Wheelchairs and Special Seating for Neurological Conditions

Since 1932 when Everest and Jennings built the first lightweight folding wheelchair (US patent no. 2095411), there has been a huge increase in the options available for wheelchair users. The range of existing wheelchair designs, features and accessories can be bewildering to patients and clinicians. The aim of this article is to detail the general types of wheelchairs available in the UK and a number of their important features. We believe that this will be useful to any clinician interested in maximising independence for a disabled patient, or perhaps dealing with clinical problems related to wheelchair or special seating use.

Manual wheelchairs

A self-propelled manual wheelchair can allow great flexibility to a wheelchair user with sufficient upper body stability and arm dexterity and strength (Figure 1). They are generally lighter, less bulky and more manoeuvrable than a powered chair. They are not limited by the need for recharging and with quick release wheels and swingaway footrests they can be transported in a car, train or aeroplane. They are also cheaper to buy and maintain than a powered chair. However self-propelling in a manual chair requires significant energy[1] and upper body strength and can be a cause of shoulder pain and injury. Only a small proportion of wheelchair users can self propel outdoors, where even small changes of incline, camber and surface, imperceptible to pedestrians, may obstruct people in manual chairs.

A manual wheelchair can be rigid or folding; the folding version obviously taking up less space in the home or vehicle when it is not being used. A folding chair is also more flexible and may be more stable over rough terrain, but flexibility increases the amount of energy required for propulsion. The simpler design of a rigid chair allows it to be lighter and stronger, which may offer the user more energy efficiency and allow the user to participate in sports activities (Figure 2).

For the user of a self-propelling wheelchair to push comfortably and efficiently, the chair must have the correct seat height and wheel diameter (Figure 3). For example, starting a push with the elbows extended will lose power and efficiency of propulsion, or if the user has to start a push with raised shoulders and flexed elbows, this is also inefficient and may unnecessarily strain muscles. The minimum seat height is that which allows the feet to sit comfortably on the footrests, when the footrests are positioned clear of the ground, castors and door thresholds. The seat angle can be customised on a rigid chair according to the user's preference – a seat angled backwards will bring the user's arms closer to the wheel rims. Once the seat position is correct, then wheel diameter should be chosen to allow the user to push in a comfortable manner.

Another customisable feature of a manual chair is the placement and angle of the wheels. The wheel axle constitutes the point of pivot of the chair which supports the user's weight and this can be moved forward or backward in relation to the seat in most modern chairs. If this is moved forwards, the centre of balance of the chair moves behind the axle and the chair will tip backwards more easily, lifting the front castors off the ground. This may be advantageous to an experienced user negotiating a step or kerb, but even a less experienced user should be able to tip the wheelchair back a little to negotiate rougher terrain, and it makes it easier to turn from side to side. Cambered wheels give greater lateral stability and may help a sportsperson to turn quickly or lean out of the chair, but for the casual user, they may present difficulty in getting through doors due to the increased width of the chair.

The handrims of a manual chair should also be of a suitable diameter[2] – a wider rim allows easier pushing but less speed. They should be easy to hold – grips can be added if a user lacks grasp strength – but should be smooth enough not to injure the hands on braking. Rims wear more quickly than other parts of a chair as they often strike doorways and are under constant friction and it is important that they are maintained to prevent hand injury. Many users also wear fingerless gloves to avoid friction burns. It is important also to ensure that the chair's user can work the handbrakes to allow safe transfers.

Powered wheelchairs

A powered wheelchair may be more suited to a person with significant trunk and upper limb impairments (Figure 4). For easily fatigued patients, powered mobility can help to preserve energy for other activities. A powered wheelchair also leaves a hand free to carry or perform other tasks; however they are limited by battery life and need more maintenance than a manual wheelchair.

