

## **Prescription and positioning: evaluating the physically disabled individual for wheelchair seating**

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### **Abstract**

Within the past 10 years, technology has provided members of the seating team with new approaches in dealing with severely physically disabled children and adults. Positioning is often the first step in overall provision of technical aids. Before physically disabled individuals can operate augmentative communication devices, computer keyboards or other assistive or rehabilitative devices, they should be provided with the optimum seated posture from which to operate. The proximal stability provided by a therapeutically designed seating system will enhance motor potential. Presently, there are many approaches to providing dynamic seating. A thorough evaluation, with input from all team members including the client and his family is necessary to define clearly the goals for the seating device. Once these goals are defined, the team can investigate the possible technical solutions. Thorough ongoing re-evaluation and follow-up of both the client's needs and the possible technical solutions will ensure that persons with physical disabilities will be in the best possible posture to perform the tasks of daily living.

### **Introduction**

A stable posture enables persons with physical disabilities to participate more fully in everyday activities be they educational, vocational, recreational or related to the challenge of independent living. For many children and adults with severe physical disabilities, positioning equipment, especially

therapeutically designed and prescribed seating systems in mobility bases, can make a dramatic difference at home, school, work and in the community.

Twenty years ago, the field of wheelchair seating was just emerging. There were perhaps two types of standard folding wheelchairs in a few sizes and one or two adult-size powered wheelchairs. The extent of the seating that was commercially available included several cushions for pressure management and a few special order items such as flat wooden upholstered seats for wheelchairs. Most seating modifications were hand fabricated plywood and foam inserts done in therapy departments of paediatric hospitals or schools. In the intervening years, the available technology has changed incredibly. In fact, there are so many choices that consumers and professionals alike can be overwhelmed. There are lightweight chairs from at least fifteen companies, powered chairs, folding and non-folding, a myriad of different control options for many of the chairs with some applicable for some chairs and not for others, many three wheeled carts, powered scooters and specially designed childrens devices that stand have seats that rise and so on. There are also many commercially available seating options. There are planar and contoured systems. Some are custom made while others can be purchased from standard modules in a catalogue. There are different materials used, and a variety of delivery systems in place such as catalogue order, central fabrication or custom fabrication on site. It only becomes more confusing for clinicians, engineers and therapists as time goes on.

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However, one thing has not changed. Before the selection of the type of technological solution is begun, a thorough evaluation of the client's skills, problems and goals must be completed. With that information well established, the choice of appropriate technology becomes much easier. The focus of the choice is centred on the functional requirements of the client and not the glamour of the new technology.

### **Evaluation process**

Goals for seating will vary for each client. The basic considerations become ranked by priority as the evaluation is performed and as the team listens carefully to the client, the family, the caretakers and other involved professionals. Basic goals for seating can be to:

- facilitate motor abilities to maximize function,
- alleviate abnormal muscle tone,
- prevent, delay or accommodate deformity,
- increase comfort,
- manage pressure,
- improve self image,
- facilitate physiological function,
- enhance quality of life,
- promote care giving or independent activities of daily living.

If the client is elderly and wheelchair bound, the first priority may be comfort. If the client has had a spinal cord lesion and has insensitive tissue, the first priority would be pressure management. An eight year old child with cerebral palsy who attends school may need to have functional use of a computer and therefore must be seated so that control of the keyboard is as efficient as possible. Adults at work may need seating not only for functional considerations but also for the aesthetics of presenting themselves well in the marketplace. Of course, all the above clients would wish to be as comfortable as possible, but other priorities may come into play in the decision making as to which system is best, especially if any compromise is necessary.

The evaluation by the therapist should contain neuromotor and orthopaedic summaries, sensory status, fine and gross motor abilities, strength especially as it relates to the performance of functional activities, work/educational status, psychological implications and environmental considerations. Each of

these areas of evaluation is presented below in more depth.

### *Neuromotor summary*

The neuromotor summary includes an evaluation of tone and the presence of primitive postural reflexes, particularly as they influence tone during functional activities. The reflexes usually involved include the asymmetric tonic neck reflex, symmetric tonic neck reflex, tonic labyrinthine reflexes and positive supporting reaction. In evaluating tone one determines if the individual is generally hypotonic, hypertonic, athetoid, or if they have a mixture of tone present. Most individuals diagnosed as being spastic quadriplegics actually have hypertonic extremities with a hypotonic trunk. Also noted are the changes in tone which result from functional activities. For example, a marked increase is seen in tone in some persons with neuromotor disabilities when they attempt speech or when they reach for the controls of their powered wheelchair. If a person with an asymmetric tonic neck reflex (ATNR) to the left looks to the left, there will be an increase in extensor tone in the left upper limb and an increase in flexor tone on the right upper limb. Finally it is important to note if the person is able to alter tone voluntarily through postural adjustments or alternatively is locked into the abnormal patterns with no volitional control once reflex patterns occur.

