical environment (such as a neuro critical care unit) can support the patient.

38.2 Often a diagnosis is *provisional* based on best available information at that time or *uncertain* while awaiting further information or clinical developments. Many healthcare professionals from different professional bodies and specialities may be involved at achieving a diagnosis. Although traditionally considered to be the domain of medically qualified doctors, there has been an expansion in the roles of allied health professionals such as Advanced Nurse Practitioners and Enhanced Role Physiotherapists who have the training to make a diagnosis. Many roles in healthcare can be designated or delegated to appropriately qualified and skilled professionals. This would include qualified doctors who are in higher professional training, previously referred to as *Junior Doctors* but as of 2025 referred to as *Resident Doctors*. The Junior Doctors would be under the supervision of a more senior doctor and ultimately under the supervision of a consultant or registered General Practitioner if working in Primary Care. Supervision could be direct or indirect, on-site or remote depending on the circumstances. It would be appropriate for qualified healthcare professionals to provide a patient with information including their diagnosis and associated risks, benefits, alternatives and prognosis relating to their condition. All involved appropriately qualified and trained healthcare professionals are accountable and responsible for their actions and communication with a patient.

38.3 Many aspects of neurosurgery rely on involvement of multidisciplinary teams contributing to the care of a patient in either an individual or combined capacity. A neurosurgery unit is one part of multiple interconnected and supporting units that would more appropriately be described as a *Clinical Neuroscience Unit*. For example, interventional neuro-radiologists might undertake cerebral angiograms and coiling of aneurysms. It would be entirely appropriate for the radiologist to discuss diagnosis, risks, benefits and alternatives with a patient or their relatives if the patient lacked capacity. The patient might then be admitted to the intensive care unit where a neuro-intensivist would communicate with the patient and family about other interventions and risks and benefits as well as prognosis. It is common practice for a patient to be admitted into hospital under an *admitting consultant* a senior clinician with admitting rights. Although this might be regarded as “*the name above the bed*”, the named consultant can change several times during a patient’s time in hospital or during

their diagnostic and treatment pathway. Which specialist background that admitting consultant is affiliated with can vary from unit to unit. Typically, it would be a Consultant Neurosurgeon but, in some circumstances, it might be an Emergency Care Consultant, a Neurologist, an Elderly Care Consultant, Infectious Disease specialist, Oncologist or Psychiatrist (by way of examples and not an exhaustive list).

39. What was the accepted practice relating to pre-operative marking in spinal surgery over the relevant period?

39.1 There was no standardised practice for pre-operative marking in the United Kingdom prior to 1995. During the relevant period of 1995 – 2015 there was an increase in awareness of possibilities of wrong patient, wrong site, wrong side and specifically relevant to spinal surgery given multiple similar structures of vertebrae and discs, wrong level surgery.

39.2 General principles of pre-operative marking include confirming with the patient the proposed operation, which region of the spine is to be operated upon (cervical, thoracic, lumbar, sacral), the laterality (left or right) or whether surgery is intended to be bilateral or midline. The surgical site is marked with an indelible / permanent marker in an unambiguous fashion either by the operating surgeon or designated responsible clinician subsequently confirmed by or in the presence of the operating surgeon. The mark should remain visible after preparation or cleaning of the skin with aqueous or alcohol-based solutions and remain visible after sterile drapes are applied. Specifically, for spinal surgery, a further *intra-operative* check using x-ray or image intensifier fluoroscopy to confirm the appropriate spinal level must be undertaken although this is the stage beyond pre-operative marking.

39.3 The above principles apply predominantly to posterior approaches to the spine. However, in some regions of the spine, particularly with anterior or anterolateral approaches, modifications may be required. The principle remains that the vertebral level must be counted from a correctly identified landmark.

