

It will mean that there will be little refinement and it must be designed to meet the fundamental requirements of a transit user, that is to take him from home to his transport and to be such that it can easily be carried with him.

Weight saving may be achieved by the use of alternative materials for the framework. Currently, mild steel solid drawn tubing is favoured. It has the advantage of ease of manipulation and, what is perhaps not readily appreciated, it lends itself to fabrication locally when adaptations are required to meet the needs of special cases after the wheelchair has been manufactured. In contrast, high tensile aluminium alloys are not suitable for this kind of treatment. If aluminium is to be a serious contender in this field, different techniques will need exploiting. It may be worth examining the possibility of diecasting the framework in a few major components but such tooling costs are high and can only be economical when large quantities are produced. The use of plastics and perhaps glass fibre reinforced plastic materials should not be overlooked.

5. CONCLUSIONS

The wheelchair has developed through evolution. In the Ministry we have always been conscious of changing demands and have attempted to anticipate them. Sometimes we have been caught out because there are occasionally fashion changes which, unfortunately, do not seem to be dictated by the physical requirements of invalids. I have attempted in this paper to outline some of the factors which require consideration to enable a satisfactory wheelchair to be evolved which lends itself to bulk production methods and will meet the needs of the majority of invalids. I think there is still a long way to go. It is perhaps in the direction of new materials and techniques that the major advances will be made.

WHEELCHAIRS FOR PARAPLEGICS

By J. J. WALSH, M.D.

*Deputy Director, National Spinal Injuries Centre,
Stoke Mandeville Hospital, Aylesbury, Bucks*

AN affliction of the spinal cord, whether due to injury or disease, can give rise to the disability known as paraplegia. If the lesion is in the upper part of the cord, that is in the neck, then the upper limbs are also affected and these patients are called tetraplegics or quadriplegics. When the cord lesion is complete, the disabled person not only has paralysis of all skeletal muscles supplied from the cord below the level of the lesion but has also lost all sensory appreciation over a corresponding area. Moreover, he has lost control of bladder and bowels. After the first few weeks following onset, the paralysis may be flaccid or spastic, and the degree of spasticity varies from patient to patient. As a general rule, the lower lesions (below the 11th or 12th thoracic segment) are flaccid and lesions above this level spastic. The sensory loss results in a tendency to develop pressure sores if insensitive areas are subjected to prolonged pressure and also impairment of the patient's balance.

Some patients with incomplete cord lesions and very low lesions do not

require wheelchairs but, apart from these cases, the paraplegic patient must rely a great deal on his or her wheelchair in achieving independence, as the normal person relies on his legs.

The exact number of paraplegics in Britain requiring wheelchairs and particularly the number of people who develop paraplegia each year is not available as far as I know. Such a figure would be of value.

Purpose of the Chair. The paraplegic requires his wheelchair to accommodate him comfortably and safely (particularly with regard to pressure effect) for the greater part of the day; to permit him to move about both indoors and outdoors easily, safely and independently, and in most cases to allow him to carry out the duties of his employment, including independent travelling to and from his place of work by means of his motorised vehicle.

Successfully achieving these aims involves a number of problems pertaining to the material and measurement of the chair, its weight, strength and mobility and also its appearance. The last point is one which is not always taken into consideration but the psychological value of an aesthetically pleasing appearance in a wheelchair is one widely appreciated as an important factor in social and indeed in industrial reintegration.

REQUIREMENTS

The chair should be capable of being propelled easily and safely by the occupant. This may sound a rather superfluous statement, but it is not so very long since my recommendation for an Everest and Jennings chair for a tetraplegic evoked the suggestion that a push chair with four small castor wheels would be quite satisfactory. The official concerned obviously did not know that even tetraplegics with complete lesions below the sixth cervical segment can propel their own wheelchairs.

In my experience the most suitable diameter for the large (driving) wheel is 24 inches. This size obviates the need for too many arm movements and yet is not inconveniently large. The question of whether the tyres should be solid or pneumatic depends on the kind of surface on which the chair will be used. If it is for use only on smooth floors, then a solid tyre is satisfactory and of course does not develop punctures. However, in most cases the chair will be used both indoors and out, on hard surfaces and soft and therefore, as a general rule pneumatic tyres are more suitable. They have the additional advantage of reducing vibration and, therefore, giving a more comfortable ride on hard rough surfaces, and also the rough tread of the tyre gives better purchase to the tetraplegic patient who cannot grip the rim and may rely on the pressure of his gloved palm against the tyre to propel the chair. Some tetraplegics are happy to use the capstan type of rim to ensure adequate purchase for their paralysed hands, but I have found that a large number dislike this adaptation.

