



# **Effective Neuroradiology**

## **Guidelines for Safe and Effective Practice**

**The British Society of Neuroradiologists  
2003**

# **Neuroradiology ~ the challenge ahead**

The specialty of Neuroradiology has continued to evolve rapidly over the past few years with the introduction of new imaging technologies and new interventional treatments.

The management of clinical services is largely undertaken at hospital level. Whilst local decision making has brought many advantages 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 first edition of Effective Neuroradiology was published in 1996. This updated document aims to define the minimum requirements for a Neuroradiology service and to make recommendations for the future.

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This document is also available electronically at [www.bsnr.co.uk](http://www.bsnr.co.uk)

# 1. INTRODUCTION

Neuroradiology is a relatively small specialty which is crucial to the running of many acute clinical services, at the forefront of which are Neurosurgery and Neurology. A number of problems are evident.

## 1a Equipment

- (i) There is no identifiable structure for introducing expensive developments into the National Health Service. There is for example no national policy for a UK Magnetic Resonance Imaging (MRI) service. Each Neuroradiological centre has had to make it's own local case and has often had to become involved in 2-3 years of negotiation with the local authority.
- (ii) The same problem has slowed the application of Interventional Neuroradiology techniques. The consumable costs may easily add £250,000 - £500,000 to the annual budget of a Neuroradiology department. A central advisory body is desirable if technological developments are to be introduced in a coherent manner across the country.

## 1b Staffing

- (i) Neuroradiology is squeezed between rapidly rising clinical demand and financial constraints inherent in the health system. This has resulted in many Departments of Neuroradiology being forced to accept new technologies and services without the additional staff required to provide a safe and effective service.
- (ii) There is a serious crisis in the medical staffing of Departments of Neuroradiology. This affects both Diagnostic and Interventional Neuroradiology services equally.

## 1c Training

- (i) The development of Neuroradiological training posts has been haphazard. The criteria for a suitable training centre have now been established and an appropriate inspecting body, the Training Accreditation Committee of the Royal College of Radiologists, is in place. Recommendations are contained within this document.
- (ii) The situation with regard to training in Interventional Neuroradiology is less developed. There are Specialist Registrar posts dedicated to training in Interventional Neuroradiology in Newcastle and Edinburgh. There is an MSc course at the University of Oxford but no funding for trainees. The course has to date been largely filled with overseas trainees. Although the situation is improving it remains the case that for some consultants currently carrying out interventional procedures their training has consisted only of short periods of observation at another centre. The availability of training placements in Interventional Neuroradiology needs to be improved.

## 2. BACKGROUND

**2a** The British Society of Neuroradiologists (BSNR) produced a Report on Training and Consultant Posts in Neuroradiology in 1973 [1] with amendments in 1975 and further Advice on Training in Neuroradiology in 1990 [2].

**2b** 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 National Health Service. The elected Committee of the BSNR produced 'Effective Neuroradiology' which was published in 1996.

**2c** This updated edition has been prepared by the Committee of the BSNR and membership was as follows:

Dr Simon Barker	Dr Richard Bartlett
Dr John Bradshaw	Dr Juliet Britton
Dr James Byrne	Dr Andrew Clifton
Dr Adam Ditchfield	Dr Margaret Hourihan
Dr Andrew Molyneux	

**2d** Since 1973 there have been three major advances which have been responsible for radical change in Neuroradiological practice.

(i) The first advance occurred in the mid 1970's with the widespread introduction of computed tomography (CT) which replaced pneumoencephalography and a substantial portion of diagnostic cerebral angiography. General purpose CT also brought in a new era of widely available non-invasive Neuroradiological investigations with a consequent lowering of the threshold for investigation and a resultant increase in diagnostic Neuroradiological examinations.

(ii) The second advance has been the introduction of MRI which has expanded Neurodiagnostic capabilities and has replaced most myelography.

(iii) The third advance has been the development of Neurointerventional techniques which now permit a therapeutic role for the Neuroradiologist. This is an area which continues to develop and expand. Many procedures are time consuming and interventional work accounts for a significant and increasing proportion of neuroradiological workload. The International Subarachnoid Aneurysm Trial has shown an improved outcome for patients treated by coiling rather than surgery following intracranial aneurysm rupture [3]. This will have a significant impact on Neuroradiological practice.

**2e** Government guidelines for patients with stroke and cancer have added to the pressures on Departments of Neuroradiology.

### **3. Necessary facilities and services for safe and effective Neuroradiological practice**

#### **3a Computed Tomography (CT)**

- (i) Speed of examination and image production are important in Neuroradiology to achieve:-
- High throughput.
  - Volume scanning and angiography.
  - More effective examination of infants, children, the mentally disturbed and patients with multiple trauma.
- (ii) Spiral and multislice scanners have dramatically reduced scan times. High quality reconstructed images in coronal and sagittal and oblique planes can be readily acquired as can extracranial and intracranial angiography.