39.4 The World Health Organisation (WHO) Surgical Safety Checklist [ELJ0001-00064] was introduced between 2008-2009. Surgical site verification and marking was embedded as part of the checklist *Sign-in* and *Time-out* procedures. Many hospitals incorporated the WHO checklist for all surgical specialties including spinal surgery. Its introduction therefore embedded the widespread adoption of pre-operative marking. In the United Kingdom (England & Wales) the National Patient Safety introduced a *Never Events* program intended

to identify incorrect procedures or events that should never happen because they were considered to be entirely preventable. Wrong site surgery was one of the original core Never Events. Wrong site surgery was defined as surgery on the wrong patient, wrong body part or wrong site and thus included spinal wrong site events. In 2018 (beyond the relevant period of 1995 – 2015) the *Never Events* list was changed and specifically *excluded* wrong level spine surgery because it could not be determined that there were robust and reliable enough methods of always ensuring correct level of spinal surgery.

Surgery

40. Are there any circumstances in which it would be acceptable for a neurosurgeon not to undertake the surgery which it had been agreed with the patient would be performed? If there are, please explain when such a course would be acceptable.

40.1 For a competent patient, any decisions to not undertake the agreed surgery should be discussed with the patient. The change in decision should be recorded in the medical records and appropriate consent documented. Examples of such a situation would be when a patient's symptoms have changed between the time of making a decision to operate and the immediate pre-operative discussion with the patient. Similarly, a tumour may have changed appearances on scans performed just before surgery altering the conduct of the proposed surgery.

40.2 Sometimes, intra-operative findings lead to consideration of performing an alternative procedure to the planned course of action. For a patient who lacks competence, the surgeon must always act in the patient's best interest. When considering "best interest" the surgeon should consider whether the patient is likely to regain capacity soon enough to safely defer proceeding with a specific action; the surgeon should also consider any opinions expressed by the patient in pre-operative discussions and any beliefs, values or other factors that the patient is likely to consider relevant. It would not be normal practice to consult next-of-kin or those with Power of Attorney during an operation.

41. What principles and practices should guide a neurosurgeon in taking intra-operative decisions where the patient is anaesthetised?

41.1 When a patient is anaesthetised, they lack competence. Once an operation has commenced the surgeon should adhere to the operation for which consent has been obtained unless he/she is of the opinion that this is no longer in the patient's best interests. The surgeon should only perform additional procedures if it is in the patient's best interests to undertake the additional procedure at that time. If there is doubt about what is or isn't in the patient's

best interest, it is good practice for the surgeon to discuss matters with the anaesthetist and with a consultant surgical colleague to cast a fresh pair of eyes on the situation.

42 How would / should decisions be made by neurosurgeons about the use of products or devices in neurosurgical practice, in particular where their use was unlicensed or experimental? How would this responsibility be shared between the surgeon and the board which held responsibility for ordering such products or devices?

42.1 Historically the introduction of products into clinical and neurosurgical practice is something that has evolved from no formal process to “*light-touch*” regulation through to much more structured, robust and accountable regulatory and governance processes. The introduction of novel or unlicensed products into neurosurgical practice in the United Kingdom during the relevant period of 1995 - 2015 occurred within a developing regulatory and governance landscape. Although the systems of oversight were less formalised than those that exist today, surgeons were nonetheless subject to clear legal, ethical, and professional duties.

42.2 During the 1990s, UK medical device regulation was largely shaped by European law, particularly the Medical Devices Directive 93/42/EEC. This Directive was implemented into domestic law through the Medical Devices Regulations 1994. These regulations established the requirement for CE marking as evidence that a device met essential safety and performance requirements before being placed on the market within the European Economic Area. Oversight of medical devices in the UK was initially exercised by the Medical Devices Agency and later, from 2003 onward, by the Medicines and Healthcare products Regulatory Agency (MHRA). Devices without CE marking could not generally be marketed or supplied unless falling within specific exemptions, such as custom-made devices or devices used within properly authorised clinical investigations. This high-level regulatory approval related to *market placement*, not necessarily to *clinical indication*. A CE-marked device could be used “off-label” at the discretion of a clinician, provided that such use was professionally justifiable.

