

Clinical neurophysiology

i Description of the specialty and clinical needs of patients

Clinical neurophysiologists undertake a variety of recordings and measurements of the electrical activity of the central and peripheral nervous systems. This information can be used to aid the diagnosis and management of a wide range of neurological conditions in all age groups. Activity is usually divided into four areas:

Electroencephalopathy (EEG)

The electrical activity of the brain (the EEG) can be recorded using either scalp (surface) or, in special circumstances, intracranial electrodes. The majority of studies are undertaken on an outpatient basis using scalp electrodes. Recordings may last from a half to several hours, particularly if a period of sleep is included. The principal indication for EEG is in the investigation of epilepsy and other disorders of consciousness. Since it is rare for brief recordings to capture a clinical attack, these EEGs are usually referred to as interictal recordings. Interictal EEG is used to classify the type of epilepsy or seizure disorder and to provide evidence to support a diagnosis of epilepsy.

EEG activity now includes more specialist studies such as ambulatory EEG and video telemetry monitoring. These studies monitor EEG for several days in an attempt to capture a clinical attack and characterise the associated EEG. Some patients, particularly those being considered for surgical treatment of intractable epilepsy, may require intracranial electrodes (depth or sub-dural electrodes) as part of video telemetry EEG studies.

EEG is also used in the diagnosis and management of other conditions such as encephalitis, Creutzfeldt Jacob disease, coma, developmental and neurodegenerative disorders, including dementia. EEG studies may be undertaken during neurosurgical procedures to monitor cerebral activity, identify particular areas of cortical function and assist in the placement of deep-brain stimulators with intractable movement disorders.

Nerve conduction studies (NCS) and electromyography (EMG)

NCS recordings are made using electrical stimulation of the peripheral nerves. EMG activity measures the spontaneous and voluntary electrical activity produced in skeletal muscle. Many general medical disorders, as well as neurological disorders and trauma, can cause damage to the peripheral nervous system. EMG and NCS identify and characterise the site and nature of the pathological processes affecting the peripheral nervous system.

Evoked potential (EP) studies

These studies are used to monitor the response of the peripheral or, more commonly, central nervous system to a variety of sensory or cognitive stimuli.

Intraoperative monitoring (IOM)

Monitoring EPs, and in some cases EEG and NCS/EMG, can protect various neurological structures and systems during neurosurgery or orthopaedic surgery. Monitoring during functional neurosurgery for disorders such as Parkinson's disease and pain relief surgery can identify the correct neural structures for stimulation and lesioning.

ii Organisation of the service and patterns of referral

Clinical neurophysiology is largely a consultant-provided service. The majority of neurophysiological investigations are undertaken by consultant clinical neurophysiologists supported by trained neurophysiology technicians. In general, NCS/EMG and intraoperative monitoring (IOM) procedures are undertaken by medical staff. EEG and EP examinations are performed by technical staff and the results reviewed and reported on by consultant clinical staff. Some senior technical staff also perform NCS tests under consultant supervision. There are currently 31 specialist registrar (SpR) posts in the UK for the training of future consultant clinical neurophysiologists, but no junior staff at senior house officer (SHO) level.

Most consultant clinical neurophysiologists are based in neuroscience centres or larger district general hospitals (DGHs) with neurological services. Many consultants also cover local DGHs from their bases in the tertiary referral centres on a 'hub-and-spoke' model. A few consultants are based in larger DGHs with academic or teaching links to their local neuroscience centre. Clinical networks spanning strategic health authorities tend to be informal with some consultants taking the lead in highly specialised areas, usually as part of a multidisciplinary team (MDT).

Neurophysiological testing requires appropriate recording equipment, an appropriate environment and trained technical personnel. Therefore, neurophysiological services are usually only available in tertiary referral centres or larger DGHs.

The majority of investigations are carried out on an outpatient basis. However, some patients with severe neurological or medical/surgical conditions may require treatment and investigation as inpatients. Studies may be undertaken in intensive care units or special care baby units.

Special patterns of referral

Most patients are referred for investigation from other hospital consultants, principally neurologists, general physicians, rheumatologists, paediatricians and orthopaedic surgeons. Some neurophysiology departments provide access for GP referrals but this is usually limited to specific conditions or indications, except where GPs are specialists, for example in orthopaedics.

iii Working with patients: patient-centred care

A neurophysiological opinion usually forms only part of the management of a patient as the majority of referrals come from consultants in the frontline specialties. Where referrals are accepted directly from primary care the patient needs to receive understandable information from the neurophysiology service to aid appropriate consent and any subsequent discussion of the management of their problem. The British Society for Clinical Neurophysiology (BSCN) has produced national guidelines on consent for neurophysiological procedures.

iv Interspecialty and interdisciplinary liaison

Multidisciplinary working is the foundation of investigation using EEG and EP; the consultant is totally reliant on the skills of the technician performing these tests.