### *Orthopaedic summary*

When examining a client's orthopaedic status, it must be determined which deformities are realistically correctable and which simply must be accommodated. This decision is often based on whether the deformity is fixed or flexible, what the underlying cause of the deformity is and the degree of the deformity. For example, an individual with a slight (10°) scoliosis can be supported in a fairly upright position, whilst correcting the curve of the spine. An individual with a 30° or greater scoliosis would need to be reclined to either correct or comfortably accommodate the curve. Someone with a fixed scoliosis of 20° would have to be accommodated but if the same curve was still flexible, then a goal would be to try to partially correct the deformity. If a rotational scoliosis is part of a total ATNR pattern that is reinforced constantly during the day, it is

unlikely that the magnitude of the problem can be lessened by seating. In many cases, the line between accommodation and attempts at correction is a fine one. If correction is the goal, then realistically orthotic intervention or surgery must be considered.

#### *Sensation status*

In this evaluation, particular attention is paid to areas of impaired or absent sensation, and especially bony areas, such as over the ischial tuberosities, which will be contacted by the seat and/or backrest. Individuals with normal sensation and severe orthopaedic deformities with many bony prominences who cannot accomplish weight relief are treated as if they have no sensation. Also of concern are the forces applied to the trunk by the back components of the seating system. For persons with scoliosis, especially when there is a rotational component, the seating components can put tremendous pressure on non-weightbearing surfaces of the trunk. The risk of pressure problems should be avoided or minimised by the design of the seating components including shape and materials used.

The length of time that an individual sits in one chair during the day, the responsibility for the supervision of skin care and how frequently this is carried out are additional issues to consider. A person who stays in their seating system for the entire day requires a different type of sitting surface than one who is in their system for only a half hour at a time. People who can alter their position are at much less risk than those who must rely on others for position change.

#### *Activities of daily living (ADL), gross and fine motor abilities*

The individual's ability to independently carry out ADL skills is evaluated primarily so the seating provided assists, not hinders independence. For example, if the person can independently pivot transfer forward out of the wheelchair from a certain seat height from the floor, it would be essential to ensure that the seat height is maintained when modifying the wheelchair with a seating system. Occasionally, there must be compromises between the clients independence and the therapeutic goals which have been established for the seating system. In

almost all cases, independence must be maintained unless long term complications of considerable magnitude are anticipated if seating goals are compromised. For example, a person with a severe rotational scoliosis should be discouraged from using an ATNR to accomplish reach if over years it is anticipated that the scoliosis would worsen to the extent of precluding sitting at all. Once an appropriate seating system is implemented, the ADL and fine motor skills can be re-evaluated to determine possible strategies in the performance of functional activities.

#### *Educational/work history*

An educational history includes the client's current educational level as well as the long term goals of the school personnel/family/individual. Severely physically disabled clients without the abilities to communicate, write, or independently access a computer should be given opportunities to interact meaningfully with their appropriate academic environment. In these situations, receptive communication skills are carefully evaluated by a speech pathologist/occupational therapist/educator team to determine the need for an augmentative communication system. The need for computers and other educational aids such as special trays for communication systems, page turners, and other technology used to assist the client in the academic environment are addressed as part of the client's overall seating system.

Transportation to and from school must also be considered. If a child is to be transported in the seating system several issues must be considered. The wheeled base must be crash tested and an approved tiedown system must be used to ensure compliance with safety standards. Many school districts and colleges provide vans or buses with lifts and wheelchair tie downs. If the child is in a stroller base, then an alternative mode of transportation such as a safety approved car seat and a secured storage space for the base is recommended. If powered mobility is a consideration, both school and home transportation must be able to accommodate the device and environmental accessibility must be evaluated.

If the client has entered the work place, both the environment and the job characteristics are evaluated to ensure that the recommended

technical aids will be compatible. This is particularly important in reference to wheelchair height versus work space heights, transportation accessibility and environmental considerations for ADL such as entrance ramps, accessibility of bathrooms, location of eating facilities.

#### *Psycho-social considerations*

Functional seating systems, must be "user friendly". Systems which require continuous adjustments, which come out of adjustment easily, have removable parts that are easily lost, or are difficult to transport, are less likely to be used in the intended manner. Cosmesis is an important consideration especially when dealing with children. Choices such as the colour of the seat, the fabric of the cover and the material of the tray are very important to the clients and their families. The seating system should be considered an extension of the individual's tastes and self image.