42.3 A distinction should be made between off-label use and an unlicensed product. First, the product might be CE-marked but used for a new or unconventional indication. This constituted off-label use. Off-label use placed a heightened burden on the clinician to justify the decision through evidence, peer practice, or sound clinical reasoning. Second, the product might not be CE-marked at all. In this scenario, use was generally restricted to either

formal clinical investigations or tightly defined exemptions such as custom-made devices prescribed for an individual patient or the exceptional needs of an individual patient.

If the device was CE-marked but used off-label typically a surgeon would:

- Review the evidence base.
- Ensure the use was justifiable and responsible clinical practice.
- Obtain enhanced informed consent regarding the variation from standard practice.
- Seek local hospital approval for example via a medical devices or clinical governance committee if one existed. In some units this function might be undertaken by the ethics committee.

42.4 If the device was not CE-marked (Unlicensed Device) it might be introduced into clinical practice through one of three routes: a) clinical investigation, b) as a custom-made device or c) through justification of exceptional use for a named patient.

42.5 For a clinical investigation the surgeon would need to ensure the following procedures were in place since this would classify as research, not ordinary clinical care:

- Formal clinical investigation protocol.
- Ethics committee approval (Local Research Ethics Committee – LREC).
- Manufacturer cooperation.
- Patient consent specifically stating experimental status.
- Additionally in current times MHRA notification of the investigational status is required.

42.6 Through a “custom-made” device route, devices for an individual patient are permitted where a device is manufactured specifically for an individual patient and effectively prescribed for that patient.

42.7 The named patient / exceptional use route might occur in rare instances where a surgeon might justify exceptional use for a specific patient when no licensed alternative exists and / or there is exceptional clinical need.

42.8 Responsibility for introducing a novel or unlicensed product is typically shared but differentiated. In simple terms a neurosurgeon would be responsible for clinical justification and safe use of an unlicensed product or off-label use of that device including professional

duties of informed consent. The Trust Board would have responsibility for governance processes, procurement and policy oversight including risk management.

Post-operative practice

43. What is the purpose of and best practice with regard to conducting ward rounds following surgery, who should be involved in conducting them and why?

43.1 It is normal practice for the operating surgeon to see all operated patients in the first few hours after surgery. Most surgeons make it their normal practice to visit cases in the theatre recovery department in the time interval between cases. This is not always possible due to the requirement for the surgeon to be in the operating room, sometimes for many hours without a break. The purpose of a visit to recovery is to evaluate whether any immediate post-operative concerns are evident. Such concerns may include an unexpected, depressed level of consciousness, new neurological deficits or seizures. Such problems normally result in close clinical observation and sometimes an emergency CT or MRI scan (dependent upon the pathology). While recovery nurses are looking out for these issues, with a low threshold for escalating concerns to the medical team, most surgeons are keen to personally evaluate the status of their patients. It is reasonable for a consultant surgeon to delegate this task to a junior doctor (particularly if the doctor has participated in the operation), who should be competent to assess the patient and escalate any concerns. It is also normal practice for patients to be seen during a ward round on the evening of surgery to assess that there are no early post-operative concerns (the last patient may still be in theatre recovery at this juncture). This assessment would normally be conducted by the operating surgeon but can reasonably be delegated to a competent junior member of the medical staff. For those patients who remain in hospital, regular clinical reviews should take place. The normal format now, and during the relevant time period, is that a neurosurgical trainee (Specialist Registrar equivalent) conducts a morning ward round with junior medical staff (SHO and other registrars), nursing and allied health professionals. The junior doctor must be competent to detect problems and seek advice from the operating surgeon, or other consultant neurosurgeon, in the absence of the operating surgeon. Where appropriate, involvement of other specialists (e.g. intensive care specialists, rehabilitation specialists, neurologists) and allied health professionals (e.g. physiotherapy, occupational therapy, speech and language therapy) should be invoked or catalysed. A consultant neurosurgeon would be expected to review inpatients when concerns are raised about the clinical status of the patient and pro-actively on a minimum of two

occasions per week, provided the consultant is not on leave. During periods of leave, handover of care to a colleague should take place.