#### **3b Magnetic Resonance Imaging (MRI)**

- (i) Whilst current imaging systems provide facilities which meet most of the needs of day-to-day Neuroradiology, further developments in software, coil design and speed of imaging are likely to bring significant benefits to both Diagnostic and Interventional Neuroradiology.
- (ii) The ability to perform diffusion, perfusion, functional imaging and spectroscopy are now desirable in modern neuroradiological practice.
- (iii) A high field MRI system with powerful shielded gradients is desirable.

#### **3c Angiography**

High resolution digital angiographic equipment is essential for satisfactory cerebral and spinal angiography, as part of the diagnostic and interventional service. It is now recommended that biplane angiographic equipment with a rotational 3D processing facility should be installed for departments carrying out interventional procedures, and is essential when equipment is replaced.

#### **3d Ultrasound**

Colourflow duplex ultrasound is a standard tool for the assessment of extracranial carotid disease. Transcranial Doppler has already become an important part of cerebral blood flow monitoring in many centres. Per-operative ultrasound has become an essential aid to some Neurosurgical procedures.

### **3e Nuclear Medicine**

The role of Nuclear Medicine in clinical Neuroradiology is currently limited but both Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET) scanning offer important diagnostic and functional data. Their use is likely to expand, particularly in the clinical fields of epilepsy and neuro-oncology.

### **3f Conventional Radiographic techniques including myelography**

- (i) Whilst the role of conventional radiographic techniques and myelography are declining they can still provide valuable information and access to such facilities is essential.
- (ii) For myelography a fluoroscopic unit with an extended table tilt and a facility to screen in multiple planes is desirable.

### **3g Developments**

In order that Departments of Neuroradiology within the NHS can generate and retain the confidence of their patients and clinical referrers it is essential that they should be able to keep up to date with “state of the art” developments which make a significant contribution to patient care, particularly those which improve patient safety and reduce radiation dose.

### **3h New Technology**

It is necessary to be aware of developments and plan for investment in the future. Introduction of new technologies into some centres to evaluate clinical potential should be encouraged and a national strategy to this effect would be desirable.

### **3i Information Technology**

- (i) A Consultant Neuroradiologist should not be appointed without the provision of an adequately equipped personal office, including a personal computer with internet access.
- (ii) Access to a networked diagnostic workstation is essential. This workstation should have the ability to manipulate image data to allow reformatting of images, to construct angiographic and three dimensional images, to review remote image data and possibly to enable procedures to be performed employing virtual reality techniques.
- (iii) Network links between the Department of Neuroradiology and appropriate wards and clinics, for the transmission of reports and images, are highly desirable.
- (iv) If the Consultant Neuroradiologist is providing a service to one or more remote sites the provision of a teleradiology link for image transfer is essential.

- (v) Teleradiology links between hospital and home for on call are desirable.

### **3j Recommendations**

- (i) A Department of Neuroradiology should have:-
- Spiral Computed Tomography (CT) scanner. Multislice is desirable.
  - Magnetic Resonance Imaging (MRI) system with Echo Planar Imaging (EPI) capabilities. Spectroscopy is desirable.
  - High resolution biplane digital angiographic equipment with a rotational 3D processing facility for diagnostic and therapeutic use.
  - Fluoroscopic unit capable of performing myelography.
  - An integrated diagnostic workstation for image manipulation is essential. Additional networking capabilities would be desirable.
- (ii) There must be adequate 24 hour access to the appropriate diagnostic modalities.
- (iii) Consideration should be given in future hospital design to the efficient integration of diagnostic, interventional and operating theatre services. The induction and recovery areas for anaesthesia should be located near to both radiological facilities and ITU.
- (iv) A room should be provided for counselling and obtaining consent.

## **4. STAFFING**

### **4a 2001 Survey**

The 2001 survey of Neuroradiology departments in the United Kingdom produced data on the current state of British Neuroradiology. (Appendix)

### **4b Staffing**

- (i) Neuroradiology is a Consultant led service.
- (ii) The definition of a Consultant Neuroradiologist is a radiologist who has undertaken appropriate Neuroradiological training as defined in this document and who holds a consultant post undertaking at least five clinical sessions per week in the practice of Neuroradiology.
- (iii) The United Kingdom has 34 departments where Neuroradiological procedures are performed by Consultant Neuroradiologists either within general departments of Diagnostic Radiology or in separate Departments of Neuroradiology.
- (iv) Most departments have 3 or more Neuroradiologists, although there are a number of exceptions with only 2.
- (v) Most Neuroradiologists are full-time or maximum part-time and their working week is spent carrying out CT, MRI, angiography, interventional procedures, myelography and clinical meetings.
- (vi) Some Neuroradiology departments provide a visiting Neuroradiologist to District General Hospitals on a sessional basis.
- (vii) The Royal College of Radiologists recommended in 1990 that the sessional commitment of radiologists to reporting and procedural radiology should not exceed seven notional half days per week for non-teaching hospital Consultants and not more than six notional half days per week for teaching hospital Consultants [4]. This may change with any new Consultant Contract.