There must be regular meetings and reviews between users of neurophysiological services and the medical and technical staff who carry out the neurophysiological studies. In centres undertaking complex surgical treatment for patients with epilepsy this may involve MDT meetings between neurologists, neurosurgeons, neuroradiologists, neuropsychologists and neurophysiology staff. Similarly, departments undertaking NCS and EMG testing may require MDT meetings between neurologists, paediatricians, and muscle and nerve histopathologists. In smaller centres or DGHs, which do not require MDT meetings, there should still be regular audit and review of activity between the referring clinicians and the neurophysiology department

v Delivering a high quality service

Resources required for a high quality service

An adequate neurophysiology service requires appropriate accommodation, testing equipment, and technical and other support personnel.

Specialised facilities

Accommodation

- The modern neurophysiology department should be a self-contained unit with a patient reception, clinical investigation rooms and office space. Scattered rooms located on wards or corridors do not provide an adequate or safe environment for a quality neurophysiology service.
- Clinical rooms should be of sufficient size to accommodate the testing equipment, examination chairs or couches, patients, medical and technical personnel together with the patient's carers and/or relatives.
- There must be suitable access for disabled patients or inpatients transferred on ambulance trolleys or beds.
- The department should contain suitable, separate office space for consultant and technical staff and for secretarial and administrative support staff.
- Neurophysiology departments should be sited for ease of access for outpatients who form the bulk of the patient workload.
- Testing equipment should be located well away from heavy electrical switchgear, which might preclude satisfactory recording.
- Departments undertaking video telemetry monitoring should be within easy reach of the monitoring suite.

Equipment It is essential that all departments have sufficient neurophysiology equipment to undertake the required EEG/EP or EMG activity. Equipment must be tested regularly for safety and accuracy. Many departments have now converted to digital EEG recording with significant advantages for storage retrieval and transmission of data. This is particularly important for smaller departments where there may not be a consultant neurophysiologist present on every working day.

Workforce requirements

Medical staffing The consultant clinical neurophysiologist should not work in isolation. Larger departments may contain two or more consultant neurophysiologists. Smaller DGH units, which may support only a single consultant, should have close links with a nearby larger clinical neurophysiology department. Each department should be led by a consultant clinical neurophysiologist with support from a senior member of the technical staff. The number of technical staff required will depend upon the workload of the department. For reasons of continuity of patient care and safety no department should be staffed with less than two whole time equivalent (WTE) technicians. Larger departments will require three or more trained technical staff and should be able to support a programme of technician training.

As this is a specialty that supports regional neurological centres, calculations based on 250,000 population are less relevant. However, based on national needs, it is estimated that 0.75 WTE consultants per 250,000 population are required. This would mean an additional 106 WTE consultants across the UK, representing an increase of 153% over the next few years.

Technical staffing The provision of suitably trained and qualified technical staff is essential for the safe and efficient operation of a neurophysiology department. There is a national shortage of suitably trained technicians and the numbers of technicians entering basic grade training has fallen in recent years. Larger departments, especially those in regional neuroscience centres, must develop basic-grade training programmes and attract suitably qualified and motivated applicants to these training places. Larger departments should also provide continuing post-basic training, particularly in more advanced areas such as video telemetry and IOM.

Administrative and secretarial staffing Neurophysiology departments should be equipped with adequate IT to support an appointment and reporting system. The system should provide statistical information regarding activity and waiting lists. There should be adequate secretarial and administrative support for the consultant neurophysiologists and technical staff undertaking the various studies: one WTE secretary per seven consultant programmed activities (PAs) in direct clinical care. Departments should set standards for waiting times for investigation and processing times for generation of reports and dispatch. The department should provide a system for prioritising requests, usually divided into urgent, soon or routine. Further subdivision may be helpful, for example in carpal tunnel screening clinics.

vi Quality standards and measures of the quality of specialist services

Specialist society guidelines

Waiting time standards are outlined by the Association of British Clinical Neurophysiologists (ABCN). To provide a quality service for patients it is essential to set standards for waiting and reporting times. The following guidelines would provide an acceptable minimum standard of service for most departments:

- For routine investigations, waiting times should be less than four weeks for EEG and EP studies, and less than six weeks for NCS/EMG.
- More urgent cases should be seen within two days for EEG and one week for EMG.
- Urgent inpatient cases for both EEG and EMG should be seen within 24 hours.

CLINICAL WORK AND/OR LABORATORY WORK OF CONSULTANTS IN CLINICAL NEUROPHYSIOLOGY

Contributions made to acute medicine

Neurophysiologists are rarely directly involved in the delivery of care in general internal medicine (GIM).

Direct clinical care

Inpatient work

The volume of EEG, EMG and other investigations requested in support of acute medical care can be highly variable. In larger departments it may be possible to programme inpatient clinic slots for EEG and EMG with little wastage. Providing an inpatient service on sites away from the main base can be challenging and so may be limited to patients for whom transfer is not practical, for example critical care units and secure psychiatric facilities.