44. What is best practice with regard to telling patients or their representative(s) when things have gone wrong or have not gone in accordance with what had been discussed pre-operatively with the patient? Has best practice in this regard changed over the period which is relevant to the Inquiry and, if so, why?

44.1 The 1995 Good Medical Practice [ELJ0001-00019] guidelines state that doctors “must be honest and trustworthy”. Failure to inform a patient when things have gone wrong or have not gone in accordance with what had been discussed preoperatively, is not concordant with the requirement to be honest and trustworthy. The GMC also stated in 1995 that doctors must not “improperly disclose or misuse confidential information about patients”. Being economical with the truth or lying about events is not consistent with these core principles.

44.2 Best practice throughout the whole of the relevant period is to meet with the patient and their chosen representatives to explain, in terms that the patient and their representatives can understand, the conduct of surgery and the events that led to the unanticipated adverse event(s). Any actions taken to remediate the events should be explained. The consequences of the event should be explained. The discussion should include information about any recommendations for further treatment and any probable adverse sequela from the event(s). It is good practice to offer an apology and to submit a Datix⁵⁰ report on the event to try and promote learning from any mishaps. Holding such discussions with a patient and their representatives is difficult. It requires honesty, sensitivity and empathy, while at the same time endeavouring to maintain the bond of trust that underpins the doctor-patient relationship.

44.3 Although the principles of honesty and trustworthiness have been constant throughout the relevant period, the awareness of doctors to disclose information to patients and their representatives has increased during and after the relevant period. Defence organisations (e.g. MDDUS, MDU, MPS)⁵¹ and the GMC have provided information on the conduct of such discussions. The GMC Duty of Candour Professional Guidance was published in 2015 [ELJ0001-00021].

⁵⁰ Datix – an adverse event reporting system.

⁵¹ MDDUS: Medical and Dental Defence Union of Scotland; MDU: Medical Defence Union; MPS: Medical Protection Society.

45 Are there any circumstances in which it would be acceptable not to inform a patient or the patient's representative(s) of these matters post-operatively? If there are, when would that be appropriate and what course of action should be followed?

45.1 When a patient lacks competence, it may be reasonable not to inform him/her of events where things have gone wrong. The surgeon may reasonably consider that such information is not in the patient's best interests. If the patient regains capacity at a future date, it is normal practice to explain the event(s), actions taken, consequences and subsequent management options to the patient in terms they can understand. In such circumstances it is normal practice to inform, at an early opportunity, the patient's representative(s) of any adverse events, the actions taken, the consequences, and the management plan looking forward. It is good practice to offer an apology and to record a Datix event to promote future learning. Only exceptionally would it be reasonable to withhold information. The reasons for this should be recorded in the case notes. An example would be that if release of information to the patient or representative would be anticipated to have a high risk of causing psychological distress. Any withholding of information should be reviewed and discussed with the patient and/or representative when the risks of psychological distress have subsided.

Part E – Conclusions

46 Please highlight any limitations on your ability to compile the report, based on the material provided or available to you, including (where relevant) materials relating to the matters you have been asked to address in your report which you would suggest that the Inquiry should recover to assist with its investigations.

46.1 None of the experts undertake DBS surgery. Items discussed in this area of practice are therefore addressed from a general neurosurgical perspective.

46.2 The neurosurgery experts would be interested to review any relevant protocols used in the Dundee Neurosurgical Unit during the relevant period.

46.3 The neurosurgical experts have not been provided with evidence to address some of the specific Terms of Reference of the Inquiry in relation to specifics about Mr Eljamel's practice and behaviours.