#### **4c Workload**

(i) The annual diagnostic workload of a Department of Neuroradiology:

	Mean	Range	Increase since 1996
CT	5,500 examinations	2,900 - 8,500	31%
MRI	4,700 examinations	1,000 - 7,000	68%
Angiography	350 examinations	120 - 800	

- (ii) Workload figures vary depending upon the imaging modalities available, the number of referring clinicians and the number of practical procedures performed, particularly if Interventional Neuroradiology is undertaken.
- (iii) It should be emphasized that the interventional workload is increasing rapidly and encroaching on the time previously devoted to diagnostic procedures.
- (iv) In some departments Neuroradiological CT and MR scanning lists are overseen by general Radiologists because of an insufficient number of Consultant Neuroradiologists.

#### **4d On-Call**

- (i) Consultant Neuroradiologists provide on-call cover either as a 1st on-call or 2nd on-call.
- (ii) A small number of departments provide 1:2 cover and in these there are about two months each year when each consultant is on-call 1:1 while the other is on leave.

#### **4e Teaching Commitment**

- (i) The Neuroradiology Advisory Committee Report in March 1990 recommended that all Radiologists in training should receive the equivalent of 3 months WTE training in Neuroradiology.
- (ii) Almost all Neuroradiologists are actively involved in training at Specialist Registrar level. These trainees usually rotate in attachments which vary from 2 months to 12 months.

#### **4f Vacant Consultant Neuroradiologist Posts**

In 2001 there were WTE vacancies in at least 7 departments. (17 by October 2002)

#### **4g Requirements for Additional Consultant Posts or Sessions**

In 2001 additional full time Consultant Neuroradiologist posts were being negotiated in 75% of departments.

#### **4h Retirements**

3 WTE posts will become available due to retirement in the next 5 years.

#### **4i Changes in Working Practice**

- (i) Current practice has changed since the report of the Sub-committee on Training and Consultant posts in Neuroradiology compiled by the British Society of Neuroradiologists in 1973 [1] and amended in 1990 [2].
- (ii) A significant influence on the working practices of training departments has been the implementation of Hospital Doctors: Training for the future (Calman report [5]). Both the reduction of the service work element of training posts and the increased supervision of training have increased the workload of Consultants.
- (iii) Other factors which have influenced the Consultant workload are:-
  - New developments in existing techniques e.g. high resolution CT and spiral or multislice CT which have led to an increase in patient throughput and complexity of examination.
  - The introduction of new imaging techniques e.g. MRI. MRI alone has resulted in a significant increase in workload which far exceeds the reduction in some of the more invasive diagnostic procedures presently performed. Some of this increase in workload has occurred because of a lowering of the threshold for referral for the more non-invasive investigations.
  - Interventional Neuroradiological techniques are constantly evolving. Both current practice and the learning of new techniques require considerable time.
  - The number of specialities referring patients for Neuroradiological examinations has increased. These “non-Neuro” referrals play a large part in the workload of a Consultant Neuroradiologist and should be reflected in Consultant numbers. There have been increased referrals from each of ENT, Ophthalmology, Endocrinology, Dentistry, Facio-maxillary Surgery, Psychiatry, Oncology, General Medicine, Care of the Elderly, Vascular Surgery, Orthopaedics, Rheumatology and others.
  - The provision of a Teleradiology service may occupy 1-2 hours per Consultant per week. (Appendix)
  - Consultants may have sessions at referring District General Hospitals providing a local Neuroradiology service.
  - NHS reforms require an increase in Consultant involvement in the process of audit and management. (1-3 sessions/week).

- Continuing Professional Development (CPD) for Consultants to ensure the maintenance of standards, competence and experience is now obligatory.
- Formal training in Neuroradiology is being recommended in the training programmes of the other Neurosciences, i.e. Neurosurgery, Neurology and Paediatric Neurology as well as specialities allied to the Neurosciences, e.g. ENT, Ophthalmology and Endocrinology.