Outpatient work

The number of patients seen per EMG/NCS clinic will depend upon the complexity of the investigations required. Usually, between four and six patient appointments would be expected per four-hour PA of direct clinical care. This number should be reduced if the consultant is required to supervise concomitant carpal tunnel or peripheral nerve testing clinics undertaken by suitably trained technicians, or if supervising SpRs undertaking their own NCS/EMG clinic. The ABCN guideline is that least one hour of an NCS/EMG PA in direct clinical care should be for the generation of reports on patients seen in the clinic.

A consultant undertaking an EEG reporting session might be expected to report between 15 and 25 routine outpatient interictal EEGs per four-hour PA. This would include paediatric EEG studies and short-term sleep studies. The number of the EEGs reviewed per session should be adjusted downward if there is a significant teaching element for SpRs and technicians attending the reporting session.

The number of long-term ambulatory or video telemetry studies that could be reported in a session will depend on the degree of data analysis carried out by the recording technician. If there has been significant editing and data selection then four to six studies could be assessed per session. If the consultant does all the data analysis, only one or two studies could be assessed per session. It is good practice to involve the recording technicians in all consultant EEG reporting sessions.

Specialist investigative and therapeutic procedures

Larger departments in neuroscience centres are increasingly involved in IOM, which is highly labour intensive. The consultant may perform the studies, such as corticography or deep brain stimulation, or supervise technical staff in monitoring neurological structures, such as in scoliosis surgery.

Specialist on call

Few centres have enough staff to enable full consultant and technician on-call rotas for a reliable out-of-hours service for EEG – this being the test required most often. Various ad hoc arrangements tend to be in place.

Other specialist activity

Multidisciplinary team meetings must be fully recognised, formalised and auditable (the meeting must follow an agenda and the minutes be recorded etc).

Patient-related administration

This includes communication with and about patients with whom the consultant has had direct involvement or responsibility (phone calls, letters, emails, reading referrals). This would include consent issues, direct meetings and report writing. Work relating to complaints is part of the consultant's clinical governance responsibilities and so constitutes supporting professional activities (SPA).

Work to maintain and improve the quality of care

This work encompasses duties in clinical governance, professional self-regulation, continuing professional development (CPD) and education and training of others. For many consultants at various times in their careers it may include research, serving in management and providing specialist advice at local, regional and national levels.

This work falls within SPA and a consultant would devote 10 hours per week (2.5 PAs) to this on average. For many consultants the amount of time spent on research, serving in local management and leading in other activities such as audit will vary during their career. Other NHS responsibilities need to be agreed with the employer and included in the job plan.

ACADEMIC MEDICINE

The NHS workload of academic neurophysiologists depends on their academic responsibilities and individual job descriptions but, in general, academic neurophysiologists are a central component of a complex and technological discipline. Advances in the understanding of neurophysiological function of the nervous system are crucial to developing practice, and academic appointments make a strong contribution to the work of NHS departments.

In general, most academic neurophysiologists will need to devote at least two to four PA sessions to academic work rather than NHS service activity. Academic appointments should not include any significant sessional commitment outside the regional or academic centre. It is important that academic departments have sufficient technical and support staff, possibly including engineers and IT specialists to support clinical academic research.

CONSULTANT WORK PROGRAMME/SPECIMEN JOB PLAN

The range of activities in average mixed practice is reflected below. In some neurosciences centres a consultant may only work in one field viz. EEG, EMG or EP.

Travelling between multiple sites may have a significant impact on direct clinical care. This can be accommodated by reducing the length of the clinic/reporting session or taking the travelling time as extra direct clinical time in addition to the four-hour PA.

At least one hour in each four hour NCS/EMG clinic should be allowed for the generation of clinical reports.

EEGs are the main out-of-hours requirement, limited by the availability of technicians. Some neurosciences centres have a formal rota but most operate an ad hoc arrangement.

Activity	Workload (cases/patients)	Programmed activities (PAs)
Direct clinical care		
Routine outpatient EMG/NCS clinics	4–6	2–5
Inpatient EMG (department)	3–4	0–1
Inpatient EMG (portable multisite)	1–2	0–1
Reporting routine EEG and EPs/Technician NCS	15–25	1–3
Reporting (± performing) specialist tests, eg telemetry or visual electrophysiology	1–5	0–1
Intraoperative monitoring	1	0–2
Multidisciplinary clinics eg epilepsy or neuromuscular disease		0–2
Patient-related administration		0–1
Total number of direct clinical care PAs		7.5 on average
Supporting professional activities (SPA)		
Work to maintain and improve the quality of healthcare	Education and training, appraisal, departmental management and service development, audit and clinical governance, CPD and revalidation, research.	2.5 on average
Other NHS responsibilities		
	eg medical director/clinical director/lead consultant in specialty/clinical tutor	Local agreement with trust
External duties		
	eg work for deaneries/Royal Colleges/specialist societies/Department of Health or other government bodies etc	Local agreement with trust