

## The "Gillette" Sitting Support Orthosis

J. MARTIN CARLSON, M.S., C.O.<sup>1</sup>  
ROBERT WINTER, M.D.<sup>1</sup>

**D**uring the past four years the Orthotic and Prosthetic Laboratory at Gillette Children's Hospital has developed a Sitting Support Orthosis which has become very important in the treatment of our non-ambulatory children with severe cerebral palsy or advanced Duchenne Muscular Dystrophy (Fig. 1). The Gillette Rehabilitation Therapy Department has also been very actively involved in the development and use of the Sitting Support Orthosis. Their knowledge of the problems associated with cerebral palsy has ensured that the orthosis not only addresses these problems but is compatible with and complementary to the rest of the child's adaptive equipment and his daily routine. Specific problems of concern are those of feeding, communication, reflex patterns, abnormal muscle tone, and learning potential in addition to spinal support and deformity. The medical staff of our Cerebral Palsy Service, our Spine Service, and our Growth and Development Service has provided the impetus, encouragement and support for the project.

### BACKGROUND

The development began on our Cerebral Palsy Service. Most cerebral palsy children who do not acquire the ability to ambulate lack the balance or



Fig. 1. The "Gillette" Sitting Support Orthosis with anterior thoracic support and head support.

voluntary means to have a good sitting posture in their first decade of life. They sit in a kyphotic or kyphoscoliotic posture. The pelvis is often not horizon-



tal. In some cases, balance, voluntary control, and sitting posture improve rapidly enough so that the flexible spine deformity of the first decade does not become a rigid, progressive deformity during the second decade. However, a significant portion of non-ambulatory cerebral palsy children do progress during the second decade to a serious spinal deformity. The spine curvature may make sitting very difficult or eventually even impossible. Pelvic obliquity can aggravate the symptoms of a dislocated hip. Cardio-pulmonary function may be seriously compromised. Another important consideration is that a small but significant portion of these patients have an average or superior intelligence. Their education, social interaction and self-esteem is very important and greatly affected by their sitting posture and function.

Better head control, whether it comes indirectly through stabilization of the thorax or directly by head support, is extremely important. A child who is looking chronically straight down or straight up or sideways at the world is deprived of normal avenues of discovery, stimulation, and social interaction.

The child with Duchenne Muscular Dystrophy begins to develop a spinal deformity about the time he becomes non-ambulatory. The deformity progresses to become a very large single curve, that includes rotation, scoliosis, and either kyphosis or lordosis. The spine deformity sometimes affects cardio-pulmonary function and almost always causes a sitting posture so poor that the patient's functions are seriously compromised long before he would lose the function because of other manifestations of his disease.

Our approach on seating in the past has been to utilize the hospital's carpentry shop to construct wedged seats with upholstered lateral supports, an ap-

proach very common around the country and that is successful to some degree. However, it does not control adequately the location and orientation of the pelvis. Lack of contoured conformance to the anatomy results in a concentration of the pressures generated by gravity. The padded, upholstered sides of the seat are too bulky to extend lateral thoracic support sufficiently high in the subaxillary area. Even the best of these seats accomplished very little in the way of real spine support.

### THE GILLETTE SITTING SUPPORT ORTHOSIS

The Sitting Support Orthosis developed here at Gillette consists of a custom-molded, plastic shell mounted on a base. The plastic shell conforms to the body contours posteriorly and laterally from the knees to the upper thorax. The base provides the proper support to the shell and allows the unit to be removed from the wheelchair for use in the car or other places. A lap belt is provided to hold the pelvis snugly back into position. The hips are positioned in the amount of flexion recommended by the physical or occupational therapist. Since reflex patterns in severe cerebral palsy are frequently affected by the degree of hip flexion, we follow the recommendation of the occupational or physical therapist. These children also very often have overactive hip adductors. The pommel prevents excessive hip adduction, and it also helps to prevent the patient from sliding out of the seat. In the case of muscular dystrophy the hips are positioned as close to 90 degrees of flexion as possible. The pommel is usually not necessary and is eliminated in favor of easier usage of the urinal. Figure 2 is an example of a Sitting Support Orthosis for a child with advanced muscular dystrophy.





Fig. 2. Example of a Sitting Support Orthosis for a child with advanced muscular dystrophy. Note the thoraco-abdominal support apron and the head rest.



Fig. 3. This child's orthosis includes a fabric panel which provides thoraco-abdominal support to the convex aspect of his spine curvature.

Various anterior components are added as necessary. A lordotic muscular dystrophy patient will need a large abdominothoracic apron to pull him upright. For the kyphotic patient, a fabric halter or rigid, custom-contoured, sub-clavicular support may be necessary, depending on the force required to obtain an acceptable posture.