#### **4j Manpower issues**

##### **Number of Consultant Neuroradiologist Posts**

- (i) It is unsatisfactory for there to be Departments of Neuroradiology with only one Neuroradiologist. Equivalent cover cannot be available when leave is taken. Training provided may be unbalanced or unreasonably focused, and the educational and other benefits of peer review are precluded.
- (ii) In Departments with two Neuroradiologists each Neuroradiologist is single handed for significant periods of time whenever leave is taken.
- (iii) The Society of British Neurological Surgeons regards a catchment population of 1.5 million as the smallest desirable for a Neurosurgical Unit, and recommended four Consultant Neurosurgeons for this population in 1993 [6]. The Society now recommends that this should rise to six Consultant Neurosurgeons by 2005 [7]. This will have an effect on Neuroradiology workload.
- (iv) There is currently one Consultant Neurologist per 177,000 population in the UK. The equivalent figure in France is one per 38,000. The Association of British Neurologists believes that a 24 hour neurological service should be available to all patients admitted with acute neurological illness. To achieve this using a service based on a Neurological Centre requires one Consultant Neurologist per 62,600 population [8]. There are significant implications for Neuroradiology workload.
- (v) The development of a 'hub and spoke' arrangement with Neuroradiologists visiting DGHs where appropriate would address some of the issues related to Neuroradiology performed outside Neuroscience Centres.
- (vi) To cover the current workload and achieve a 1:3 rota, a Neuroscience unit serving a 1.5 million population requires a minimum of four WTE Consultant Neuroradiologists.

#### **4k Workload**

- (i) There has been a significant increase in workload because of the continued expansion of demand for CT and MRI and the development of Interventional Neuroradiology. There is no co-ordinated plan at present to increase Neuroradiology Consultant sessions.

- (ii) When hospitals appoint Consultants who are likely to refer work to the Neuroradiology Department the Neuroradiology sessions should be increased appropriately.

#### **4l On-call**

Specialised Neuroradiological imaging requires a Consultant Neuroradiologist to be either 1st or 2nd on-call. This level of service requires at least 4 WTE Consultant Neuroradiologists to provide an acceptable rota.

#### **4m Additional Activities**

The increased involvement of doctors in management and mandatory requirements for CPD and Audit each put extra demands on the Consultant Neuroradiologist's time. The time required for these additional activities will vary but will represent at least two sessions per week.

#### **4n Training**

Implementation of "Hospital Doctors: Training for the Future" and the requirements for training of Specialist Registrars in Radiology and junior medical staff in the other Neurosciences, place further demands on time.

#### **4o Other Staffing**

##### **Anaesthetic**

- (i) Anaesthetic support to meet the varying demands of individual Departments of Neuroradiology is essential. A significant number of departments already have inadequate anaesthetic cover (appendix) and this is likely to worsen with the increase in endovascular treatment of intracranial aneurysms.
- (ii) It is a recommendation of the Royal College of Radiologists that the person performing a procedure should not be responsible for sedation [9,10]. This task should not be delegated to the Specialist Registrar as he should be learning the procedure. The scrub nurse should not be responsible for sedation. An additional nurse or ODA or Anaesthetist is required.

##### **Radiographic**

- (iii) In the past Neuroradiography has been a subdiscipline within Diagnostic Radiography. Neuroradiographers have provided a wide range of expertise in different diagnostic modalities. In many departments there is now radiographic specialisation in a diagnostic modality rather than in a clinical discipline.

- (iv) Irrespective of which approach is taken in any one department it is essential that radiographers with appropriate experience, of appropriate grade and in sufficient numbers are provided to ensure the proper provision of Neuroradiology services.

### **Nursing**

- (v) Skilled and experienced nursing support is necessary for diagnostic procedures such as cerebral angiography to be performed safely.
- (vi) There is an extended role for the nurse caring for patients undergoing Interventional Neuroradiological procedures which is crucial to patient safety. This role may range from pre-procedural counselling of the patient and their relatives to ensuring that equipment and consumables required for a procedure are both available and properly prepared.
- (vii) The nurse may also have responsibility for ensuring that the working environment is sterile and safe and that instructions for post-procedural management are correctly conveyed to nursing staff on the ward.
- (viii) Appropriately trained nursing support for anaesthetic sedation sessions is required.

### **Secretarial**

- (ix) Each Consultant Neuroradiologist requires the equivalent of one full-time personal secretary.

## **4p Recommendations**

- (i) There should be a minimum of four full time Consultant Neuroradiologists in post to offer a comprehensive Neuroradiology service for a 1.5 million catchment population.
- (ii) Those departments with only two WTE Consultant Neuroradiologists should be expanded to three without further delay.
- (iii) Trust Boards must be encouraged to adhere to the mechanism whereby the implications of appointing new Consultants in other specialities who may have a significant impact on the Neuroradiology service are recognised. The number of Neuroradiology sessions should be increased appropriately.
- (iv) Where local resources allow, the development of a 'hub and spoke' Neuroradiology service to District General Hospitals is to be encouraged.

