
It was at the request of William Hammond (1828–1900), Surgeon-General of the United States Army, that, in 1863, Silas Weir Mitchell (1829–1914) and Dr George Morehouse (1829–1905) established a 400 bed hospital at Christian Street (moving later to Turner’s Lane) in Philadelphia to which was referred ‘a vast collection of wounds and contusions of nerves including all the rarest forms of nerve lesion of almost every great nerve in the human body’ suffered during the American Civil War. Writing in 1917, Jules Dejerine (1849–1917) introduced the medical public the work of his pupil Jules Tinel (1879–1952) and how surprised they were during the early months of the War, at the numerous cases of peripheral nerve wounds brought into our hospitals... we had... to connect each of the symptoms with the determining lesion... my pupils and myself have been enabled to set up the main syndromes of nerve interruption, of compression, irritation or regeneration, and the syndromes of dissociated or partial lesions’. And lest any reader doubted wherein lay the authority for Dr Tinel’s work, Professor Dejerine points out that ‘...written, so to speak, in my very presence, it is a faithful résumé of the investigations undertaken upon in my service by all my fellow-workers of the Charcot Clinic’. Of the 639 cases, 408 affect the arm (in descending order of frequency—musculo-spiral, median, combined lesions, brachial plexus, circumflex and musculo-cutaneous nerves) and 231 affect the leg (sciatic, external popliteal, anterior crural, short saphenous, lumbo-sacral plexus, musculo-cutaneous, anterior tibial, external cutaneous, ilio-inguinal and obturator nerves, respectively). Major Gordon Taylor [Sir Gordon Gordon-Taylor, KBE, CB, MD, FRCS (1878–1960), surgeon to the Middlesex Hospital, London] had with him a copy while serving with the British Expeditionary Force in France, where he saw action in the battles of the Somme and Passchendaele, and which he annotated extensively. This was subsequently subscribed ‘to C[harles] Ernst Lakin Esq, Physician, Neurologist, Pathologist and Friend’ (1878–1972) on 2 November 1922.

Tinel includes cleverly illuminated photographs of soldiers showing the posture, muscle wasting and weakness of their injured limbs. These are complemented by explanatory line drawings of the sensory loss and topographical anatomy of the affected peripheral nerves. Although disorders of peripheral nerve were often seen in civilian practice during the intervening years—Russell Brain (1895–1966) devotes 20 of 899, and Kinnier Wilson (1878–1937) 47 of 1838 pages to individual nerve lesions (of which one third deals with sciatica)—with the outbreak of War in 1939, medical practitioners again started to see many cases of peripheral nerve injury.