There are many options available to the powered wheelchair user. For instance, front wheel drive will provide a better turning circle and may be better when moving onto an uneven surface. Rear wheel drive may feel more stable, but may cause the wheelchair to tip if going steeply uphill. Centre drive, 6 wheel, chairs combine many of the benefits of both. Larger wheels may make it easier to travel over rougher terrain, although may increase the wheelchair's width, and will carry more mud into the house.

Most powered wheelchairs are controlled by a joystick which should be within easy reach of the user's least impaired hand without compromising posture. For people unable to manage hand controls, the wheelchair may be driven using chin, head or breath controls. An ataxic user may prefer less sensitive controls, which may not register some unintended movements. The controls take time

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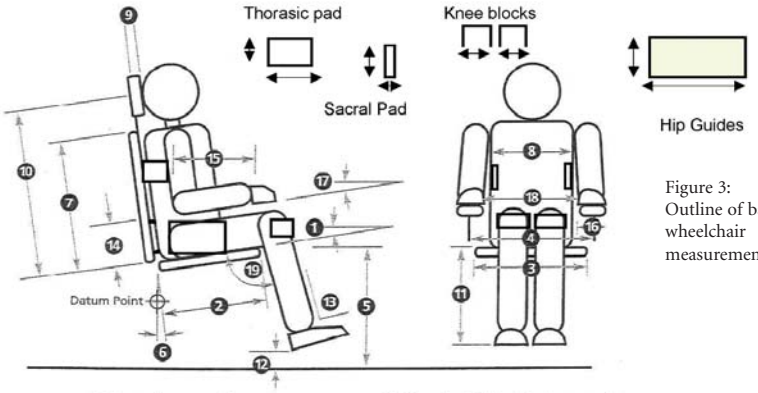
Figure 1: Basic manual folding wheelchair.

Figure 2: Rigid manual wheelchair suitable for sports.



1 Seat plane angle
2 Effective seat depth
3 Seat width
4 Effective seat width
5 Seat surface height at front end
6 Backrest angle
7 Backrest height
8 Backrest width
9 Headrest in front of backrest
10 Headrest height above seat
11 Footrest to seat
12 Footrest clearance
13 Footrest to leg angle
14 Armrest height
15 Armrest length
16 Armrest width
17 Armrest angle
18 Distance between armrests
19 Leg to seat surface angle

Figure 3: Outline of basic wheelchair measurements.

Figure 4: Powered wheelchair with joystick for right-hand control.

Figure 6: Individually moulded seat insert ready to fit onto wheelchair chassis.

Figure 5: Adjustable modular seating system.

Figure 7: Gyroscopically-controlled standing wheelchair.

and practice for a user to perfect and should be reviewed in conjunction with a knowledgeable wheelchair engineer.

Cushions

The purpose of a cushion is to allow the wheelchair user to travel in comfort and safety, with good pressure distribution and postural support.[3] It is vital that the cushion does not allow pressure areas to develop, especially if the user has muscle atrophy, sensory loss or tends to slide on the cushion. A good cushion should support spinal alignment, and if a spinal deformity is present, should prevent worsening of the deformity. The size of the cushion will influence other factors including seat height and footrest position.

There are four main types of cushion. Foam cushions can adapt their shape to spread pressure across the surface and can be layered to provide different degrees of softness and memory in different places. Foam cushions are relatively cheap and easily modified, but tend to wear quickly and need to be replaced frequently to prevent pressure on the skin.

Gel cushions spread and mould to pressure placed upon them and therefore provide excellent pressure distribution. It is also possible to provide moulded gel inserts, for example to keep adducted knees apart. They are however much heavier than foam cushions and less able to absorb impact as they are already moulded to the user's shape.

An air cushion sits the user on rows of connected rubber balloons. Air is distributed between neighbouring balloons and pressure is evenly balanced. They are therefore superior to gel and foam cushions at relieving pressure.[4] They are better at absorbing impacts but are very dependant on the user or carer to ensure they are correctly inflated. Some air cushions may even allow the user to inflate different areas of the cushion to different pressures which may be useful when managing a pressure sore. They are fairly robust but can leak or puncture and require frequent maintenance to be effective.