## 5. TRAINING

There are three issues:-

1. Structured Training in Clinical Radiology.
2. Training of Specialist Registrars who will become specialised Neuroradiologists working in a Neurosciences Unit.
3. Training of general Radiologists who undertake Neuroradiology in a District General Hospital without dedicated Neuroradiological support.

### **5a Structured Training in Clinical Radiology**

#### **Present Position**

Neuroradiology training is part of the core curriculum for all Specialist Registrars (SpRs) training in Radiology (Structured Training in Clinical Radiology, 3rd Edition 2001). This document details the Neuroradiological curriculum in terms of the core knowledge, core skills, core experience and optional experience which should be acquired by SpRs during their first 4 years of training [11]. Prior to being awarded the Certificate of Completion of Specialist Training (CCST) in Radiology, the SpR must demonstrate that they have acquired the appropriate knowledge, skills and experience as detailed in the modular training objectives form for Neuroradiology in their Personal Portfolio.

### **5b Training of Specialist Neuroradiologists**

#### **Present Position**

There are currently 24 Neuroradiology Specialist Registrar posts in: Oxford (2), Manchester (2), Edinburgh (2), Newcastle-upon-Tyne (2), The National Hospital for Neurology and Neurosurgery, Great Ormond Street, Atkinson Morley's Hospital, The London and King's College Hospital London (8), Glasgow (2), Southampton, Cambridge, Liverpool, Nottingham, Sheffield and Belfast. As of September 2002 19 SpRs were in post and 5 positions were vacant. Recruitment prospects currently seem to be reasonable.

### **5c Training of General Radiologists who undertake Neuroradiology in a District General Hospital without dedicated Neuroradiological support**

#### **Present Position**

All general Radiologists in the course of their structured training, leading to the CCST in Radiology, receive training in Neuroradiology.

## **5d Recommendations for Neuroradiological training in the United Kingdom**

### **Structured Training in Clinical Radiology**

- (i) During the first four years of general radiological training all trainees should receive clinical Neuroradiological instruction including head and neck radiology, achieved by a mixture of didactic and practical training. The core knowledge, core skills and optional experience are outlined in 'Structured Training in Clinical Radiology, Third Edition'.
- (ii) Training should include a familiarity with all the imaging modalities of modern Neuroradiological practice and attendance at Clinico-Neuroradiological meetings.

## **5e Training of Specialist Neuroradiologists**

- (i) Specialist training in Neuroradiology would normally commence after four years of general radiological training during which time the FRCR should have been obtained. In some instances it may be possible to identify trainees for specialist training earlier than this.
- (ii) A minimum of 18 months full-time training in Neuroradiology is essential, but two years is recommended. The majority of training must be in an accredited Neuroradiology Specialist Registrar (NSpR) post. Dedicated Neuroradiology training received at a Neuroscience centre within an accredited general radiological training scheme may be taken into consideration. A trainee undertaking training in Neurointerventional procedures requires two years of training [12].
- (iii) There should be access to training in specialised areas e.g. Paediatric Neuroradiology. Opportunities for secondment to appropriate centres in the UK and abroad should be available, particularly where local training facilities in the UK are inadequate.
- (iv) A Department of Neuroradiology responsible for training should provide a modern service with access to appropriate modern CT, MRI, digital subtraction angiography, ultrasound and nuclear medicine.
- (v) Trainees should have access to neonatal cranial ultrasound, Doppler ultrasound.
- (vi) The organization of the training department should allow integration with some, if not all, of the following:
  - Adult and Paediatric Neurosurgery.
  - Adult and Paediatric Neurology.
  - Neuropathology
  - Trauma
  - Rehabilitation services

- (vii) The following inter-relationships are necessary to achieve a satisfactory standard of training:
- Neurology
  - Neurosurgery
  - Neuropathology
  - Neurophysiologists

Other specialities may provide particular opportunities in particular institutions, these may include:

- ITU/trauma
- Ophthalmology
- Otology
- Genetics
- Endocrinology
- Psychiatry
- Facio-maxillary surgery
- Spinal surgery

- (viii) The training programme should be whole-time devoted to Neuroradiology, and have Consultant supervision for all imaging and interventional procedures.
- (ix) The training programme should include two sessions for research/study.
- (x) The NSpR should participate in the Neuroradiology on-call service.
- (xi) The NSpR should be encouraged and given the opportunity to attend appropriate educational meetings and courses.
- (xii) Attendance at meetings of the British, European and American Neuroradiology Societies should be encouraged.
- (xiii) A NSpR should be encouraged to become an associate member of the British Society of Neuroradiologists (BSNR).
- (xiv) The assessment of centres which are able to offer Neuroradiological training (year 5/6), is the responsibility of the Training Accreditation Committee (TAC) of The Royal College of Radiologists (RCR). The TAC membership should always include one or more Neuroradiologists.
- (xv) Neuroradiology training posts must be approved and recognised for training by the TAC of the RCR.
- (xvi) The projected number of vacancies in Neuroradiology in the UK should be updated annually by the BSNR and the information made available to members.