#### **Prescription process**

Before a specific piece or method of seating technology is matched to a client's individual needs positioning goals are established. There are established therapeutic guidelines of positioning in sitting (Bergen and Colangelo, 1985). Positioning usually begins at the pelvis, then continues to the lower limbs, the trunk, head, and shoulder/upper limbs. Guidelines assist in establishing a systematic approach for the seating team.

Professionals ultimately rely upon observation skills, evaluation results, the ability to try the client in a number of positions (simulate) during the evaluation process and also rely upon the input from the client.

#### **Positioning principles**

The general goals of seating have already been stated. The decision making process as to the specific seating components and the body position, almost always begins with the pelvis.

#### *The pelvis*

With few exceptions, positioning begins with support at the pelvis as this generally dictates what happens in the rest of the body. The pelvis is positioned and held as close to midline as feasible. This will encourage a stable base of

support on which the remainder of the body may be positioned. A lap belt mounted at about 45° is used to maintain pelvic positioning. For those clients with fixed posterior pelvic rotation the lap belt mounted closer to an 80–90° angle to the horizontal may work better to keep the child from sliding forward and under it. Fixed deformities about the pelvis should, for the most part, be accommodated within the seating system with the goal of a balanced trunk and head position. More flexible deformities should be addressed by unilateral seat height buildups, custom contouring or with other unique solutions. At all times, care should be taken not to compromise trunk and head position through creative problem solving at the pelvis.

#### *Lower limbs and feet*

The lower limbs are positioned in neutral rotation at the hips and with 90° flexion at the hips, knee, and ankles. An angle greater than 90°, particularly at the hips and knees, encourages a posterior pelvic rotation posture, which results in the client sliding out of the seat. This is especially noticeable in clients with increased lower limb extensor tone. Failure to maintain 90° or less at the hips and knees often results in a lower limb extensor pattern with posterior pelvic rotation, internal rotation, adduction and extension at the hips, and extension at the knees. Because the hamstring muscles pass over both the knee and hip joints, knee flexor tightness (hamstring tightness) is accommodated to avoid posterior rotation at the pelvis. If efforts are made to place the feet on wheelchair footrests when the hamstrings are tight, the stretch on the muscles will pull the pelvis into a posterior tilt. In this case, flexion of greater than 90° at the knees will allow the pelvis to maintain a more neutral tilt.

Deformities such as a "windswept" deformity (adduction contracture of one hip, abduction of the opposite hip) are all too often present in the lower limbs. If correction is not feasible, the deformity is accommodated at the pelvis and the head and trunk are positioned as forward facing as possible.

Tendencies toward adduction of both hips is discouraged by positioning in abduction. This is particularly important in clients with the potential for, or history of, hip dislocation or subluxation. Pommels (abductors) are placed distally, so as not to facilitate adduction by

stimulating the medial thighs. The feet are optimally positioned at a neutral ankle angle. Foot straps placed at a 45° angle encourage pressure towards the heel rather than only the ball of the foot. This inhibits elicitation of the positive supporting reaction. Extreme deformities are either accommodated or braced.

### *The trunk*

Depending on the degree of active trunk control, midline support can range from a "low profile" trunk support, for those who simply need a tactile reminder of where midline is, to rigid trunk support for those who have little or no trunk control. Support for those with spinal deformities, such as scoliosis and kyphosis is carefully evaluated to ensure that corrective forces applied to the individual are tolerable. Scoliosis is managed with the three point pressure technique. Support pads are placed under the apex of the curve, high on the opposite side and bilaterally at the pelvis. Severe deformities should always be accommodated comfortably, using a seating technique that allows for contact with as much surface area as possible. Usually, when supporting a scoliosis, some degree of tilt (maintaining 90° hip angle) is necessary to alleviate some of the effects of gravity on the spine. Also, if the client is not forced to counteract gravity, the lateral supports do not need to be as aggressive and can be made more comfortable and tolerable.

Persons with a flexible kyphosis are managed with a custom contoured back component and an anterior support, usually a flexible anterior harness. The custom component is particularly important in the region of the apex of the curve. If the curve is fixed, the spine is accommodated. In either case it is often advisable to tilt the system in space to decrease the effects of gravity.

Anterior trunk support is necessary for individuals who cannot maintain an upright position independently for an extended period of time, but require a more upright position for functional or therapeutic reasons. Chest belts are helpful for those who simply require a gentle assist into upright. Chest panels, harness, or other four point supports (over the shoulders and laterally around the trunk) are useful for those who tend to come forward with

their shoulders, or who tend to elevate at the shoulders to obtain stability.

