Neuroradiology ~ the challenge ahead

The subspecialty of Neuroradiology is an area of special interest within the specialty of Clinical Radiology and has continued to evolve rapidly with the introduction of new imaging technologies and new interventional treatments. Training requirements have changed and there is increased rigour around revalidation and quality of service.

The management of clinical services is largely undertaken at hospital level. Local decision making has brought many advantages but it has also led to great variability in the provision and delivery of Neuroradiological services.

Standards for safety and the provision of effective practice in Neuroradiology need to be reviewed on a regular basis. The second edition of Effective Neuroradiology was published in 2003 [1]. This updated document aims to define the requirements for an NHS Neuroradiology service in terms of manpower, infrastructure and training to ensure that it is fit for purpose.
1. INTRODUCTION

1.1 Neuroradiology is a subspecialty of Clinical Radiology which involves the investigation and treatment of patients with neurological diseases. Modern imaging requirements and the development of image guided interventions has resulted in a large increase in neuroradiology workload. It is important that this workload is managed safely within a service that is fit for purpose. Important integrated responsibilities include training and education, research and development and close working with colleagues in a wide variety of other specialties through multidisciplinary team (MDT) working.

1.2 The NHS in 2011 demands quality standards in patient care and increased accountability of Clinicians. Clinical Governance and Revalidation are important in reassuring the public and commissioners that services are safe and cost effective. This has led to examination of Hospital services by the Care Quality Commission (CQC), directives from the Department of Health (DoH) and the National Institute of Clinical Excellence (NICE) and centrally defined targets for imaging service delivery.

1.3 Neuroradiologists have worked hard to develop the subspecialty and achieve recognition through The British Society of Neuroradiology (BSNR). This society and its members have an international reputation based on rigorous self regulation and standard setting in the interests of patients. This resulted in the publication of ‘Effective Neuroradiology’ in 1996 [2] updated in 2003 [1]. The demands on Neuroradiology have changed and whilst a number of the objectives described in the 2003 publication have been achieved shortfalls remain. In addition there are new pressures on service that have developed such as stroke imaging and interventions.

1.4 The purpose of ‘Safe Neuroradiology 2012’ is to provide a commentary on progress since 2003, outline the current state of Neuroradiology and to describe the responses needed to maintain and improve standards and safety.
2.0 BACKGROUND


2.2 At the annual meeting of the Society in 1994 it was agreed that there was a need to revise those documents in the light of the changing practice of Neuroradiology and the changes in the NHS. As a result, the elected Committee of the BSNR produced ‘Effective Neuroradiology’, which was published in 1996 [2].

2.3 Effective Neuroradiology was revised in 2003 [1]. Since this time there have been further advances in the practice of diagnostic and interventional Neuroradiology (DN and INR). These include wider access to CT and MR scanning with linear increase in demand for MR across the UK of 10% year on year [5].

2.4 The development of digitised imaging has facilitated the introduction of picture archiving systems (PACS) and enabled rapid transfer of imaging between hospitals. This has opened up Neuroradiological expertise to a wider population and resulted in a large increase in requests for off site second opinions. This has resulted in a substantial additional workload in most neuroradiology departments that is rarely even part funded [6].

2.5 The development of MDT working, with emphasis on MDT meetings is often driven by imaging and is work intensive, requiring meeting preparation time. The number of these meetings and complexity of case mix has led to a large increase in Neuroradiology workload, which has received limited funding for appropriate service delivery.

2.6 NICE guidelines, often compiled with limited input from Neuroradiology, have had a significant impact on service design, resulting in increases in workload. Guidelines have now been produced in areas that are image intensive, such as
Stroke & TIA [7,8], Head injury [9], Cord compression [10], Epilepsy [11], Dementia [12] and Paediatric Neurosurgery [13].

2.7 Interventional Neuroradiology has developed into an essential evidence based service, particularly in the management of patients with acute and chronic neurovascular diseases [14,15]. Many procedures are time consuming and interventional work accounts for a significant and increasing proportion of Neuroradiological workload.

2.8 There are increasing requirements for Neuroradiological expertise to be available outside traditional working hours.

2.9 The increasing presence of Independent Sector providers, as part of the DoH ‘any qualified provider’ strategy, has the potential to increase workload. NHS Neuroradiology consultants in particular are often asked to re-report studies performed in this sector, and in other NHS units outside neuroscience centres, providing an unfunded quality safety net for this work.

2.10 Medical training has also undergone major changes at both undergraduate and postgraduate levels and there are increasing requirements to comply with European training standards [16]. There remains an ongoing drive toward a ‘24/7 consultant delivered service’, with increased workload pressures, potentially restricting non-clinical activities, such as teaching.

2.11 In view of these developments, it was agreed at the annual meeting of the British Society of Neuroradiologists in 2009, that there was a need to revise ‘Effective Neuroradiology’. The responsibility was delegated to the appropriate subcommittees, themselves inaugurated in 2009 by the elected BSNR Committee, and endorsed at the 2009 AGM.

2.12 This updated edition has been renamed ‘Safe Neuroradiology’ and has been prepared by the following members of the Standards and Training Subcommittee of the BSNR:
Dr Roger Laitt
Dr Phil White [Chair Standards SC]
Dr Chris Rowland-Hill [Chair Training SC]
Dr Danny Birchall
Dr Mary Gawne-Cain
Dr Gerardine Quaghebeur

Additional input has been received from the Academic Subcommittee (Chair Prof Paul Griffiths) & the President/Immediate Past Presidents of the BSNR - Dr Anil Gholkar & Dr Robin Sellar.
3. Necessary facilities and services for safe and effective practice

3.1 Equipment provision

3.1.1 The pivotal role of imaging in the management of acute and chronic Neurological disease is reflected in increased demand for neuroimaging which is now required on a 24/7 basis. This, coupled with rapid advances in technology, requires constant review of minimum standards for imaging access and equipment provision.

3.1.2 Where access to imaging is at risk, this should be clearly identified and recorded through the appropriate Trust Risk Register and Governance Structure.

3.1.3 Arrangements with other local providers should be put in place to mitigate against these risks where identified.

3.1.4 Appropriate equipment replacement programs should be in place.

3.1.5 Consideration should be given in future hospital design to the efficient integration of radiological services to ensure efficient and safe patient flow.