- (xviii) The NSpR must have full access to appropriate medical library and research facilities.
- (xix) The NSpR is expected to participate in the teaching of undergraduate and postgraduate teaching including training for the FRCR, FRCS and MRCP.
- (xx) There should be an increase in the number of NSpR posts to address the shortage of trained Neuroradiologists. This could be co-ordinated by the BSNR to ensure that future needs are met. A wider geographical distribution of training posts is recommended [13].
- (xxi) New posts should be able to fulfil the curriculum requirements for training in Interventional Neuroradiology.
- (xxii) There is increasing subspecialisation in Neuroradiology, e.g., Paediatric Neuroradiology, functional imaging, head and neck imaging, as well as Interventional Neuroradiology, and training should reflect this diversity.

#### **5f Training of General Radiologists who undertake Neuroradiology in a District General Hospital**

- (i) Where there is a perceived need at the time of appointment for a general radiologist to be required to interpret Neuroradiological studies for patients in potentially life threatening situations, an additional six months training should be provided in a recognised Department of Neuroradiology.
- (ii) General Radiologists currently in post and required to interpret Neuroradiological investigations should, in the interests of patient care, be encouraged to attend appropriate courses in the process of their continuing professional development (CPD). They should liaise with their Neuroradiological colleagues in the interpretation of difficult cases, and attend case conferences by arrangement.
- (iii) Ideally the development of a 'hub and spoke' arrangement between the Neuroscience centre and the referring DGHs should be encouraged. If resourced appropriately this service would include:
  - A Neuroradiologist visiting the DGH.
  - Clinico-Neuroradiological meetings at the DGH.
  - DGH radiologist to attend Clinico-Neuroradiological meetings at the Neuroscience Centre and other CPD.
  - Teleradiology service for 'hot review' of DGH cases.

## **6. INTERVENTIONAL NEURORADIOLOGY**

### **6a Departments**

Most of the 34 UK Departments of Neuroradiology now undertake interventional procedures. This practice has expanded rapidly over the past decade.

### **6b Workload**

This is largely devoted to the treatment of intracranial aneurysms, intracranial and spinal vascular malformations, intracranial and skull base and spinal tumours. In 2001 there were an average of 30 coil embolisations for aneurysm per year per centre over the 34 centres, the average percentage of aneurysms treated by coiling being 35%. 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 has already had a dramatic impact on the working practice of Interventional Neuroradiologists, with a substantial growth in workload being seen. By October 2002 over 70% of aneurysms were being treated by coiling.

### **6c Definition**

An Interventional Neuroradiologist is a Neuroradiologist who undertakes therapeutic procedures; currently these are largely endovascular in nature.

### **6d Equipment**

Many departments have had difficulty in obtaining funding for interventional equipment. Additionally it has been difficult to secure funding to upgrade angiographic equipment. Interventional Neuroradiology departments should ideally 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 ideal but not essential. Ready access to multi-slice CT with CT angiographic facilities and MRA is essential.

### **6e Training Posts**

The only designated interventional training posts are in Newcastle and Edinburgh. There is an MSc course offered by Oxford University but this does not have its own funding. It is essential that more designated training posts in interventional neuroradiology are established, otherwise it will be impossible to provide a full interventional service for ruptured intracranial aneurysms in this country.

## **6f Recommendations**

The recommendations which follow are based on discussions with the UK Neurointerventional Group (UKNG):

## **6g Staffing**

- (i) There should be at least two Neuroradiologists with appropriate experience in any centre performing neuro-interventional procedures.
- (ii) Neurosurgical and anaesthetic support should be available. In the light of the ISAT results, the working week may need to be restructured to cover the emergency interventional workload. This may require restructuring and flexibility of existing Consultant timetables in departments. To cover the extra workload, either more anaesthetic sessions need to be made available or anaesthetic sessions will need to be diverted from the neurosurgical theatre lists when an emergency embolisation procedure for aneurysm rupture needs to be carried out.
- (iii) New and existing Consultant posts with an interventional commitment should have at least two nominated procedural sessions per week with full anaesthetic support when elective cases can be booked and also emergency cases treated.
- (iv) One session included in a job plan for procedural work may require up to one additional session for pre-procedural counselling and post procedure follow up.
- (v) 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.
- (vi) In some geographical locations it may be possible for Neuroscience Centres to link together in order to provide a comprehensive acute interventional service.