47 Please set out any other particular matters relating to the field of neurosurgery arising from your consideration of the matters listed above which appear to you to be relevant to the Inquiry's Terms of Reference or List of Issues, which you think should

be brought to the Inquiry's attention and / or you think the Inquiry should investigate further.

47.1 None.

48 Are there any other matters or areas which are covered by the Inquiry's Terms of Reference or provisional List of Issues to which the area of neurosurgery relates? Please explain how your area(s) of expertise cover(s) any such areas or issues.

48.1 We do not know whether Mr Eljamel partook in medico-legal expert witness work. If the Public Inquiry identifies concerns in relation to Mr Eljamel's practice, any evidence he provided as a medico-legal expert has the potential to be discredited due to concerns about his level of expertise.

49 Are there any other matters or areas which are covered by the Inquiry's Terms of Reference or provisional List of Issues on which other areas of expertise would be able to provide relevant and helpful evidence? Please explain how any other area of expertise could assist the Inquiry and which issues evidence from any such field of expertise would be able to contribute to resolving (beyond those matters already raised with existing expert groups, as set out in the letters of instruction for the experts in medical ethics and healthcare management/ administration, copies of which are attached to this letter).

49.1 We consider that the Inquiry may wish to seek opinions from medical and managerial experts that work closely with neurosurgeons. Such expertise may provide the Inquiry with a viewpoint of how to manage interactions between individuals in the workplace.

49.2 Many neurosurgical consultants have undertaken "Fellowship" training in specialist areas of practice. The quality of such training is highly variable and often unregulated. We do not know if Mr Eljamel underwent fellowship training.

49.3 Participation in medical research is a regulated, structured process with various assigned roles including Chief Investigator and Principal Investigator. We do not know details of Mr Eljamel's participation in research, but this aspect of his professional practice may warrant further investigation with expert academic neurosurgical advice.

APPENDIX 1

Robert M Redfern Précis Curriculum Vitae:

MB BS	1977
FRCS (Eng)	1983
CHST (Neurosurgery)	1991
Consultant neurosurgeon	1992 - 2018

My consultant practice was in a tertiary unit located within a DGH (district general hospital) in Swansea. All aspects of neurosurgery were covered, except for functional neurosurgery and epilepsy. My practice would thus involve acute and elective adult neurosurgery including trauma, hydrocephalus, benign and malignant CNS tumours, CNS infection, and vascular neurosurgery (AVMs (arterio-venous malformations) and aneurysms). Paediatric cases, particularly trauma, tumours, hydrocephalus and CNS infections, were also dealt with locally. A specialist paediatric neurosurgeon was appointed in 1996. From then on my exposure to paediatric cases reduced significantly.

Initially I worked on a 1:2 rota for approximately 2 years before being joined by another colleague in 1994. The rota was then 1:3 until the appointment of a 4th consultant in 2002. We tended to have relatively junior trainees, at the start of their neurosurgical careers, so that on call would regularly involve consultant attendance in theatre at night.

On first appointment I inherited a number of complex cases, particularly vascular and tumour, which presented significant technical challenges. These cases included a number of patients who had undergone aneurysmal wrapping (usually with dura mater) following SAH and who subsequently re-bled, then requiring re-exploration and clipping of residual / recurrent aneurysms; and several patients with very large posterior fossa tumours which, having been managed expectantly, now necessitated high morbidity surgery or the acceptance of terminal demise.

I introduced stereotactic neurosurgery to the unit in Swansea, initially with a Leksell frame and then, later – and in collaboration with a consultant colleague - using a frameless system. Soon after appointment I introduced pituitary surgery via the nasal approach, and set up regular combined pituitary clinics with an endocrine colleague. I also introduced the use of drug delivery systems (DDS) for pain and spasticity, and trained dedicated nursing staff for the drug refill process, with consequent minimal infective complication rate. Subsequently I

sat on a national committee (the National Intra-thecal Baclofen Committee) which wrote a set of guidelines for use by clinicians involved in DDS implantation.