3.1.6 **There must be adequate 24 hour access to the appropriate diagnostic modalities with staff cover to enable a Neuroradiology service to be provided safely and robustly.**

3.2 Computed Tomography (CT)

3.2.1 CT is the cornerstone in managing patients with acute neurological disease. It is vital in correct decision making in Neurosurgical and Stroke patients and immediate 24/7 access is required.
3.2.2 Technology continues to advance and access to multi-slice technology with supporting software to allow high quality multiplanar reconstruction and volume imaging are essential. High quality angiographic and perfusion capabilities are also required in stroke imaging [17].

3.2.3 Scanners should be appropriately located to avoid delay in patient transfer within the hospital [18].

3.2.4 The ability to perform CT under general anaesthesia is essential.

3.2.5 As a minimum, there should be immediate access to multi-slice CT for urgent Neuroscience cases [1,19]

3.2.6 Regional Neuroscience centres should have on site access to a second equivalent scanner to support expected/unexpected downtime and periods of increased demand [1,2].

3.3 Magnetic Resonance Imaging (MRI)

3.3.1 MRI is essential in the diagnosis of Neurological diseases. Access has improved, but this has not kept pace with demand.

3.3.2 There have been a number of technological advances which are now embedded in routine clinical practice, such as diffusion weighted imaging (DWI) [7,8,17]. Access to perfusion imaging, functional MRI (fMRI) and MR spectroscopy (MRS) are also desirable and are rapidly becoming standard in some areas of clinical practice e.g. epilepsy surgery [11].

3.3.3 24/7 access to MR scanning is essential [1,19].

3.3.4 The ability to perform MR under general anaesthesia on site is essential.
3.3.5 There should be 24/7 access to a high field strength MRI scanner with Echo Planar Imaging (EPI) and multichannel head coils. Spectroscopy & functional capabilities are desirable.

3.3.6 Regional Neuroscience Centres should have on site access to a second equivalent MR scanner(s) to support expected/unexpected downtime and periods of increased demand [1,2].

3.3.7 Access to 3T MRI is desirable and essential in those centres with a significant Research and Development programme.

3.4 Digital Angiography

3.4.1 On site access to diagnostic catheter angiography and image guided endovascular interventions are essential.

3.4.2 Interventional Neuroradiology is part of first line management for patients with aneurysmal subarachnoid haemorrhage [14,15,19].

3.4.3 Emergency intra-arterial stroke interventions are increasing [8].

3.4.4 Access to angiography and interventions is desirable 7/7, but is dependent on local staffing structures [15].

3.4.5 The angiographic service should be collocated with Neurosurgical theatres, recovery areas and critical care beds where possible.

3.4.6 Endovascular neurointerventions require high resolution biplane digital angiographic equipment with rotational 3D capability and appropriate software for image manipulation. Angio-CT/3D roadmapping capabilities are desirable.
3.4.7 On site access to an appropriate second angiographic facility to cover periods of down time is essential. Alternatively, formal documented arrangements should be made with other providers during these periods to minimise risk to patients [1]. This should be recognised on an appropriate risk register.

3.5 Conventional Radiographic Techniques including Myelography

3.5.1 Myelography has largely been replaced by MRI, but still has an important role in certain diagnostic situations.

3.5.2 Fluoroscopy is important in presurgical marking to ensure correct site surgery.

3.5.3 Access to a fluoroscopic unit with extended table tilt and ability to screen in multiple planes is essential.

3.6 Ultrasound

3.6.1 Colourflow Duplex Ultrasound is a standard tool for the assessment of extracranial carotid disease [8,17]. This is of increasing importance in the management of patients with stroke and TIA.

3.6.2 Transcranial Doppler is an important tool for monitoring cerebral blood flow and is widely used.

3.6.3 Peri-operative ultrasound has become an essential aid in some Neurosurgical procedures.

3.6.4 Access to appropriate Colourflow Duplex studies should be available on site 7/7 as required to support SAH, stroke and TIA services.
3.7 Nuclear Medicine

3.7.1 The role of Nuclear Medicine is limited, but is of value in the investigation of certain chronic neurological conditions [1,2,20].

3.7.2 Single Photon Emission Computed Tomography and Positron Emission Tomography are increasingly important diagnostic tools offering diagnostic and functional data. The use of these techniques is expanding, particularly in Neuro-oncology, movement disorders and Dementia [12,20].

3.7.3 Access to Nuclear Medicine is desirable

3.8 Information Technology

3.8.1 A Consultant Neuroradiologist should not be appointed without the provision of adequately equipped office space and a personal computer, linked to the hospital PACS and radiology information system (RIS) systems with internet access to facilitate remote consultation when required.

3.8.2 Access to a PACS diagnostic workstation and an appropriate reporting area is essential and new posts should not be appointed without an appropriate increase in this access. Individual PACS workstations should have the ability to manipulate data to allow appropriate reformatting [21].

3.8.3 Access to a Voice Activated Dictation System is desirable.

3.8.4 Hospital wide PACS links are required and integration of the computerised RIS and the Electronic Patient Record (EPR) is highly desirable.

3.8.5 Neuroscience Centres work with referring hospitals on a ‘hub and spoke’ basis. The provision of PACS links between these hospitals is essential to allow robust and safe image review to facilitate remote decision making about patient management.
3.8.6 If a Consultant Neuroradiologist provides a contracted service to one or more remote sites, facilities for remote reporting are desirable.

3.8.7 Diagnostic standard teleradiology is desirable to enable the delivery of a Consultant supported on call service [21].

3.9 Inequality of service provision

3.9.1 It is vital that equitable access to high quality care is available for all patients. One of the specific requirements is access to appropriate imaging and reporting expertise.

3.9.2 Neuroradiologists are specifically referred to as the expert opinion for stroke, TIA, head injury and for many cord compression cases. Specific commissioning of Neuroradiological support for the relevant services, particularly stroke, is advocated within the guidelines/National Audit Office reports [8, 17, 22].