The Medical Research Council responded by forming a Nerve Injuries Committee to prepare an atlas providing Aids to the Investigation of Peripheral Nerve Injuries. This appeared in 1942 as MRC War Memorandum No. 7, published by His Majesty’s Stationery Office, price 2s 0d net (Fig. 1). Under the chairmanship of Brigadier G. Riddoch, MD, FRCP (1888–1947), the committee comprised Brigadier W. Rowley Bristow, MB, FRCS (1883–1947), G. L. Brown, MSc, MB (1903–1971), Brigadier H. W. B. Caims, DM, FRCS (1896–1952), E. A. Carmichael, CBE, MB, FRCP (1897–1978), Surgeon Captain M. Critchley, MD, FRCP RNR (1900–1997), J. G. Greenfield MD FRCP (1884–1958), Professor J. R. Learmonth ChM FRCS (1895–1967), Professor H. Platt, MD, FRCS (1886–1987), Professor H. J. Seddon, DM, FRCS (1903–1977), Air-Commodore C. P. Symonds, MD, FRCP (1890–1978), J. Z. Young, MA (1907–1997) and F. J. C. Herrald, MB, MRCP (n.d.) (Secretary). The atlas is designed to show doctors how to examine the limbs for peripheral nerve lesions. The illustrations—74 figures on 48 pages—depict normal anatomy. They combine photographic demonstrations of each muscle in action and, where appropriate, a guiding finger from the examiner pointing to a key tendon or muscle belly. Each group of illustrations is preceded by a diagram, free from redundant anatomical information, which shows the main nerve trunk and the muscles innervated by its various branches. All seven are drawn by Mr Clifford Shepley dated 1942 and adapted from Les nerfs en schémas anatomie et physiopathologie. Traité d’anatomie humaine (Pitres and Testut, 1925). Clifford Shepley (1908–1982) graduated in Fine Art, Drawing and Painting from the Edinburgh College of Art; he founded the Department of Medical Illustration, University of Edinburgh, in 1935 and remained as director until retirement in 1973 having introduced a 3-year medical illustration course for students in the mid-1950s. The model(s) used in the atlas are not selected for...
their muscularity (Figs 2 and 3). The organization is top-down: muscles of the shoulder innervated by nerves that do not arise from the brachial plexus; the plexus itself; and the five main nerves of the upper limb—circumflex, radial, musculo-cutaneous, median and ulnar. The leg follows the arm, first the nerves of its anterior and then the posterior aspect. The lumbar plexus is not illustrated. The atlas ends with charts of the approximate area within which sensory changes may be found in lesions of the brachial plexus, the peripheral nerves of the arm and leg and their spinal segments.
The three pages of text are concise. Muscles should be both looked at and felt. A muscle may contract as prime mover, fixator, synergist or antagonist. The ‘MRC grade’ suggested to record the state of each muscle has since featured in very many research publications and clinical trials:

- 0 = no contraction
- 1 = flicker or trace of contraction
- 2 = active movement, with gravity eliminated
- 3 = active movement, against gravity
- 4 = active movement, against gravity and resistance
- 5 = normal power

Hair should be removed before testing light touch and a fine wisp of cotton wool used, the area being depicted within a continuous line. A fine needle is used for pin-prick and the affected area, usually smaller than that in which touch is appreciated, is shown by a dotted line. Deep pressure is illustrated by cross-hatching. Cutaneous sensation is always mapped from the affected into the normal area. Loss of postural sense is described at each joint. The text, three sides only, ends with a list of muscles tested clinically or electrically when considering the integrity or otherwise of the main nerves of the arm and leg. As for the origins of the atlas, we learn only that it has been prepared by the staff of the Department of Surgery, University of Edinburgh.

A second edition appeared in 1943. Apart from the absence of G. L. Brown, the committee is unchanged. A note of realism is struck: ‘For the accurate determination of sensation’ becomes ‘for the determination of sensation’. Minor alterations to the text and captions, and the erroneous placing of the photographs on page 33 (tibialis anterior and extensor digitorum longus interchanged) from 1942, are corrected. The price is 2s 6d net (15p). After several re-printings, improvements are made in 1972 to Diagram IV, which shows the arrangement of the median nerve (Fig. 4). Hitherto, the anterior interosseus nerve has innervated part of pronator quadratus; now it also supplies the flexor digitorum profundus and flexor pollicis longus. Decimalization has arrived and Her Majesty’s Stationery Office now charges 20p (equivalent to 4s). But the winds of change are blowing and in 1976, War Memorandum No. 7 has become Memorandum No. 45. Blue paper covers are replaced with red. This, the third edition, now costs 80p (16s). A civilian revision committee met between 1972 and 1975 under the chairmanship (until October 1973) of Sir Herbert Seddon, CMG, DM, FRCS (1903–1977) and then Professor J. N. Walton, TD, MD, DSc, FRCP, with Professor R. W. Gilliatt, DM, FRCP (1922–1991), M. J. F. McArdle, MB, FRCP (1909–1989), Professor P. K. Thomas, DSc, MD, FRCP (1926–2008) and R. G. Willison, DM, FRCPE as members; Michael O’Brien, MD, FRCP joined the committee late in 1973. Reflecting the use of this atlas for students and practitioners beyond the war-time emphasis on nerve injuries, the title is changed to Aids to the Examination of the Peripheral Nervous System. Many alterations are made to the text and captions. Methods for examining certain muscles not previously mentioned are now included; and muscles rarely examined in clinical practice are omitted. Several diagrams are redrawn and the sensory dermatomes better illustrated. Photographs for the 1943 (and therefore 1942), and 1975 editions show Dr McArdle as the examining physician. All of the photographs are now replaced since the originals are no longer usable. These are prepared in London at the Guy’s Hospital and the Institutes of Orthopaedics and Neurology. Apart from Figure 5, which shows a patient, the models at Guy’s are two medical students. Michael O’Brien directs proceedings and positions the subject and examiner, Dr M. J. (Sean) McArdle, to ensure that each image is maximally