In collaboration with a neuroradiology colleague, and orthopaedic surgeons, quarterly academic sessions were introduced (CONSTRAD – Combined Orthopaedic NeuroSurgery Trauma Radiology) at which surgical trainees and several other health care disciplines attended, including Spinal Injury Rehabilitation Consultants, and Physiotherapists.

For a number of years I was a member of two Royal College of Surgeons committees, the Neurosurgery SAC (Specialist Advisory Committee) and the Opportunities in Surgery Committee. I was Chairman of the Weales Neurosurgery STC (Specialty Training Committee) from 2000-2005.

Between 2009-2013 I spent 2-3 weeks each year undertaking voluntary teaching work in the neurosurgical unit in Da Nang, Vietnam. In this connection I arranged for a Vietnamese trainee to undertake a clinical attachment with a neurosurgical colleague in Oxford, and also set up a charitable fund which helped to purchase some items of teaching equipment for the Da Nang unit, and also provide some assistance for several medical students from Swansea to travel to Da Nang for their elective.

I have had over 30 articles published in scientific journals, including revising the neurosurgical chapter in a standard surgical textbook and writing a chapter *de novo* in a neurosurgical textbook. As a trainee I undertook a period of research into the potential for the intracerebral delivery of a neurotrophic agent (MPF – melanotropin-potentiating factor) to reverse symptoms in a rat model of Parkinsonism in the Zoology Department in Liverpool University. I have been undertaking medico-legal work since 1992 and, having subsequently undertaken report writing for the PHSO (Parliamentary Health Services Ombudsman), in the latter stage of my consultant career, and post-retirement, medical negligence work.

I was the High Sheriff of West Glamorgan in 2015-16.

I have served as a Magistrate in the Adult Court in Swansea since 2017, and in the Family Court since 2019. With effect from April 2026 I have been selected for the Crown Court panel, which generally involves sitting with Recorders or Circuit Judges on Appeals cases from the Magistrate Courts.

Peter C Whitfield Précis Curriculum Vitae:**BM (Distinction) PhD FRCS Eng FRCS (SN) FAcadMed FHEA**

I was awarded a Bachelor of Medicine Degree with a Distinction in Clinical Medicine in 1987. I became a fellow of the Royal College of Surgeons of England in 1992. In 1998 I was awarded the degree of Doctor of Philosophy (Southampton) after a period of MRC funded research performed in Cambridge. I undertook specialist training in neurosurgery in Cambridge, UK, between 1993 and 2000. I was awarded a Certificate of Completion of Specialist Training in 1999. I am on the GMC Specialist Register. I was first appointed as a Consultant Neurosurgeon in 2000 in Aberdeen and moved to the South West Neurosurgery Centre, Plymouth Hospitals NHS Trust in 2002. I was appointed Associate Professor in Neurosurgery at Plymouth University Peninsula School of Medicine and Dentistry in 2011 and Honorary Professor in Neurological Surgery in 2021. I was Personal and Professionalism Development Lead at Plymouth University Peninsula School of Medicine from 2013 until 2023.

I was elected to the Court of Examiners at the Royal College of Surgeons of England in 2004 and continue to work as an Intercollegiate Examinations Assessor. In 2006 I was elected to serve as a member of the Specialists Advisory Committee in Neurological Surgery and subsequently served as Chairman (2017-2020). I led the recruitment of neurosurgical trainees in the UK in the role of Secretary to the National Neurosurgery Selection Board 2014 - 2017. In 2011 I was selected as an examiner for the Europeans Association of Neurosurgical Societies. I was the Inaugural Chairman of the European FEBNS Neurosurgery Examination (2015-23).

I have been a consultant in NHS practice in neurosurgery since 2000. My clinical practice has included neurotrauma, neurovascular conditions, brain tumours, hydrocephalus and degenerative (non-instrumented) spinal disease. In the last five years, my practice has been increasingly focussed on neurovascular, neurotrauma and neuro-oncology.