### *The shoulders/upper limbs/head*

Shoulder protraction is provided occasionally to assist in relaxing extensor tone. Shoulder protraction "wings" added to the back or the lap tray, encourage a more midline upper limb posture. However, before any seating modification is done, it is suggested that the child's head position in space is re-evaluated as the problem may be the presence of the tonic labyrinthine supine reflex. If this is the case, the tilt of the seating system should be altered (probably brought closer to the vertical) and often the degree of protraction is lessened.

Head position can dictate overall body tone, particularly in the trunk and upper limbs/shoulder girdle. Reclining or tilting an individual often results in increased trunk and shoulder girdle extensor tone, because of the effects of the tonic labyrinthine supine reflex. In addition, the symmetrical and asymmetrical tonic neck reflexes can affect positions of the trunk and upper limbs. In situations where the ATNR is very dominant, the overriding abnormal tone and asymmetries must be dealt with before any pelvic positioning can be started.

A hyperextended position of the neck, with a kyphotic posture of the upper trunk is a difficult positioning problem. This indicates overall trunk hypotonicity, resulting in a tiring and non-functional position of the head. Tilting the individual, maintaining hip angle and at the same time bringing the head to a more upright position can alleviate the effects of gravity on a hypotonic spine, while providing a more functional head position.

Another difficult functional problem is when a child has a flopping head or a head that pulls into flexion. Individuals with this problem are observed with their heads "hanging down", no matter what the angle of tilt. Some individuals cannot be reclined or tilted because their functional position is vertical. Many devices, including snugly fit head straps, chin cups, and soft cervical collars have been used to resolve this problem. Any device about the head needs to be carefully applied and observed, as it can affect tone, neck position, and swallowing. In unattended situations when the lap belt is not well secured, the resultant problems can prove dangerous.

### The seating simulator

The ability to simulate postures and positions in space is an important part of the evaluation for a seating system. Holding someone on an examining table or taking measurements in the lying position is an inaccurate assessment and does not provide adequate information. The effects of position on tone, realistic forces which can be applied, initial acceptance of positioning, and effects of positioning on the individual's function can only be accurately evaluated with the client in the sitting position. Also, the child's reaction to the upright position in a seating system is not well observed unless he can be seated without the assistance of therapists and parents holding hands. The use of a seating simulator helps provide the seating team with the technical information required for assembly of an individually designed seating system.

Simulators should have angular adjustments, adjustments in thigh length, hip angle, and back height, as well as varying shapes and sizes of seat and back components, both planar and contoured, lap belts, head rests, chest supports and footrests. In addition, a variety of powered and manual chairs should be used for the evaluation. Manual or powered bases should not be recommended purely on the basis of catalogue information. Especially when dealing with evaluating powered wheelchair controls for the severely physically disabled, the patient should be allowed to actually try the proposed solution. When a child does not yet have his own seating system, the simulator components can be used to "simulate" the desired combination of seating components. This is the only way that it is possible to provide needed proximal trunk support so that the child can use their limited distal control to operate a powered device. By using a simulator, the therapist can know by the end of the evaluation what the functional position is, and what types of equipment may be appropriate and possible.

### Matching devices to needs

Once the desired posture is found through evaluation, the therapist investigates which commercial devices will achieve the desired goals. Again, functional and therapeutic goals are defined before deciding what hardware to use. Whenever possible, commercially available devices are chosen. A second choice is

to modify a commercially available product and the last choice is to custom fabricate a device. In most cases, custom fabrication is more costly than the commercially available options if all factors are considered.

Fastening the seating components into the wheeled base must also be considered. Fastenings must be easy to use, durable and safe. It is also important to be able to locate a seating system in more than one base if powered mobility is a consideration.

A number of factors which must be coordinated to form a basis for decision-making toward a specific seating device include: the presence and degree of abnormal tone and reflexes; the amount of postural control that can be obtained and sustained by the individual; functional skills resulting from external postural control; the potential for, or existence of orthopaedic deformities; and sensory status (Hobson, 1984). For the purpose of a frame of reference, individuals will be defined in terms of three groups; mildly involved, moderately involved, and severely involved (Fig. 1).

A mildly involved individual is one with mild tone/strength problems (the ability to readily maintain symmetrical postures) and minimal orthopaedic involvement (no limitations in range of motion in sitting).