**Figure 2** (Dr M. J. McArdle) Rhomboids (nerve to rhomboids; C4, C5). The patient is trying to brace his shoulder backward against resistance. The muscle bellies can be felt and sometimes seen (1942 edition).

**Figure 3** (Dr M. J. McArdle) Rhomboids (dorsal scapular nerve; C4, C5). The patient is pressing the palm of his hand backwards against the examiner’s hand. Arrow: the muscle bellies can be felt and sometimes seen (1976 edition).
informative. Those photographs taken at Queen Square are identified in the subsequent edition (2000). The examiners are Roger Gilliatt or Robin Willison. The model is unknown. Professor Jack Joseph (1913–1998), not a member of the committee, edits and constructively criticizes the text. Recognizing that the Medical Research Council scale lacks sensitivity in the context of slight degrees of weakness, Grades 4−, 4 and 4+ are introduced for movement against slight, moderate and strong resistance,
respectively. When testing sensation, the subject is first asked to demonstrate the boundaries of the affected area. Moving from the impaired to the normal zone is still preferred, but the reverse direction recommended in cases of hyperaesthesia. Two-point discrimination is tested on the fingers. The 52 motor plates are now 66; and the 21 sensory diagrams expanded to 33. Shepley’s 1942 black and white diagram of the brachial plexus is replaced by a three colour cartoon showing the arrangements and location of the roots, trunks, divisions, cords and five main nerves emerging from the plexus (Fig. 5). This is drawn by Patricia Archer from the Department of Medical Illustration at Guy’s Hospital Medical School, later chairman of the Medical Artists Association. But Dr Archer did not produce the intended image of the lumbo-sacral plexus on time and page 31 is therefore blank; as is page 55, so as to allow printing of dermatomes for the trunk and upper limb on facing pages.

In 1984, the Medical Research Council decided that their affiliation with *Aids to Examination of the Peripheral Nervous System* was no longer appropriate. At about the same time, the government decreed that its documents need no longer be published by Her Majesty’s Stationery Office, which gave the committee the option of transferring publication to a commercial firm. The proposal that the committee might divide future spoils amongst its members did not find favour. At the suggestion of the chairman, John Walton, responsibility for publication passed to the Guarantors of *Brain* for whom the fourth edition was produced in 1986 by Baillière-Tindall, already a subsidiary of W.B. Saunders. The hope was that the publisher would produce foreign language editions and so increase global exposure; in the event, those that materialized were in Japanese (1976), Spanish (1976) and French (2009). The editorial committee from 1975 acted for the Guarantors with the addition of Michael Hutchinson, MB, BDS, who checked the text and diagrams for anatomical accuracy. The preface reveals further details of the pamphlet’s history. This is based on Dr McArdle’s recollection of events from the 1940s as told to Michael O’Brien. Realizing the need to deal with peripheral nerve injuries and working with Sir James Learmonth (professor of surgery at the University of Edinburgh), Dr George Riddoch had, in 1940, established peripheral nerve injury centres at Gogarburn near Edinburgh and at Killearn, near Glasgow, the two neurosurgical centres in Scotland at the time. The first photographs were taken with the assistance of Dr (William) Ritchie Russell (1903–1980) in 1941. There was an initial printing of around 20 copies, distributed in Scotland as a loose-leaf illustrated guide for surgeons working in district hospitals. On Ritchie Russell’s return to Oxford, Dr McArdle was appointed Neurologist to Scottish Command and he completed the atlas in association with staff from the Department of Medical Illustration in Edinburgh.