With regard to the orthodox rim used by paraplegics to propel the chair, a wooden one is the most unsatisfactory because of the danger of splinters caused by the rim striking a doorway or wall. I think the argument which has been used against metal rims on the ground of their being too cold is not very important, and provided the chromium plating is of high standard, metal rims are satisfactory, but a covering of really durable plastic would be an added luxury.

There still exists some disagreement about the best position of the large wheel—in front or at the back. I think that, as a general rule, paraplegics are better off with the large wheel at the back. On medical grounds this is preferable for cases due to fractured spines at least for the first 6-12 months as it obviates the necessity for marked flexion of the spine when propelling the chair. Also in the case of tetraplegics who rely largely on the biceps to turn the wheel and whose triceps are paralysed it gives a marked mechanical advantage to have the large wheels at the back. Furthermore, moving sideways from chair to bed or car is easier and safer with the large wheels at the back. The main disadvantage of this design is that it is more difficult to negotiate loose rugs or narrow depressions such as surface drains on concrete and also to mount a kerb or steep ramp. Provided, the castor wheels are large enough, and they should be 8 inches in diameter, the first two hazards cause little trouble. With regard to a kerb, many paraplegics soon learn to jump the castors on to the kerb by momentarily tilting the chair backwards. Alternatively they can mount the kerb backwards, but this method is sometimes unsatisfactory because the castors get locked sideways or against the kerb. With regard to the question of steep ramp, the paraplegic soon learns to adjust his centre of gravity during ascent by leaning forwards, but there are some chair models in which the placing of the large wheel bearings half an inch or so further back would greatly increase the safety though at the expense of a slight increase in overall length. It would, of course, be very useful if the chair design allowed easy change-over of the backrest so that the chair could be used with large wheels either at the back or front as in the Jack Cross chair.

One further point in this connection is that it is an advantage to have handles projecting backwards from the chair back, not just for the convenience of someone pushing the disabled person's chair but as a safety measure in the event of the chair tipping back. The presence of the handles together with the occupant's reflex flexion of his trunk make serious injury to the head or neck most unlikely. However, it would be an advantage, especially for children's chairs, if two reclining bars were incorporated in the design (as in a chair produced by the American Wheel-Chair) which prevents the chair tipping backwards beyond a certain angle.

I have always believed that the modern wheelchair, usually made of tubular metal is an example of precision engineering, but it is surprising how often one of the main-wheel bearings is proved to be out of true on delivery. Usually the defect can be corrected by a few adjustments, but I would make a plea for a more careful inspection of each chair. It can be very disappointing for a disabled person who may well have waited several weeks for delivery, to find his new chair defective on arrival.

Folding or Rigid. A paraplegic's chair should be of the folding type to allow carriage in motor chair or car and should be easy to fold by the paraplegic himself. The type and size of seat and the height of backrest are very important points for the paraplegic. The seat must be wide enough to insure no pressure on the hips, and for the average adult 18 inches is usually required. Obviously various sizes should be available, and indeed adult and junior sizes are available in most modern chairs. The canvas type of seat is widely used and facilitates folding and reduces weight, but has the disadvantage that after a time the seat sags in the centre and so tends to produce localised pressure on the sides of the thighs. This can be corrected by a small cushion in the centre, but soft material which is truly non-stretch would

be an advantage. A hard seat, even though it is hinged in the centre is not quite so easy to fold and may also interfere with stability when travelling on rough ground.

One very important point is that all paraplegics require to sit on a thick (4-inch) sorbo rubber cushion placed on the chair. This is necessary to be sure of preventing pressure sores. It obviously raises the centre of gravity by 1-2 inches of the patient-chair combination and also increases the length of reach to brake and wheel. It would be a big advantage if this could be allowed for in design of chairs for paraplegics.

For most paraplegics a vertical backrest 18-20 inches high is much more suitable than one of 12-14 inches as it both gives support and is more comfortable. A semi-reclining or fully reclining backrest is not required except in certain tetraplegic cases or in the occasional case with joint deformities. A headrest attachment is a luxury except in the very high cervical lesions. It is important that the dimensions and design of the chair ensure that the metal uprights of the chair back do not interfere with the movement of the arms in propelling the chair.