Urethane honeycomb cushions consist of a network of cells which together absorb and distribute pressure. The easy airflow keeps skin cool and dry which can protect against skin breakdown. They are light and good at absorbing impacts and are machine washable but as they are a more recent product, there is less experience of their use. The cover material has a great impact on the pressure relieving properties of a cushion: if it does not stretch in both directions, the potential benefits of more sophisticated cushions will be lost.

Seats and backs

Whether used in a manual or powered wheelchair, the seat should be of the correct dimensions and configuration to improve posture, minimise pressure areas and maximise function. There is evidence that good posture improves cardiopulmonary function, respiratory function, upper limb function and mental performance.[5] It is possible that adaptive seating may help to reduce scoliosis for the duration of use[6] although evidence for this is scanty.

The seat width should be wide enough to allow seating without pressure points even in a heavy coat, but also as narrow as possible to maximise manoeuvrability and to prevent slumping to one side. The base of the seat should accommodate the correct cushion and not impede its function. An inadequately deep seat base (see Figure 3) may decrease trunk stability and worsen posture. A very deep seat will catch behind the user's knees rotating the pelvis into sacral sitting which may risk spinal deformity and pressure damage to the popliteal fossae. Tipping the base of the seat backwards may aid sitting into the chair which makes the user feel more stable. However, posterior tilt may increase shear forces on the sacral area and hinder safe transfers.

It is important that the wheelchair has the correct back support, particularly for a user with less strength and trunk stability. A back can have a number of adjustable pads to provide support where required (Figure 5) or individually tailored, moulded back supports can be fabricated to the user's shape which can wrap around laterally (Figure 6). A hip (not waist) or chest belt may help a user who tends to slide to stay in position, although care must be taken if the person would not be able to extricate themselves if they slip into a dangerous position or if they have seizures and

there is a risk of asphyxiation or injury.[7]

The back should be high enough to provide support if necessary, but some users find a high back restricts their ability to rotate freely in the chair and to socialise. Reclining the back increases support and may aid positioning but may encourage sliding and make it difficult for the user to reach or lean forward to propel themselves up an incline.[8]

Tilt and recline

Tilt and recline systems are a useful option for people with very limited trunk stability and strength or who have spinal deformities or muscle contracture and need a mechanism to shift their weight to ease pressure. With a tilt-in-space system (chassis of wheelchair in Figure 5), the back, seat and footplates tilt backwards as one unit, maintaining the angle between seat and backrest. This may be useful for someone with significant lower limb spasticity who is unable to straighten their legs in a recline system. A recline system simply moves the backrest, and usually elevates the footplates to allow the user to rest in a recumbent position. Recline facilities may provide a greater degree of pressure redistribution than tilt systems although the user will tend to slump when returning to the upright position if they are unable to reposition themselves, suffering significant shear forces.[9] Tilt systems may be more efficient to self propel.[10] Both systems decrease the pressure running vertically through the spine and decrease pressure on the sacrum and ischial tuberosities, transferring it along the backrest.[11] It is important that these systems incorporate good back and head support when tilting or reclining and most users who need this facility need lateral back support, perhaps with a contoured back cushion. In powered chairs, tilt and recline functions may be operated by the user, from a multifunction joystick control.

Other features

There are many other customisable options when a user chooses a wheelchair, including swingaway footrests, angled footrests, position and type of brakes, suspension systems, anti-tipping devices, armrests, clothing guards and a range of accessories including cup holders, storage for clothes, shopping or walking aids, trays and weather shields. A wheelchair may become an important part of the user's image and it is important that it gives the desired impression. Some users may want a chair that facilitates eye level communication to aid conversation and participation, emphasising ability rather than their disability (Figure 7). Other users may want to emphasise certain features of the wheelchair as an aesthetic statement and certain features may be crucial to one person and unimportant to another. Many users will require more than one wheelchair for different situations, for instance, an attendant propelled wheelchair as a backup for when a powered chair is impractical or undergoing maintenance. It is therefore vital that the person who will be using the wheelchair is as informed and involved as possible in any decision making associated with obtaining or modifying it in order that their function and participation are maximally enabled.