The 1986 edition has 90 illustrations, as in 1976, but with alterations; 16 are those from the Institute of Neurology and 54 are taken at Guy’s Hospital Medical School. Patricia Archer is
identified as the artist for diagrams of the brachial and lumbar plexuses. These images were exhibited at the Science Museum and subsequently reproduced in editions of Gray’s Anatomy. Most of the remaining drawings are adapted by Dr Archer from Shepley’s original diagrams, and from Head and Sherren (Brain 1905: 28; 116–338) and the MRC Special Report No. 54, 1920. The patient shown in Figure 5 is replaced by a healthy model. Figure 70 (from 1976) showing sensory loss expected in lesions of the lateral cutaneous nerve of the forearm is omitted, as is Figure 78 (from 1976) indicating sensory loss with combined lesions of the median and ulnar nerves. An additional figure (79) is included in 1986 representing loss of sensation with lesions of the femoral nerve.

A so-called fourth edition (in fact the fifth, the 1942 edition having been over-looked) was produced on behalf of the Guarantors of Brain by Michael O’Brien and published in 2000. Each illustration is new and in colour. A physiotherapist from New Zealand is the model for muscle actions; and a female physiotherapist of his acquaintance proved to have the ideal physique for showing the sensory charts. Dr McArdle had always opposed inclusion of sensory charts with the diagrams and photographs showing the innervation and action of muscles, and he drew eccentric boundaries for some dermatomes (see, for example, T2 and T3 from 1976; Figure 88, page 57). He would not allow the axial lines that Michael O’Brien favoured (see 1986 edition, Figures 87 and 88, pages 56–7). These features were not changed until 2000. The examiner (with tightly buttoned cuff, white coat, neatly pared nails and signet ring) is now Michael O’Brien. Ralph Hutchings is responsible for the photography, the images being taken in his home studio with a video recorder strapped to the camera and linked to a television screen, so as to ensure that the angles and shadows are right for each shot. Paul Richardson redrew the diagrams, which now include the main sensory branches; and Michael Hutchinson, also from the 1984 committee, provides advice on the neuro-anatomy. Sarah Keer-Keer from Harcourt Publishers is acknowledged for considerable help and general encouragement with the project. The text is unaltered. But the pragmatic and economic approach to examination taught by Dr McArdle is encapsulated by Michael O’Brien in a new table of commonly tested movements listing the upper motor neuron contribution, nerve root, peripheral nerve and muscle effecting core functions of the arm and leg.

Figure 6 Front and back covers of Aids to the Examination of the Peripheral Nervous System (2010 edition).
Now, in 2010, Saunders Elsevier has published a fifth (i.e. sixth) edition on behalf of the Guarantors of Brain (Fig. 6), also prepared by Michael O’Brien. The introduction is revised to include a scheme for motor examination that reflects the teachings of Sir Gordon Holmes (1876–1965) and the methods imbibed by generations of trainees at Queen Square (and elsewhere). Movements are chosen to distinguish upper from lower motor neuron lesions; to separate the individual nerve roots and peripheral nerves; and to localize where in the course of an individual nerve the injury has occurred. As before, the illustrations show the position in which each muscle is best tested to reveal normal strength (Fig. 7), and with elimination where possible of agonist and antagonist actions needed to maintain posture. The principles of sensory testing are rehearsed with emphasis on the variable distribution of the radial nerve and lateral cutaneous nerve of the thigh. The dermatomal distributions represent a compromise given the extensive and variable overlap. Three new diagrams are added to show the sensory distribution of the trigeminal nerve and its branches. Minor alterations, by Richard Tibbetts, are made to a few other figures.