I have written many scientific papers and abstracts and have been the lead editor of a multi-author textbook, "Traumatic Brain Injury: a multidisciplinary approach" (2nd edition published), Neuroanatomy Section Editor for "Gray's Surgical Anatomy" (2nd edition in preparation) and am an editor for "Elements in Neurosurgery" (Cambridge University Press). I have presented lectures and talks to many learned societies in the UK and Internationally. I achieved a Distinction in a Post Graduate Certificate of Clinical Education in 2016 and was appointed as

a Fellow of the Higher Education Academy (FHEA, 2016) and the Academy of Medical Educators (2020).

I was a Society of British Neurological Surgeons Council Member (2017-2025) and served as President from 2022-24. I was a member of the European Association of Neurosurgical Societies Council and Board 2015-2023. I am a Board Member and examiner for the FRCS Surgical Neurology Examination and am an Assessor for the MRCS examination. I undertake Independent Review Mechanism visits (IRMs) for the Royal College of Surgeons of England and have been a member of the Surgical Specialities Board in Neurosurgery at the Royal College of Surgeons of Edinburgh (2022-25). I was elected to the Administrative Committee, as Assistant Treasurer, of the World Federation of Neurosurgical Societies (WFNS) in 2025.

I have a long-standing interest in medicolegal and ethical aspects of medicine and have delivered lectures on these topics. I am a member of the Medical Defence Union (MDU) Council and a member of the MDU Cases Committee (appointed 2021).

I prepare medicolegal reports for personal injury and clinical negligence cases. My expertise includes traumatic brain injury, brain tumours, brain haemorrhage, cauda equina syndrome, spinal injury and post-operative complications of cranial and spinal surgery. I prepare reports for complainants (80%) and defendants (20%). I prepare joint reports on request, though this is unusual in practice. I have attended court as an expert witness (Civil and Coroner) and as a professional witness (Criminal). I have contributed to a video teaching on appearing as a witness in a Coroner's Court: Inquests: Top tips and advice for the medical witness - University of Plymouth.

- Neurosurgical Training (SHO): Glasgow (1989-90)
- Neurosurgical Training: Cambridge 1992 – 2000 including PhD
- Consultant Neurosurgeon: Aberdeen 2000 – 2002
- Consultant Neurosurgeon: Plymouth 2002 – present
- Honorary Professor in Neurological Surgery: 2021 - present
- Chairman European Examination Board: 2015 -2023
- Chairman SAC Neurosurgery: 2017-2020
- Lead for National Selection in Neurosurgery: 2014-17 (Secretary) & 2017-2020 (Chair)
- MDU Council Member (2021 – present)
- Examiner: MRCS (assessor); FRCS (Neurological Surgery); FEBNS

- President Society of British Neurological Surgeons 2022-24
- Elected Assistant Treasurer and member of Administrative Committee of World Federation of Neurosurgical Societies (WFNS) 2025 – onwards.

Crispin Wigfield Précis Curriculum Vitae:**BSc(Hons), MB ChB, MD, MSt, PGCert, FRCS(Eng), FRCS(Neurosurg), FFMLM****Precis Curriculum Vitae:**

I graduated from the University of Birmingham with a Bachelor of Medicine and Bachelor of Surgery degree in 1993 having previously completed an Intercollegiate degree with Honours in Pharmacology in 1990. As a medical student I represented the BMA Medical Students Committee. I undertook pre-registration house jobs at the Queen Elizabeth Hospital in Birmingham followed by Emergency Medicine at Manchester Royal Infirmary and a lectureship in anatomy at the University of Manchester leading to completion of the primary FRCS examination in 1995. I was awarded Fellowship of the Royal College of Surgeons of England in 1997. I undertook a dedicated period of research focussing on biomechanics of the cervical spine with a particular emphasis on cervical spine arthroplasty (disc replacement) and was awarded a Doctorate of Medicine by research from the University of Birmingham. I completed specialist registrar training in neurosurgery at Cambridge, Plymouth and Bristol. I was awarded the Intercollegiate Fellowship of the Royal College of Surgeons of England in Neurosurgery in 2005. I was awarded the Certificate of Completion of Specialist Training (CCST) in 2006. In 2006 I was appointed as The National Spine Fellow undertaking post-CCST clinical experience in the subspecialty of spinal surgery in Leeds. I subsequently was awarded an HCA International Travelling Fellowship to visit the USA where I undertook observing fellowships at The Hospital for Special Surgery in New York and the Semmes Murphey Clinic in Memphis.