A moderately involved individual is one with moderate tone problems manifested by an inability to maintain functional or symmetrical postures; and moderate orthopaedic

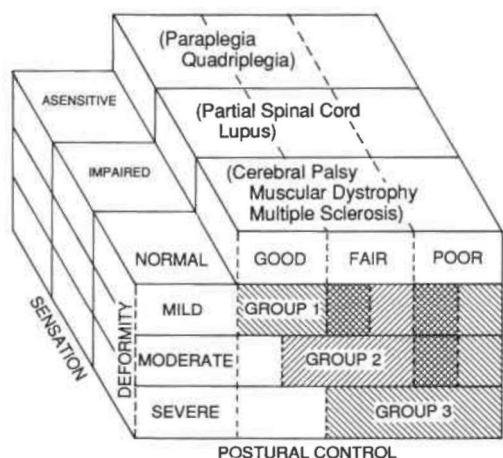


Fig. 1. A three-dimensional representation of the key intrinsic factors (control, deformity and sensation) that guide decision making in specialised seating.

involvement which could include a flexible scoliosis of less than 30°; flexible kyphosis; dislocated hip with a leg length discrepancy of less than two inches; contractures of the hips/knees of less than 110°; and feet which are unable to maintain a plantigrade position.

A severely involved individual has severe tone/strength problems which would prevent obtaining or maintaining symmetrical postures; severe, fixed curvatures of the spine (greater than 30°) and/or fixed deformities about the pelvis or lower limbs greater than those previously described.

A person need not fit all of the descriptions to fall into a category. For example, a person could be defined as severely involved if only tone were severely impaired, but no orthopaedic deformities were present; such is the case with many individuals with athetoid cerebral palsy.

Sensation is considered separately. Aside from the obvious categories of "absent", "impaired", and "normal", one also considers the individual's ability to relieve pressure independently and move away from discomfort. Many severely involved individuals are categorised as having impaired sensation because of the combination of severe, bony deformities combined with the inability to move away from discomfort.

In choosing hardware, no one piece of equipment is appropriate for everyone. Careful evaluation of an individual's needs combined with knowledge of available equipment can assure an appropriate match.

#### *Mildly involved*

Generally, mildly involved individuals can be seated using planar, commercially available components. These are systems which have modular, interchangeable parts which can be readily adjusted for growth or change. Functionally, they provide midline stability and encourage maintenance of midline postures.

Examples of mildly involved individuals would include:

A child with spastic diplegic cerebral palsy who is partially ambulatory, but requires a wheelchair for distance mobility. With a flat seat, the child can have the proximal stability necessary for her/him to obtain upper limb function to propel the chair.

A low level paraplegic who requires a simple pressure relieving cushion in a lightweight wheelchair to provide pelvic stability and assist in maintaining skin integrity.

#### *Moderately involved*

Moderately involved individuals can be seated using custom-contoured systems, or combinations of planar and contoured systems. The main goals with this group are to correct/accommodate orthopaedic deformities and provide enough stability for the individual to be functional.

Examples of moderately involved individuals would include:

A child with spinal muscular atrophy with no orthopaedic deformities. Although the child has no deformities, he requires very aggressive midline support to obtain distal function. In addition, the child cannot weight relieve and is very bony, and needs a surface which can assist in providing pressure relief. While a midline linear back could be used, customisation of the seat would be necessary to provide pressure relief.

A head-injured adult with hip and knee extension contractures, kyphotic trunk posturing, poor head and trunk control, and a dominance of overall extensor tone. An intimately contoured approach would allow accommodation of deformity, control of tone, and provide the ability to control resiliency of the sitting surface to decrease the possibility of pressure sore development.

#### *Severely involved*

With few exceptions, severely involved individuals require a total customised approach to control severe tone; accommodate severe deformities which often result in bony prominences; and/or accommodate for sensation problems. The sitting surface which contacts the body must closely approximate the individual's body contours, particularly if severe orthopaedic deformities are present, to prevent pressure areas over bony deformities.

Examples of severely involved individuals include:

A high tone athetoid with minimal orthopaedic deformity. Although minimal deformity is present, very aggressive

contouring is necessary to provide midline stability because of the high tone. In addition, the retained abnormal reflexes can dictate the need for a less resilient sitting surface to protect integrity of the skin.

A young man with advanced Duchenne Muscular Dystrophy, with severe pelvic obliquity and spinal deformity. He requires a contoured seat to comfortably accommodate the orthopaedic deformities. The back, however, can be less contoured providing some midline stability because some trunk movement is necessary to obtain upper limb movement and placement.

An adult with severe spastic quadriplegic cerebral palsy, with multiple, severe orthopaedic deformities, and no head or trunk control. The main goal with this individual is to provide a contoured seating system to comfortably accommodate deformities.

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