Apart from Michael O’Brien (editor from 1999 and member of the Medical Research Council and Guarantors of Brain committees since 1972), Aids to the Examination of the Peripheral Nervous System and its predecessor Aids to the Investigation of Peripheral Nerve Injuries have largely been the work of one person, Sean McArdle. He was much influenced by Riddoch, Symonds and Holmes. In an account of McArdle’s life and work (Munk’s Roll, volume IX, pp. 326–7) Christopher Earl, a friend and colleague at The National Hospital, Queen Square, acknowledges McArdle’s insistence that the symptoms of nocturnal acroparasthesia result from compression of the median nerve at the wrist. McArdle presented his ideas at a meeting of the Association of British Neurologists (in 1947). These were greeted with some cynicism by Sir Francis Walshe (1885–1973), but supported by Lord Brain. McArdle emphasized that sensory symptoms (but not signs) could occur outside the median nerve distribution and pain might occur in the forearm. Walshe argued that these features must indicate a more proximal lesion, which he ascribed to traction on the brachial plexus. Dr Earl speculates on the extent to which McArdle contributed more to the alleviation of pain and suffering in his 40 years of elegant clinical reasoning than some of the more spectacular medical advances of our time (Munk’s Roll, volume IX, pp. 326–7). ‘He was at his best with the difficult problem – and the more difficult the patient… the more he relished the challenge… ‘his ability [was] to elicit and assess details of the physical examination in a way that could be relied upon absolutely’. Towards the end of his consultant career, residents became wary of assisting at Friday evening sessions in the operating theatre at Queen Square when McArdle, increasingly troubled by postural tremor, continued to inject the Gasserian ganglion with alcohol for the treatment of trigeminal neuralgia. He spoke on those occasions of Wilfrid Harris (1869–1960) who had introduced the technique. Harris wrote a monograph on the comparative anatomy of the brachial plexus (The morphology of the brachial plexus with a note on the pectoral muscle and its tendon twist, 1929); McArdle acquired this and a copy of Harris’s Neuritis and neuralgia (1926), in which many diagrams that anticipate exactly the illustrations of muscle and nerve activities contained in the 1942 edition of Aids to the Investigation of Peripheral Nerve Injuries are to be found, in 1936. McArdle wrote practically no papers during his career. The memory of this quixotic and quintessentially clinical neurologist survives through the oral tradition—and his arms and hands appearing as ghostly images out of the darkness in issues of Aids to the Investigation of Peripheral Nerve Injuries from 1942 until those illustrations were replaced with Michael O’Brien as examiner in 2000.

Despite inflation in the cost from 1942 by 18 000%, no neurologist in 2010 can afford to be without Aids to the Investigation of the Peripheral Nervous System; and no neurologist should be shy about reaching for a well-thumbed copy when seeing patients. The Guarantors of Brain are grateful to Michael O’Brien for nurturing, over a period of 37 years, this classic monograph that encapsulates in pictures and a few words a very considerable amount of neurology gathered on the battlefields of Gettysburg and Flanders, and the beaches of Normandy, and rehearsed daily in civilian clinics from Aachen to Zywiec.

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Figure 7 Top: Flexor digitorum superficialis (median nerve; C7, C8, T1). The patient is flexing the finger at the proximal interphalangeal joint against resistance with the proximal phalanx fixed. This test does not eliminate the possibility of flexion at the proximal interphalangeal joint being produced by flexor digitorum profundus (anterior interosseus nerve; C6, C8). The patient is flexing the distal phalanx of the thumb against resistance, while the proximal phalanx is fixed (2010 edition).