3.9.3 Due to the relative scarcity of Neuroradiologists and the need to sustain normal highly specialised daytime services, it is the view of BSNR that active consideration be given to a commissioned expert supraregional network/service approach to out of hours Neuroradiology support (especially for stroke, head injury and paediatric neuroimaging).

3.9.4 The BSNR is working with relevant professional groups to establish service standards and to approach commissioners to develop robust Neuroradiology services to support all hospitals.

3.10 New Technology
3.10.1 There are a number of major technical developments, which will soon enter routine clinical neuroradiology practice, where they have not already done so.

3.10.2 This will pose an additional workload which needs to be included in job planning. These developments include intraoperative MRI, fMRI, MRS, PET-CT/MRI in neuro-oncology, advanced stroke imaging, stroke interventions, MRI for dementia (including fMRI).

3.11 Summary of Recommendations

3.11.1 24 hour accesses to the appropriate diagnostic modalities with staff cover to enable safe provision of service.

3.11.2 There should be immediate/next available slot access to multi-slice CT.

3.11.3 There should be 24/7 access to MRI with Echo Planar Imaging and multichannel head coils. Spectroscopy & functional capabilities are desirable.

3.11.4 Additional equivalent CT and MR scanners should be available on site to support downtime and periods of increased demand.

3.11.5 There should be appropriate on site access to high resolution biplane digital angiographic equipment with rotational 3D capability and appropriate software for image manipulation.

3.11.6 On site access to an appropriate second angiographic facility to cover periods of down time is essential. Alternatively, formal arrangements should be made with other providers for these periods and this should be recognised on an appropriate risk register.

3.11.7 Access to a fluoroscopic unit with extended table tilt and ability to screen in multiple planes is essential.
3.11.8 Access to appropriate Colourflow Duplex studies should be available as required to support stroke and TIA services.

3.11.9 Access to Nuclear Medicine is desirable.

3.11.10 There should be appropriate IT infrastructure to include adequate access to workstations and remote visualisation of imaging studies in support of a hub and spoke Neuroscience service models.
4.0 STAFFING AND WORKLOAD

4.1 Background

In 2009 BSNR conducted a Benchmarking and Manpower Survey of Neuroradiology practice in the UK informed by previous manpower surveys. Twenty Departments were sampled in an attempt to improve understanding between Neuroradiology Departments in the United Kingdom relating to staffing, work output, Consultant workload and work intensity [23].

These surveys indicate that there are significant variations in the pattern of work and work intensities in different units. To a large extent, these differences reflect variations in centre size, nature of clinician base and type of imaging performed. However, it is evident that work patterns vary considerably, with varying demands being made on individual Consultants and Consultant led teams. It is important to understand this variation so that, in the interest of individual Neuroradiology services, Trusts, and Consultants, ‘best practice’ can be identified and aspired to.

This process is particularly important with current changes in the NHS environment, including increased demand for services arising from new imaging imperatives (for example, providing imaging for acute stroke and in support of Major Trauma Centres); from the potential loss of support from independent imaging providers; and from internal pressures to provide efficiency improvements.

4.2 Context

4.2.1 Neuroradiology is a Consultant delivered service.

4.2.2 A Consultant neuroradiologist is defined as a radiologist who has undertaken appropriate neuroradiological training as defined in this document, and who holds a consultant post in which the majority of work undertaken is in the practice of neuroradiology.
4.2.3 The United Kingdom has 34 Departments in which Neuroradiology is practised by Consultant neuroradiologists, either within General Departments or within specialised Neuroscience Centres.

4.2.4 Based on the Benchmarking Survey, Neuroradiology Departments are staffed by 2 – 7 full time equivalent (FTE) Consultants, supplemented by 0 – 3 part-time Consultants. The average departmental number of FTE Consultants within the surveyed group was 4.75 FTE.

4.3 Departmental Output

4.3.1 The Survey analysed Departmental Output for diagnostic and interventional aspects of Neuroradiology practice, including output for MR, CT and angiographic work.

4.3.2 In order to standardise comparisons between Departments, output has been analysed as ‘examinations’, rather than ‘attendances’, so that multi-site, post-contrast and complex scans can be appropriately included in output information. Output has been measured in this way because this provides a better measure of scan length and complexity than does a record of patient attendance; and most radiology information systems (RIS) record work in this way. The BSNR has detail available on the exact methodology applied, and comparative data needs to be understood in the light of this.

4.3.3 For the purpose of this Survey, ‘Angiography’ refers to diagnostic and interventional examinations.

4.3.4 The annual Departmental Output for surveyed Neuroradiology Centres based on the 2009 Survey was as follows:
<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Average (in examinations)</th>
<th>Range (in examinations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR</td>
<td></td>
<td>11,000</td>
<td>6,000 – 20,000</td>
</tr>
<tr>
<td>CT</td>
<td></td>
<td>6,500</td>
<td>4,000 – 9,000</td>
</tr>
<tr>
<td>Angiography</td>
<td></td>
<td>450</td>
<td>200 - 800</td>
</tr>
</tbody>
</table>

4.3.5 Comparison with previous output data (for example, as cited in ‘Effective Neuroradiology 2003’) is difficult, as previous data was largely measured in “attendances” rather than “examinations”. However, further analysis of the previous information extrapolating the data as “examinations” suggests the following approximate comparison of 2001 and 2009 Departmental Output. For reference, an examination is a single area scan e.g. a whole spine MR scan represents three examinations. For further information please refer to the full BSNR benchmarking study available on the BSNR web site.

<table>
<thead>
<tr>
<th></th>
<th>2001</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>7,500</td>
<td>11,000</td>
</tr>
<tr>
<td>Range</td>
<td>1,500 – 9,000</td>
<td>6,000 – 20,000</td>
</tr>
<tr>
<td>CT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>6,000</td>
<td>7,000</td>
</tr>
<tr>
<td>Range</td>
<td>3,000 – 9,000</td>
<td>4,000 – 9,000</td>
</tr>
<tr>
<td>Angiography</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>350</td>
<td>450</td>
</tr>
<tr>
<td>Range</td>
<td>120 - 800</td>
<td>200 – 800</td>
</tr>
</tbody>
</table>

4.3.6 This data suggests the following increase in average Departmental Output from 2001 – 2009:
4.3.7 These data indicate a very significant increase in MR Output, reflecting increased throughput, in part as a result of increased scanner capacity and improved service efficiency.