## **6h Training**

- (i) In the UK an SpR will have gained four years of general radiology training before commencing Neuroradiology training. This training is either in Diagnostic Neuroradiology or Diagnostic and Interventional Neuroradiology. If training in both, a full additional year of training (Year 6) is necessary with extension of the CCST date by one year. It may be desirable that up to three months of that year should be at another centre, if the range of available interventional procedures is limited.

- (ii) Training in Interventional Neuroradiology should not be restricted to training in practical procedures; development of clinical judgement is equally important. The risks and benefits of each therapeutic procedure need to be appreciated. Training might include a clinical attachment.
- (iii) There is a need for additional training posts to be designated for neuro-intervention. This is based on the requirement for at least two consultants in each interventional centre to provide cover for an interventional service. A review process should be established to ensure flexibility in designation for such centres (see 6h v).
- (iv) The need for flexibility in matching new posts to local requirements is recognised but there is an immediate need nationally for additional training posts to establish a satisfactory service in Interventional Neuroradiology.
- (v) When additional training posts become available, the suitability of centres for training should be assessed by the Training Accreditation Committee of the RCR, with an appropriate individual on the visiting team, and recognition made on the basis of the quality of training available in addition to the number and range of procedures.

## **7. INTEGRATION WITH OTHER NEUROSCIENCES**

### **7a Trusts**

NHS Trusts have considerable freedom to arrange the organisation of their activities. Fragmentation of a Neuroscience service runs serious risks of losing the benefits of close day-to-day integration. Every effort must be made in planning services to recognise the essential benefits to patient care and professional development, of close geographic integration of the elements of a Neuroscience service.

### **7b Funding**

- (i) 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.
- (ii) The provision and use of costly diagnostic equipment and the staff to run it during an extended working day and on-call provides an argument for NHS Trusts to integrate Neuroradiology into general radiology. On the other hand, the increasing interdependence of Neurosurgery and Neuroradiology particularly in interventional procedures makes some justification for integration of Neuroradiology within a Neurosciences budget. The costs of Interventional Neuroradiology may be balanced not only against conventional Neurosurgical treatment but also against reduced patient morbidity and shorter hospital stays.
- (iii) 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.

### **7c Primary Healthcare Service Access to CT and MRI**

In certain circumstances it may be appropriate for GPs to have direct access to Neuroimaging, mainly CT and MRI. The Neuroradiology department needs to work with PCTs to develop Integrated Care Pathways to ensure ease of access to the appropriate investigation.

## **8. SUMMARY OF MAIN RECOMMENDATIONS**

### **8a Necessary facilities and services**

- (i) A Neuroradiology unit should have:-
  - Spiral Computed Tomography (CT) scanner, preferably multislice.
  - Magnetic Resonance Imaging (MRI) system with Echo Planar Imaging (EPI). Spectroscopy is desirable.
  - High resolution biplane digital angiographic equipment with a rotational 3D processing facility for diagnostic and therapeutic use.
  - An integrated diagnostic workstation for image manipulation is essential. Additional networking capabilities would be desirable.
- (ii) There must be adequate 24 hour access to the appropriate diagnostic modalities.
- (iii) Consideration should be given in future hospital design to the efficient integration of diagnostic, interventional and operating theatre services.
- (iv) The development of a Neuroradiology service to DGHs to support the Neurology service is to be encouraged where resources allow.

### **8b Staffing**

- (i) There should be a minimum of four WTE Consultant Neuroradiologists in post to offer a comprehensive Neuroradiology service for a population up to 1.5 million.
- (ii) Those departments with only two WTE Consultant Neuroradiologists should be expanded to three without further delay to allow expansion of Interventional Neuroradiology, appropriate expert cover for leave and to provide a sustainable on-call service.
- (iii) Trust Boards must be encouraged to adhere to the mechanism whereby the implications of appointment of Consultants who may have a significant impact on the Neuroradiology service are recognised. The number of Neuroradiology sessions should be increased appropriately.
- (iv) Provision of adequate numbers of anaesthetic staff, nursing staff, and ODA's is vital to the safe and effective running of an Interventional Neuroradiology service.
- (v) The current crisis in Radiographic staffing of many departments needs to be addressed by hospital management, as this may threaten the very viability of the service in the near future.