Armrest. All paraplegics using wheelchairs require *detachable* armrests to make transfer from chair to bed or car easy and safe, especially with regard to the danger of bruising the hips and buttocks during transfer. It does not matter whether the paraplegic himself is actually moving on or off the chair or whether (as in the case of a tetraplegic) he is being lifted by attendants. A paraplegic normally uses his chair both indoors and outdoors in winter and summer and therefore a guard between the wheel-rim and his clothing is an important necessity in the design of the armrest. Domestic armrests are a great advantage for those who work at a bench or table, and indeed are more generally useful than full-length armrests, particularly if they can be reversed so that the support may be available in front when required, as in the Everest and Jennings chair. I am glad to see that nowadays more and more armrests are padded. This is a necessity for tetraplegics in whom the insensitive inner border of the arm is liable to pressure sores from resting on an unpadded armrest, and for other cases it is not unreasonable to recommend padding when one remembers that most of their waking hours are spent in the chair.

Legrest. Legrests which are adjustable for length are an obvious advantage in a wheelchair designed to fit people of varying heights and I am sure will become a universal feature. For paraplegics, most of whom are trained to stand and walk with crutches, it is important that the footrest is so designed that each footplate can be folded so as to allow the feet to be placed easily and comfortably on the floor when standing up from the chair. This not only makes it easier for the patient to stand as the feet can be placed in the most convenient spot on the floor, but also makes it safer by removing a likely cause of damage to heels and ankles and also making it less likely that the paraplegic's shoes will slip, especially on a polished floor.

Lastly, swinging detachable footrests are a big advantage. This design allows a close approach to bath or car, and so facilitates transfer and also reduces storage space required for the chair, as for example when travelling in a small car.

Many paraplegics suffer from marked spasticity, and severe spasms can be produced by trivial stimuli. These spasms may be of flexor or extensor type and

in such cases a means should be available for fixing the shoes to the footplate without running the risk of producing damage to the soft tissues. A metal rim shaped to the sole of the shoe together with a retaining band or strap across the instep is far preferable to the combination of instep strap and calf strap so commonly used. Such a rim can be bolted to the foot plates and need take up very little more room than the occupant's shoes.

Despite the marked improvement in chair designs in the last few years—indeed in some cases perhaps because of improvements—the overall weight of the average general purpose chair has not been reduced as much as the average user would like. Thanks to improved methods of rehabilitation, the majority of paraplegics today in this country can lead very useful lives in the community. Many of them, especially the ladies, find it difficult to lift the chair into a car or motor tricycle. I understand that wheelchairs made of light metal alloy weighing only about 20 lb. have been produced and proved to be stable and durable. Such a chair would be a tremendous boon to paraplegics and I hope it will be made available to them in this country in the very near future.

Finally, I would like to suggest that everyone concerned with the supply of wheelchairs to the disabled, from the doctor who first recommends the chair to the British Railway employee who finally delivers it, should make a concerted effort to reduce the period, often of several weeks, at present commonly required to effect delivery.

THE SPASTIC AND HIS WHEELCHAIR

By RONALD MACKEITH, M.A., D.M., F.R.C.P.

Consultant Paediatrician, Guy's Hospital, London

THE spastic has usually more than his motor handicap to contend with for cerebral palsy is itself a 'symposium of handicaps, sensory, motor, intellectual, emotional and social'. But by prolonged training of his capacities as well as for his handicaps, the spastic is being helped to a useful place that only a few years ago was denied to him. To this change the Spastic Society has contributed a great deal.

THE STATIONARY CHAIR

In the care and treatment of the spastic the stationary chair frequently plays an important part. The stationary chair is used to increase the child's experience by putting him in a position in which he can see the world and use his upper limbs; it is used to assist the treatment of the child both by correcting and by facilitating movements; it is used to support the trunk and to provide security for the child. The difference in what is needed for a wheelchair for the spastic and the difference of his needs from those of the paraplegic and the amputee can probably be best initially approached by closer study of what we want of the stationary chair for spastics and then moving on to consideration of the spastic's wheelchair.

Furthermore, both stationary chair and wheelchair have in common certain basic requirements. If we achieve simplicity, lightness, good design, stability, cleanliness, comfort and, of great importance, a good fit for the stationary chair it will be the easier to achieve these in wheelchairs.