4.3.8 The increase in CT Output is also significant, although less marked. This however masks the increased complexity of examinations performed (for example, CT angiography and high-resolution skull base and spinal imaging).

4.3.9 There has been a significant increase in angiographic activity, which, in part, reflects the increase in endovascular interventions. This increase is observed, despite the increasing use of non-invasive angiography, for evaluation of intracranial vascular disease and reflects a significant expansion in considerably more time intensive interventional procedures.

4.3.10 These increases compare with an approximately 25% increase in the number of Consultant Neuroradiologists over this time period.

4.3.11 The majority of centres perform fluoroscopic and / or myelography work. The average departmental output and range (rounded) are shown below:

<table>
<thead>
<tr>
<th></th>
<th>Average (in examinations)</th>
<th>Range (in examinations)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fluoroscopy / Myelography</strong></td>
<td>200</td>
<td>10 - 800</td>
</tr>
</tbody>
</table>
4.3.12 Several centres have developed fluoroscopic services that include nerve root and facet joint injections, and these account for the higher range.

4.3.13 Most centres perform plain radiograph reporting. The average departmental output and range (rounded) are shown below:

<table>
<thead>
<tr>
<th></th>
<th>Average (in examinations)</th>
<th>Range (in examinations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain radiographs</td>
<td>800</td>
<td>0 – 2,000</td>
</tr>
</tbody>
</table>

4.3.14 All centres conduct significant numbers of clinico-radiological meetings. The average numbers of meetings conducted are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Average number (per week)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinico-radiological</td>
<td>10</td>
<td>5 - 20</td>
</tr>
<tr>
<td>meetings</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.3.15 All centres indicated that interpretation of scans generated from outside hospitals constitutes part of Departmental Output. The number of opinions generated in this way is shown:

<table>
<thead>
<tr>
<th></th>
<th>Average number (per year)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reports generated on ‘outside scans’</td>
<td>2,500</td>
<td>1,000 – 5,000</td>
</tr>
</tbody>
</table>

4.4 Consultant Workload and Work Intensity

4.4.1 Consultant workload has been analysed in terms of annual workload per Consultant (in examinations / year), and in terms of work intensity (in examinations / session). One session has been equated with one
Programmed Activity (PA), in accordance with standard Consultant contracts. This process allows comparison of ‘headline’ data, but does not however include higher-level analysis, for example relating to the complexity of individual examinations. Nevertheless, it allows valid conclusions to be made.

4.4.2 The following rounded average data for annual workload per Consultant was derived from the 2009 survey for non-angiographic work:

<table>
<thead>
<tr>
<th></th>
<th>Average (in examinations / Consultant / year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR</td>
<td>2,500</td>
</tr>
<tr>
<td>CT</td>
<td>1,500</td>
</tr>
</tbody>
</table>

4.4.3 The CT / MR mix varies considerably between Centres and this affects local patterns. On average, Consultants report 2,500 MR examinations and 1,500 CT examinations per year.

4.4.4 Consultant work intensity has also been analysed, to give a measure of workload per session or PA.

4.4.5 The following rounded average data for Consultant work intensity was derived from the 2009 survey for non-angiographic work: The CT workload reflects the increasing complexity of these examinations.

<table>
<thead>
<tr>
<th></th>
<th>Average (in examinations* / PA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR</td>
<td>16.5</td>
</tr>
<tr>
<td>CT</td>
<td>15</td>
</tr>
</tbody>
</table>

* NB workload is based on the average number of examinations not “patient attendances”
4.4.6 Angiographic work intensity has also been analysed within the 2009 Survey. This has indicated that on average 1.5 examinations are performed per session, ranging from 0.8 – 2.4. This does not however take into account the complexity of angiographic interventional procedures or the associated ward and out patient workload.

4.4.7 None of the surveyed Centres indicated that there was a separate PA commitment to interpretation of ‘outside scans’, despite the substantial workload of this type identified.

4.4.8 All surveyed centres indicated that there was separate PA commitment to the conducting of clinico-radiological meetings. This ranged from 0.25 PA – 1.5 PA, generally reflecting the range of total numbers of meetings performed and the associated preparation time.

4.4.9 Consultant neuroradiologists provide on-call cover, either as first on-call or second on-call.

4.4.10 The majority of consultant neuroradiologists are actively involved in the training of radiology SpRs. This includes core and higher training as part of radiology training programmes within Departments and on local and national FRCR courses.

4.4.11 There is a commitment to formal training of Medical Students and junior Medical staff in other disciplines including Neurosurgery and Neurology. Demands for teaching also come from AHPs including Radiographers.

4.4.12 The European Working Time Directive and the effects of Modernising Medical Careers [24] has resulted in a significant increase in Consultant engagement in on-call duties and in the time required to supervise daytime work [5].

4.4.13 There are increasing demands for emergency on-call work, for example in relation to stroke imaging [17,18]. These demands require 24/7 cover, usually
without additional resource available to sustain normal service delivery the next working day.

4.5 Non Radiologist Staffing

4.5.1 Anaesthetic support to meet the varying demands of individual neuroradiology departments is essential. Although many departments have adequate anaesthetic support, some Departments report difficulty in accessing anaesthetic support for angiographic interventional cases and scans under general anaesthesia.

4.5.2 Skilled and experienced nursing support is necessary for angiographic and other interventional procedures to be performed safely. Nursing support is also required to support patients requiring sedation or anaesthesia for MR scanning.

4.5.3 An additional nurse, (other than the scrub nurse or Operating Department Practitioner), is required for interventional procedures. Nurses involved in anaesthetic support must be appropriately trained for this role.

4.5.4 There is an extended role for the nurse caring for patients undergoing interventional procedures that are crucial to patient well being. This role includes pre-procedure counselling of patients and relatives; optimising sterility and safety of the working environment; ensuring that necessary equipment and consumables for procedures are available; post-procedural nursing care and effective communication of instructions for post-procedural management to ward staff.

4.5.5 Pressures to improve the utilisation of nursing resources within Trusts may have an effect on the availability of sufficiently trained nursing support for neuroradiology departments, and potentially on the safety of services provided. Changes in the level of nursing support need to be carefully
monitored and managed to ensure effective and safe delivery of Neuroradiology services.