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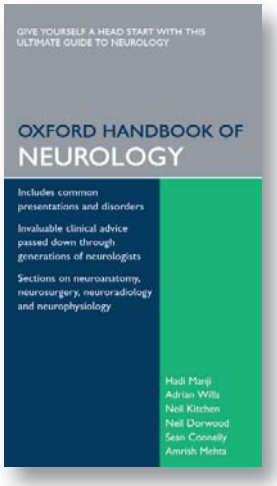
Oxford Handbook of Neurology



White coat pockets were once a target for publishers, but in an era of e-medicine and naked-below-the-elbow dress codes is there still a need for these cute tomes, or anywhere to put them? After using and scrutinising this book we think it has a great future; it does exactly what it says on the tin and with minor tweaking it could easily become the book we all use to inform and record registrar training.

The book has seven sections entitled Neurological history and examination, Neuroanatomy, Common clinical presentations, Neurological disorders, Neurosurgery, Clinical neurophysiology and Neuroradiology; an ambitious coverage but one reflecting the range of authorial interests. The text is not referenced, which diminishes its authority in areas with a strong evidence base, but it reads well.

We began by consulting it regularly regarding cases we had seen. The sections on acute myasthenia and acoustic neuroma with communicating hydrocephalus were thorough but concise and the details about actually how to do a tensilon test were useful. MND was covered comprehensively with notes on clinical features, investigation and management. The section on bedside cognitive testing section included both the Mini-Mental State Examination and the Camels in Holland version. In general clinics the tables containing the starting doses and common side effects of drugs for epilepsy, migraine, trigeminal neuralgia and spasticity were handy and the tables about seizures and syncope, short-lasting unilateral headache, and the paraneoplastic conditions and their antibodies were informative and easy on the eye. Neurosarcoid gets a (brief) mention, head injury gets ten CT images and as a primer in neurosurgery and neurophysiology it is worth having around.

Reading it cover to cover gave us some different insights. With time we became unsure whether it was a pragmatic guide to dumpety-dump clinical neurology, or a minified unreferenced version of an authoritative text. Coverage seemed uneven at times. Early on there are 20 pages of very familiar anatomical illustrations but with no insights into the diagnostic thinking required to spot the common mononeuropathies, the posterior cord plexus lesion, or the infarcted lateral medulla. Despite the importance of the consultation it gets only one page. Ten different patterns of chronic neuropathies are described but bulbar and respiratory failure in neurological disease are not discussed or indexed. There is a refreshing emphasis on inherited disorders but the degree of detail seemed disproportionate at times although we now long to make the diagnosis of Gelsolin familial amyloid neuropathy (Finnish) so we can tell our colleagues it is the stuff of handbooks, not obscure journals.

However the choice of section headings and their contents works well with minimal duplication and omission; the differential diagnosis of acute vertigo on page p58 excludes BPPV, although it is discussed in depth on p 254. The appendices were useful. Kurtzke, Barthel, Hoehn & Yahr, and Rankin make up the first. Clinical pearls follows; a nice idea but we were left wanting more. Then the eponyms appendix, which helped with Duane's, disappointed with Lewis Sumner, but put us straight about Villaret, Monakow, and Foix-Alajouanine. Some useful website addresses make up the fourth appendix.

So we recommend it to you. With some tick boxes and more room to record patient details it could become a neurological trainee's tacnometer, a combined logbook and pocket reference which no SpR will be allowed not to mention at their RITA, and its future will be deservedly ensured.

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