I was appointed as a Consultant Neurosurgeon with a specialist interest in spinal surgery to the Walton Centre for Neurology and Neurosurgery in Liverpool in 2007 until I subsequently was appointed to my present consultant post in Bristol initially at Frenchay Hospital in 2010. The service subsequently relocated to its new site at Southmead Hospital. In 2014 I was appointed through interview to the role and responsibilities of Clinical Director for Neurosciences in Bristol. With subsequent reorganisation of hospital leadership and governance structures I was appointed, again through interview, to the position of Divisional Director for Neurological and Musculoskeletal Sciences, the Major Trauma Centre was part of the Division under my leadership.

I have been an NHS consultant neurosurgeon for nineteen years. My clinical activity for the first fourteen years of consultant practice covered all adult neurosurgical emergency practice

with an elective spinal surgical practice. In the last five years I have focussed on adult complex spine surgery for both the emergency and elective components of my clinical work.

Roles beyond contracted neurosurgical consultant activity and unremunerated have included: Neurosurgical representative to the research governance committee at the Walton Centre; Neurosurgical Education lead to AO Spine International UK Chapter; Supervisor to an MPhil student; appointment to The Court of Examiners of The Royal College of Surgeons of England for the MRCS Examination; representative to the National Neurosurgery Selection Board. Between 2020-2025 I was Honorary Treasurer to The Joint Neurosciences Council contributing to steering the ebrain project – the largest peer-curated e-learning resource globally. I hold four local Clinical Excellence awards.

I have continued my educational advancement by undertaking a Masters in Social Innovation degree in 2019 from the University of Cambridge Judge Business School successfully publishing a dissertation on Healthcare Professionals' Identification when Working in Stigmatised Organisations. This has heightened my interest in the social, legal and civic drivers of healthcare and understanding of healthcare beyond a purely clinical context. This was further enhanced by completing with merit a Post Graduate Certificate in Genomic Medicine from the University of Exeter in 2021. I hold the Fellowship of the Faculty of Medical Leadership and Management (FFMLM). I am an Honorary Senior Lecturer in the faculty for Translational Health Sciences at the University of Bristol.

I am a regular member of faculty for the National Neurosurgical Finishing School lecturing on organisational change and culture in complex organisations. I have undertaken training in Maintaining High Professional Standards both as a case investigator and as a case manager. I have been part of the Royal College of Surgeons of England Independent Review Mechanism (IRM) professional team since 2024. I was elected by my peers to the Council of the Society of British Neurological Surgeons (SBNS) in 2018 completing a five-year term and then subsequently I was elected to serve as the Honorary Secretary of the SBNS for 2023-2027. I have written the SBNS policy document on Multi-Disciplinary Team working.

STATEMENT OF TRUTH

We confirm that we have made clear which facts and matters referred to in this report are within our own knowledge and which are not. Those that are within our own knowledge we confirm to be true.

We understand our duty to provide independent evidence and have complied with that duty in the provision of this report. The opinions we have expressed represent our true and complete professional opinions on the matters to which they refer.

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Robert Redfern, Retired Consultant Neurosurgeon

GMC number 2373182

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Peter C Whitfield, Honorary Professor and Consultant in Neurological Surgery

GMC number 3252044

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Crispin Wigfield, Consultant Neurosurgeon

GMC number 4017132