4.5.6 Radiographic support is often provided as part of a sub-discipline of Neuroradiography, in which there is radiographic expertise across all aspects of diagnostic and interventional practice. Other Departments operate radiographic support in terms of specialisation in an individual diagnostic or interventional modality.

4.5.7 Increasing pressures to improved utilisation of Radiographic resource within Departments may result in a pressure for less experienced and more general Radiographers to be practising within Neuroradiology Departments. Such developments may have a significant effect on the quality of Neuroradiology that can be delivered, and need to be carefully monitored.

4.5.8 Secretarial and administrative support underpins the effective functioning of Neuroradiology Departments, in terms of patient administration, general departmental functioning and support of Consultant activity. Effective clerical staffing is therefore necessary for effective delivery of Neuroradiology services [1,5]. This is particularly important for interventional neuroradiology where Consultants are often responsible for providing outpatient clinics, ward reviews and ongoing long term imaging follow-up [15].

4.5.9 Pressures to ‘rationalise’ clerical support within Neuroradiology departments need to be carefully monitored and managed, so that the basic administrative infrastructure that underpins services is maintained and optimised.

4.6 Key Points

4.6.1 There has been a significant increase in departmental workload over the last decade, out of proportion to the increase in the number of consultant neuroradiologists in the United Kingdom. Increasing departmental workload is
exacerbated by increased complexity of diagnostic and interventional workload.

4.6.2 It is important that the preparation and attendance at clinico-radiological meetings is recognised within job plans as a core activity [25].

4.6.3 Other key activities, (including consulting and provision of opinions on externally generated scans), constitute a significant part of Consultants’ workload, without necessarily being included in formal job planning. Consideration needs to be given to inclusion of these activities into the job planning process.

4.6.4 The European Working Time Directive and the effects of Modernising Medical Careers have had profound effects on the level of consultant supervision that is required for on call duties and in the supervision of daytime work.

4.6.5 There is a drive towards seven day working with extension of the normal working day. This needs to be carefully monitored and job plans adjusted where necessary.

4.6.6 Increasing pressure to rationalise radiographic, nursing and administrative support needs to be closely monitored and managed, to ensure that Neuroradiology services can still be provided as effectively and safely as possible.

4.7 Conclusions

There has been a significant change in the demands placed on consultant neuroradiologists and neuroradiology departments over the last decade, as a result of substantial medical developments and technological advances. There is likely to be a continued acceleration of change to existing working practices with the development of seven day services. This needs to be recognised and monitored to
ensure that neuroradiology services are provided as effectively and safely as possible.
5. TRAINING

5.1 Previous Training Requirements

5.1.1 When ‘Effective Neuroradiology 2003’ was written, standard Radiology training in the UK was completed in 5 years. The first 4 years comprised basic training in all the specialist areas of Radiology. Year 5 was allocated to higher specialist training, a 4+1 model. A limited number of subspecialties including Neuroradiology were allocated 2 years of higher training, a 4+2 model. This was achieved by deferment of the CCT (CCST) until the end of Year 6.

5.1.2 ‘Effective Neuroradiology 2003’ recommended the following periods of higher training

- Diagnostic Neuroradiologist: minimum 18 months, preferably 2 years
- Interventional Neuroradiologist*: minimum 2 years
- Radiologist in a DGH with a special interest in Neuroradiology: 6 months

*Interventional Neuroradiologists are also trained in diagnostic neuroradiology and the large majority contribute significantly to the diagnostic neuroradiology workload in their centres

5.2 Current Training Requirements

5.2.1 In the mid 2000’s UK radiology training was changed to a 3+2 model for all subspecialties, with core training reduced to 3 years and years 4 and 5 allocated to higher specialist training in one or more areas.

5.2.2 In 2010 the GMC approved a radically revised RCR Specialty Training Curriculum for Clinical Radiology which is based on the 3 + 2 training model [16]. In each subspecialty of Radiology, including Neuroradiology, 3 levels of competence are defined – Core, Level 1 and Level 2. Level 2 training is intended for radiologists with a single specialist interest (mono-specialist), practising at a high level of expertise [16]. Diagnostic and Interventional
Neuroradiologists working in specialist Neuroscience centres require Level 2 training.

5.2.3 In 2010 the GMC also approved a new RCR Specialty Training Curriculum for Interventional Radiology. This is based on 3 years of core training and 3 years of higher specialist training [16]. This curriculum includes Interventional Neuroradiology, with agreement with RCR to include INR as an IR subspecialty requiring 3+3 training. This will lead to a Certificate of Completion of Training (CCT) in Clinical Radiology with Interventional Radiology sub-specialisation.

5.3 Delivery of Neuroradiology Training

5.3.1 Core Training will take place during the first 3 years of Radiology training as defined in the Specialty Training Curriculum for Clinical Radiology 2010. Typically this will be a 3 month period and is focused on acute neuroimaging.

5.3.2 During Core Training the trainee will also have undertaken the Neuroradiology section of the Part 2A FRCR examination and would have passed, or be attempting, the Part 2B FRCR examination around the time of completion of Core Training.

5.3.3 All UK radiology trainees should be taking part in an acute on call rota by end of ST2 year at the latest. Neuroimaging comprises a substantial part of acute radiology. On call neuroradiology must be adequately supported at Consultant level and appropriate interaction and feedback should take place to maximise the learning opportunity from work of this type. This is important because many radiologists in the UK provide an acute neuroimaging service as part of their on call commitment, yet may have had little or no structured neuroradiology training beyond core training in Years 1 to 3.
5.3.4 **Higher Training** should take place in accordance with the Specialty Training Curriculum for Clinical Radiology 2010 and the BSNR’s Guidance on Diagnostic Neuroradiology Training.

5.3.5 **Level 1 Training** will typically take place during Year 4, after attainment of the FRCR for trainees intending to progress to Level 2 competences, and become specialist Neuroradiologists, or during Year 4 and/or 5 for those intending to achieve Level 1 only.