## **8c Training**

- (i) There should be an increase in the number of Specialist Registrar posts in Neuroradiology, with central co-ordination by the BSNR, to provide for future requirements in both Diagnostic and Interventional Neuroradiology.
- (ii) Centrally held funding for these posts would facilitate training opportunities.
- (iii) New training posts should be able to fulfil the curriculum requirements for training in Interventional Neuroradiology.
- (iv) The current shortage of Radiology Specialist Registrars wishing to enter Neuroradiology needs to be addressed, with encouragement from Medical School onwards. To this end an Education Advisor has been co-opted on to the BSNR Committee.

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# APPENDIX

## Survey of Neuroradiology Services

**A postal survey was sent to each of the 34 UK centres during the period late 2000/early 2001. Replies were received from 24 centres and the summary below is based on those.**

### A Staffing

	Range	Average
Consultants per centre	1-5	3.2
Neuroradiology sessions per centre	5-42	25.5 *
Neuroradiology sessions per million population	8-19	12.2
Interventional sessions per centre	0-8	3

\*includes flexible sessions

- Funded vacancies existed in 7 centres. (This had increased to 17 by October 2002)
- 18 Centres (75%) wished to create a new Consultant post. Only 5 of these had identified funding and 2 other posts were part funded.
- 63% of centres reported difficulty recruiting radiographers, and 57% difficulty recruiting nurses. This was usually due to a shortage of applicants rather than funding problems.

### B Clinical Demand

	Range	Average
Neurosurgeons per centre	3-10	5.5
Neurologists per centre	3-30	9.1
Other Clinicians making moderate/frequent use of a Department	4-71	

### C On-Call etc.

- 1:2 3 centre
- 1:3 8 centres
- 1:4 7 centres
- >1:4 6 centres

Although there is often participation of general SpRs, most Neuroradiologists are effectively 1st on call.

## D Resources

### CT

- 4 (17%) centres do not have spiral/multislice CT
- 7 (29%) centres do have perfusion/Xenon CT

### MRI

- 5 (21%) centres do not have significant access to 1.5T MRI
- 10 (42%) centres do have functional MRI
- 13 (54%) centres do have perfusion/diffusion MRI
- 10 (42%) centres do have spectroscopy

### Angiography

- 7 (29%) centres do have biplane angiography

### Equipment

- 13 (54%) centres considered that the quality of their equipment was inadequate
- 19 (79%) centres considered that the quantity of their equipment was inadequate

### Staffing

- 9 (38%) centres reported inadequate radiographic support
- 14 (58%) centres reported inadequate nursing support
- 14 (58%) centres reported inadequate secretarial support. Most Consultants only have access to one third WTE of secretarial time. In 3 centres secretarial provision is worse than this.
- 19 (79%) centres reported inadequate portering services

### Office Facilities

- In 5 (21%) centres Neuroradiologists do not have a personal office
- In 5 (21%) centres Neuroradiologists do not have a personal computer
- In 5 (21%) centres Neuroradiologists do not have access to the Internet
- In 5 (21%) centres Neuroradiologists do not have access to a workstation

## E Workload

	Range	Average
CT examinations per centre	2.9K - 8.5K	5,500
MRI examinations per centre	2.0K - 7.2K	4,700
Diagnostic angiograms per centre	120 - 800	350
GDC embolisations per centre	0 - 104	30
% of aneurysms treated by coiling	0 - 75%	35%

- CT examinations - 31% increase since 1995 survey.
- MRI examinations - 68% increase since 1995. During this period the number of practising Neuroradiologists in the country has increased from 96 to 106. (10.4% increase).
- % aneurysms treated by coiling - response from 17 centres.
- Direct GP access: 50% of centres. Generally for CT and MR, occasionally just CT.
- Nerve blocks or facet injections performed in 5 centres.
- Interpretation of teleradiology performed in 91% of centres. On average this service requires 1.25 hours per Consultant per week.
- Workload was considered: manageable (6 centres), excessive (15 centres), totally unmanageable (1 centre).

- Estimated routine working week:

Hours	Department Minimum (19 Depts).	Department Maximum (18 Depts).
<35	1	0
35-40	7	1
41-45	4	2
46-50	5	5
51-55	1	3
>55	1	7

## **F** **Waiting Lists**

	Range	Mean
CT Out Patients	2 - 52 weeks	11 weeks
MRI Out Patients	2m - 3 yrs	8.9 months
MRI In Patients	2 - 7 days	3.1 days

## **G** **Miscellaneous**

- (i) 52% of centres reported inadequate anaesthetic support, predominantly for paediatric cases.
- (ii) Individual centres identified a lack of academic time, a lack of interventional beds, and poor access to ITU beds, as specific problems.
- (iii) In 1996 "Effective Neuroradiology" stated that all departments with only 2 WTEs should be expanded to 3 without delay. In 2002 there were still 10 centres with only 1 or 2 Consultants.