5.3.6 Radiologists achieving Level 1 competence would be suited to practicing radiology with a special interest in neuroradiology in a non-neuroscience centre, leading the neuroimaging service and supporting colleagues who contribute to the acute neuroimaging service.

5.3.7 **It is recommended that there is at least one radiologist trained to Level 1 neuroradiology in every centre that provides acute neuroimaging.**

5.3.8 **Level 2 Training** in Diagnostic Neuroradiology would typically equate to 2 years of training, with additional training taking place in Year 5 following achievement of Level 1 during Year 4. An exception to this may be where a trainee has undertaken focussed individual training (FIT) and achieved Level 1 neuroradiology competence during Core Training.

5.3.9 Level 2 training in INR would typically equate to 3 years of training during years 4, 5 and 6. (See Sections 5.5 and 6.7)

5.4 **General Recommendations for Neuroradiology Training**

The following recommendations should apply to all higher training in neuroradiology.

5.4.1 Training should take place in a centre recognised by the RCR/GMC for training in diagnostic and/or interventional neuroradiology.
5.4.2 A training centre should be fully equipped and resourced to the minimum standard described in Section 3 of this document.

5.4.3 The full spectrum of neuroradiology practice should be available to the trainee including paediatric and head and neck radiology. If necessary, arrangements should be made with other centres to enhance this training.

5.4.4 Consultant supervision should be available at all times to a level appropriate to the ability of the trainee.

5.4.5 The trainee should take part in the neuroradiology on call service, certainly during Year 5 (and 6 if applicable) and ideally during Year 4.

5.4.6 For Level 2 training the timetable should be substantially devoted to neuroradiology, with no more than 20% of time spent on general work per week, especially during years 5 and 6. For training to Level 1 only there is scope for greater flexibility.

5.4.7 The trainee should attend relevant MDT meetings and be allocated preparation time to present cases.

5.4.8 Training for all neuroradiology trainees should include exposure to the following related specialities:
   - Neurosurgery
   - Neurology
   - Stroke Medicine
   - Neuropathology
   - Paediatric Neurosciences
   - Trauma
   - Rehabilitation services

5.4.9 For specific areas of interest and training additional specialities are relevant including:
   - Neuroanaesthesia
ICU/HDU
Head and neck surgery/ENT/Maxillofacial surgery
Ophthalmology
Endocrinology
Psychiatry
Spinal orthopaedic surgery
Genetics

5.4.10 There should be at least one session per week allocated to research, audit and study.

5.4.11 The trainee must have ready access to appropriate medical library and research facilities including high speed internet access.

5.4.12 The trainee should be encouraged to participate in research and to present at national or international meetings.

5.4.13 The trainee should be given the opportunity to take part in teaching of undergraduate and/or postgraduates.

5.4.14 The trainee should be encouraged and given the opportunity to attend appropriate courses, such as the European Course of Diagnostic and Interventional Neuroradiology [ECNR] cycle.

5.4.15 The trainee should be encouraged to attend the major Neuroradiological Society meetings in the UK, Europe and the USA.

5.4.16 The trainee should be encouraged to become an associate member of the BSNR.

5.5 Interventional Neuroradiology
5.5.1 At the time of writing, neither the Specialty Training Curriculum for Clinical Radiology 2010, nor the Specialty Training Curriculum for Interventional Radiology 2010 cover Interventional Neuroradiology Training.

5.5.2 Interventional Neuroradiology Training will be based on a 3+3 model. There has been agreement with the RCR that INR will be part of IR training and lead to a CCT in Clinical Radiology and Interventional Radiology. GMC approval is being sought for this amendment to the IR curriculum.

5.5.3 Currently, available reference documents are the RCR Neuroradiology sub specialty curriculum 2008 [16] and the BSNR Guidance on Interventional Neuroradiology Training. It is hoped that this will be incorporated into an RCR curriculum.

5.5.4 The key elements for INR training include:

- Diagnostic Neuroradiology including a specific focus on vascular imaging.
- Interventional applications and techniques.
- Clinical aspects including initial assessment, formulation of a diagnosis and management plan, preprocedural care, consent, management of complications, routine post procedural care, follow up and patient counselling.

5.5.4 Training is to be delivered over a 3 year period with the emphasis on diagnostic neuroradiology in Year 4, with focus on intervention in Years 5 and 6.

5.5.5 Exceptionally, there may be a requirement to train in more highly specialised procedures, for example paediatric neurointervention. This could necessitate additional training in a highly specialised centre beyond 3 years in total.

5.5.6 Whereas in other radiology specialities Level 1 competence is a training end point, this does not apply to INR training. Only when full Level 2 competence has been reached would a trainee be in a position to practice independently.
5.5.7 INR training should take place in an accredited centre, with a minimum of 2 Consultant Interventional Neuroradiologists.

5.5.8 The centre should have a caseload and diversity of cases, sufficient to provide a suitable number and mix of cases for the trainee within the requisite time period, and ideally work closely with other centres to provide comprehensive training opportunities.

5.5.9 Training in Interventional Neuroradiology must include exposure to, and liaison with, the related specialties listed in 5.4.8

5.6 Summary of Recommendations for Delivery of Training

5.6.1 Diagnostic Neuroradiologist: 3+2 years of higher specialist training and achievement of Level 2 competence. This period may include training in a subspecialty area such as paediatric neuroradiology or head and neck imaging.

5.6.2 Interventional Neuroradiologist: 3+3 years in a structured training programme described by the RCR Interventional Radiology curriculum that will include all necessary clinical training, diagnostic neuroradiology and interventional neuroradiology.

5.6.3 Radiologist in a non-neuroscience centre with a special interest in neuroradiology: 3+ achievement of Level 1 competence.

5.7 Workforce Monitoring and Planning

5.7.1 The BSNR has for several years maintained a database of all UK consultant and trainee posts in Neuroradiology. This includes projected retirements and new posts. It has been valuable in helping to maintain a balance between trainees and opportunities.
5.7.2 Data as of September 2010

Total Consultants in post  177
Interventionists (approx)  75

Accredited training centres for diagnostic neuroradiology: 22 including 6 in London forming the pan-London rotation. 17 if London is considered as 1 centre.

Centres that have trained an Interventional Neuroradiologists at any time in the last decade: 13 (counting London as 1)

UK NEURORADIOLOGY TRAINING POSTS AND OUTCOMES

Interventional trainee numbers

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1. 2010 incomplete – to September only.
2. Apparent shortfalls in earlier years due to posts overseas and a small number going to DGH posts.
6. INTERVENTIONAL NEURORADIOLOGY

6.1 Definition

An INR is a Neuroradiologist who undertakes therapeutic procedures. These are predominantly endovascular but also include percutaneous procedures.

6.2 Departments

All 34 UK Departments of Neuroradiology now have access to interventional endovascular procedures. In the majority of units this is an on site service, but there are several small units who have access through arrangements with larger centres. The number of endovascular procedures performed has expanded rapidly over the past decade, with the publication of Class I RCT evidence demonstrating advantages of endovascular management of aneurysmal subarachnoid haemorrhage when compared with open neurosurgical clipping [14,15].

6.3 Workload

6.3.1 This is largely devoted to the treatment of ruptured and unruptured intracranial aneurysms, intracranial and spinal vascular malformations, and tumours of the brain, skull base and spine. More specialised work including management of paediatric neurovascular disease and craniofacial malformations are performed in selected centres.

6.3.2 In 2001 there were an average of 30 endovascular aneurysm treatments per year per centre over the 34 centres, the average percentage of aneurysms treated by coiling being 35%.

6.3.3 The International Subarachnoid Aneurysm Trial (ISAT) showed a highly significant reduction in the risk of death or disability (Rankin 3-6) in those patients treated with coiling at one year over those treated with conventional Neurosurgery. This advantage has been sustained with longer term follow up
This has had a dramatic impact on the working practice of INRs, with a substantial increase in workload. By October 2002 over 70% of aneurysms were being treated by INRs and in some centres this percentage has continued to rise to over 90%.

6.3.4 The development of treatment for acute stroke is driving the organisation of stroke networks and the delivery of these patients to Neuroscience centres in appropriate time windows for IV thrombolysis [8]. Intra-arterial (IA) treatments are increasing with case series data supporting these interventions within a widened time window. This is placing an increasing workload on INRs, some of which is required out of hours on an emergency basis.

6.3.5 Many INRs also perform percutaneous spinal interventions including biopsy, spinal injections and vertebroplasty.

6.3.6 The increase in operative workload has been accompanied by an increasing requirement to become involved in the ward management of these patients and follow up through outpatient clinics. This involves pre and post operative discussions with patients and relatives about procedures and complications [15]. There is also a requirement for INRs to attend MDTs and Morbidity and Mortality (M&M) meetings with other Neuroscience colleagues.

6.3.7 INR is constantly evolving with the introduction of new procedures and devices. These need careful assessment and regulation to ensure that these are introduced responsibly, using evidence based mechanisms and governance arrangements to monitor there efficacy. This has to be balanced against over regulation that may stifle innovation and deny patients access to appropriate technology [27].

6.4 Equipment

6.4.1 INR departments should have exclusive access to high resolution digital angiographic equipment. This should be biplane with a rotational 3D processing facility. A back-up angiographic room is also essential. Formal
links with geographically related Neuroscience centres should be in place to ensure the timely treatment of patients with acute neurovascular disease during periods of both expected and unexpected angiographic downtime.

6.4.2 Rapid access to multi-slice CT, CT angiography and CT perfusion is essential. With developments in stroke and TIA guidelines, similar access to MR and MR angiography of the cervical and cerebral arteries is required. Access to carotid and cerebral duplex is also advantageous.

6.4.3 Departments should have robust equipment replacement programs in place to ensure that equipment is fit for purpose. Strategies to minimise downtime and risk to service during equipment replacement should be in place. As equipment ages this should be recognised within Trust Assurance and Risk Committees and appear on the Trust risk register.

6.5 Training Posts

6.5.1 Training has been described in detail in Section 5.

6.5.2 There are a number of training posts across the UK, but there is no formal match between the number of training posts and projected available Consultant INR vacancies.

6.5.3 A review process should ideally be established to ensure flexibility in designation of training centres in an attempt to accurately match trainees to vacancies.

6.5.4 Centres that train INRs will need to ensure that workload and assessments of knowledge and technical competencies are sufficient so that trainees can comply with the requirements laid out in the IR curriculum. Full details of training guidance are available on the BSNR web site. This training can be obtained in more than one centre and integration of training across sites may
be of great value in widening trainee experience and is supported/encouraged by BSNR.

6.6 Staffing

6.6.1 There should be at least two Neuroradiologists with appropriate experience in any centre performing INR procedures. To ensure safe practice, an INR should be available for consultation on every working day and at other times by local arrangement.

6.6.2 Neurosurgical and anaesthetic support should mirror the availability of the INR which, by definition, requires every working day access to appropriate anaesthetic sessions.

6.6.3 New and existing Consultant posts with an INR commitment should have access to at least two nominated procedural sessions per week, with full anaesthetic support when emergency and elective cases can be treated.

6.6.4 One programmed activity (PA) of procedural work will require at least 0.5 additional PAs for pre-procedural counselling and post procedure follow up [15,23].

6.6.5 Out patient facilities, including appropriate support staff, should be available in order to provide a comprehensive clinical service for patients requiring interventional procedures. Time should be allocated for this in a Consultant’s job plan.

6.6.6 In many geographical locations it may be possible for Neuroscience Centres to work together in order to provide a comprehensive acute INR services.
6.7 Training

6.7.1 Training will be under the regulation of the GMC and will comply with the INR components of the IR curriculum. Entry into INR is traditionally through a general radiology training scheme and the FRCR exam. This needs to be agreed at or by the start of ST4 after the completion of core radiology training but. FRCR is not a specific requirement to train in the sub-specialty.

6.7.2 In the UK a radiology trainee will be required to develop core skills in diagnostic imaging with satisfactory completion of years 1 to 3. The Specialty Training Curriculum for Clinical Radiology defines this core training. Advanced skills in diagnostic neuroradiology will be obtained in year 4 as described in section 5.

6.7.3 Virtually all UK Interventional Neuroradiologists also have a diagnostic neuroradiology commitment. Diagnostic neuroradiology training should take place in year 4, with advanced skills training in INR in year 5 and year 6 according to the curriculum. There may be specific requirements for further training beyond year 6 to obtain further subspecialty experience.

6.7.4 Training in INR should not be restricted to training in practical procedures; development of clinical judgement is vital to provide a safe service. The risks and benefits of each therapeutic procedure need to be appreciated. Training might include a clinical attachment.

6.7.5 Training accreditation will comply with requirements outlined in the IR training curriculum.
7.0 INTEGRATION WITH NEUROSCIENCES & OTHER CLINICAL SPECIALTIES

7.1 Service Delivery

7.1.1 Radiology is increasingly used as triage in directing patients along appropriate clinical pathways and is key to efficient use of secondary and tertiary care resource. This is particularly important in Neurosciences and allied specialties and requires Neuroradiology to be at the core of these services [1,15,18,28].

7.1.2 NHS Trusts have considerable freedom to arrange the organisation of their clinical activities. Fragmentation of a Neuroscience service runs serious risks of losing the benefits of close day-to-day integration essential for quality and patient safety. Every effort must be made in provision/planning of services to recognise the importance of close geographic and operational integration of the elements of a Neuroscience service.

7.1.3 The introduction of PACS and protocol driven imaging has increased efficiency and removed the need for Neuroradiologists to be physically present at the site of scanning. This allows remote reporting, but this must not detract from important clinical interaction with clinicians through direct Consultation and MDT meetings [23].

7.1.4 PACS allows greater access to Neuroradiology expertise from outwith the Neuroscience unit, from other subspecialty groups and also other acute providers without onsite neuroscience support. This work is mostly unfunded and produces inequity between capacity and demand [6]. Formal funded hub and spoke services between Neuroscience Centres and other providers should be encouraged.

7.1.5 There needs to be recognition by clinical commissioning groups and national funding bodies that neuroradiology is a local, regional and suprareregional service and necessarily attracts funding from both sources. Regional funding from surrounding DGHs is increasingly important in view of the increasing role
in providing second opinions and the advent of stroke and other regional services. A “hub and spoke” model, whereby Neuroradiologists travel to DGHs, or whereby a DGH radiologist is trained in neuroradiology and visits the “hub” as a regular commitment built into the consultant job plan, may be a useful model.

7.2 Funding

7.2.1 A variety of methods of funding of Neuroradiology departments exists in the UK: entirely separate; ring fenced within a radiology budget; within a radiology budget but not ring fenced; funded from a Neuroscience budget.

7.2.2 The funding method most applicable to an individual centre will vary and may depend upon the local hospital geography and level of integration of radiology facilities and staff.

7.2.3 Expensive diagnostic equipment and Radiographic staff need to be used to maximum efficiency. Increasingly, this requires seven day access with change in working practice. This provides an argument for integration of Neuroradiology into general radiology departments where possible.

7.2.4 INR requires close integration with Neurosurgery, creating justification for funding through traditional Neurosurgical budgets. The costs of this service should be balanced, not only against the costs of conventional Neurosurgical treatments, but also against reduced patient morbidity and reduced length of stay and rehabilitation costs.

7.2.5 The introduction of Service Line Reporting and internal trading within the NHS in England will allow increased transparency in funding of Neuroradiology services. This has the potential to control demand, improving quality and cost savings through reduction of inappropriate use of imaging services. It will also ensure that funding matches activity including teaching and research.
7.3 Primary Healthcare Service Access to Neuroimaging

7.3.1 There is evidence that direct access from primary care into Neuroradiology can be of value with the potential to reduce OP referrals and time to treatment [19,29]. The new commissioning arrangements are likely to increase demand for this service with competition from any qualified provider.

7.3.2 Neuroradiology departments need to be free to work with primary care to develop Integrated Care Pathways and ensure ease of access to the appropriate investigation.

7.3.3 Equitable access to primary care contracting opportunities must be established in competition with other qualified providers. This should be based around quality with improved communication between Neuroradiology and colleagues in the primary care setting in both “gate keeping” and “clinical advisory” roles. This needs to be underpinned by appropriate clinical governance structures.

7.4 Subspecialisation and supraregional networking

7.4.1 The traditional organisation of neuroscience services has changed in a number of clinical areas with the development of several regional and supraregional networks (e.g. the Scottish coiling service, the paediatric Vein of Galen service, the Greater Manchester Stroke Network). These networks are in development in some areas and require consideration in others.

7.4.2 These Networks have been driven by a number of factors including subspecialisation within neuroradiology and the drive for 7 day access to specialist services.

7.4.3 Subspecialisation has of necessity become an increasing feature of Neuroradiological practice. The safe delivery of all subspecialties and
maintenance of these services 52 weeks of the year is difficult and especially so in smaller units.

7.4.4 There is particular pressure in INR with increasing demand for weekend services and 24/7 provision of IA treatments for acute stroke.

7.4.5 New ways of working need to be explored driven by the use of teleradiology. This could result in more formal links between units to provide more equitable access to Neuroradiology services.
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<td>BSNR</td>
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<td>CCT</td>
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References


4  Advice on Training in Neuroradiology.  British Society of Neuroradiologists 1990

5  How many radiologists do we need? A guide to planning hospital radiology services. London. Royal College of Radiologists 2008


7  Diagnosis and initial management of acute stroke and transient ischaemic attack (TIA). London. National Institute for Health and Clinical Excellence 2008


14  International subarachnoid aneurysm trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial

15 The International Subarachnoid Aneurysm Trial (ISAT) and Neurovascular Services in the UK Report of a Joint Working Group. London. Society of British Neurological Surgeons and British Society of Neuroradiologists 2003


18 Standards for providing a 24-hour diagnostic radiology service. London. Royal College of Radiologists 2009


21 Standards for the provision of teleradiology within the United Kingdom London. Royal College of Radiologists 2010


23 Workload survey. British Society of Neuroradiologists 2010

24 Modernising medical careers: the next steps. The future shape of Foundation, Specialist and General Practice Training Programmes. London. Department of Health on behalf of the Modernising Medical Careers UK Strategic Group 2004

25 Cancer Multidisciplinary Team Meetings – Standards for Clinical Radiologists London. Royal College of Radiologists 2005