When a significant scoliosis exists, aprons are designed to pull one side or the other. To accomplish this without un-

duly constraining the thorax, we have borrowed the anterior upright feature from the designers of the Milwaukee Orthosis. In the case of a convex left curve, for instance, a cloth thoracic panel is anchored to the inside posterior of the shell a few centimeters to the left of center. The panel extends around the left side of the trunk (at the appropriate level) and attaches to a central anterior upright (Fig. 3). Usually, a well-padded axillary sling is attached in a similar manner on the right. The anterior upright is supported by means of a hinged outrigger

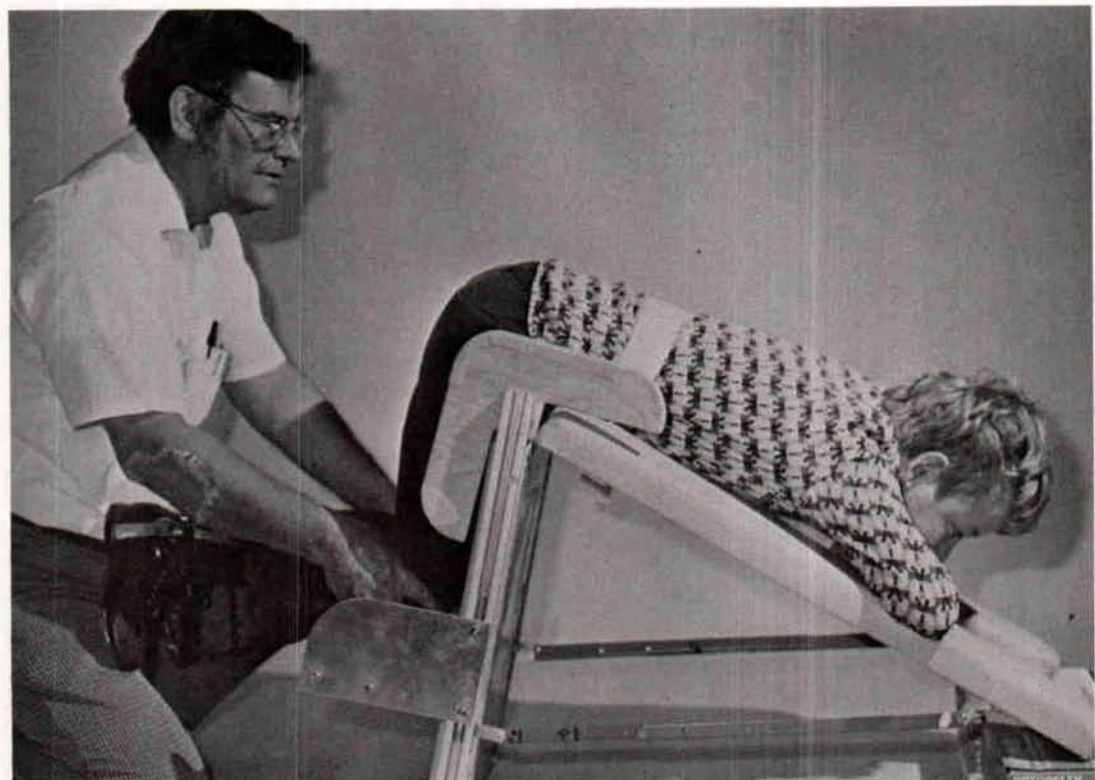


Fig. 4. The patient is placed on a padded "A" frame in a well-aligned, face-down position.

extending from the right side of the shell. To remove the patient from orthosis, the panel is loosened from the anterior upright, and the upright and outrigger are swung out of the way to the right. On rare occasions, we have installed lumbar pads for additional spinal column support.

Stabilizing the thorax obviously aids the patient's voluntary head control, but sometimes additional head support is necessary. In some cases, head control is used continuously to prevent certain head positions and the reflex patterns which are triggered by those positions. In other cases, it is appropriate to make the head support removable so that it may be used

part-time only or for feeding. This is another aspect of the design which requires consultation with an experienced therapist who has had a chance to become acquainted with the child.

The exact angle of recline is not decided until fitting the orthosis to the child. We try to bring the child as nearly as practical to a vertical sitting position.

The thin plastic shell design permits us to extend our lateral thoracic support right up to the axilla without impinging uncomfortably on the medical aspect of the arm. This support eliminates most of the collapsing action of gravity.

When the child wishes to roll around and play on the floor, supporting hard-



ware is automatically left behind in the chair. He is free to roll or scoot around unencumbered. When the child is horizontal, gravity is not operating to collapse the spine.

## FABRICATION

Fabrication of this Sitting Support Orthosis begins with an accurate impression of the child in the sitting posture desired. The patient is positioned face down on a padded "A" frame (Fig. 4) with hips and knees held flexed. The amount of hip flexion is usually 90 to 100 degrees. Bony areas such as the trochanters, ischial tuberosities and coccyx are covered with masking tape and outlined with lipstick

on the tape. Gravity and gentle but firm hands work together to position the child in the most optimum position attainable. We try to put the cerebral palsy patient, for instance, in a relaxed position of reduced thoracic kyphosis, reduced scoliosis, and as much lumbar extension as possible. His hips are held in enough flexion to break up his spastic extension reflex pattern and in a few degrees of abduction. His shoulders are abducted 90 degrees. In this position, a sealed PVC bag one-third full of polystyrene foam beads is lowered onto the child and tucked around him and between his legs (Fig. 5). The air is exhausted from the bag, and the mass of beads become solid (Fig. 6). The bag is pulled off the child, turned over and the impression ex-

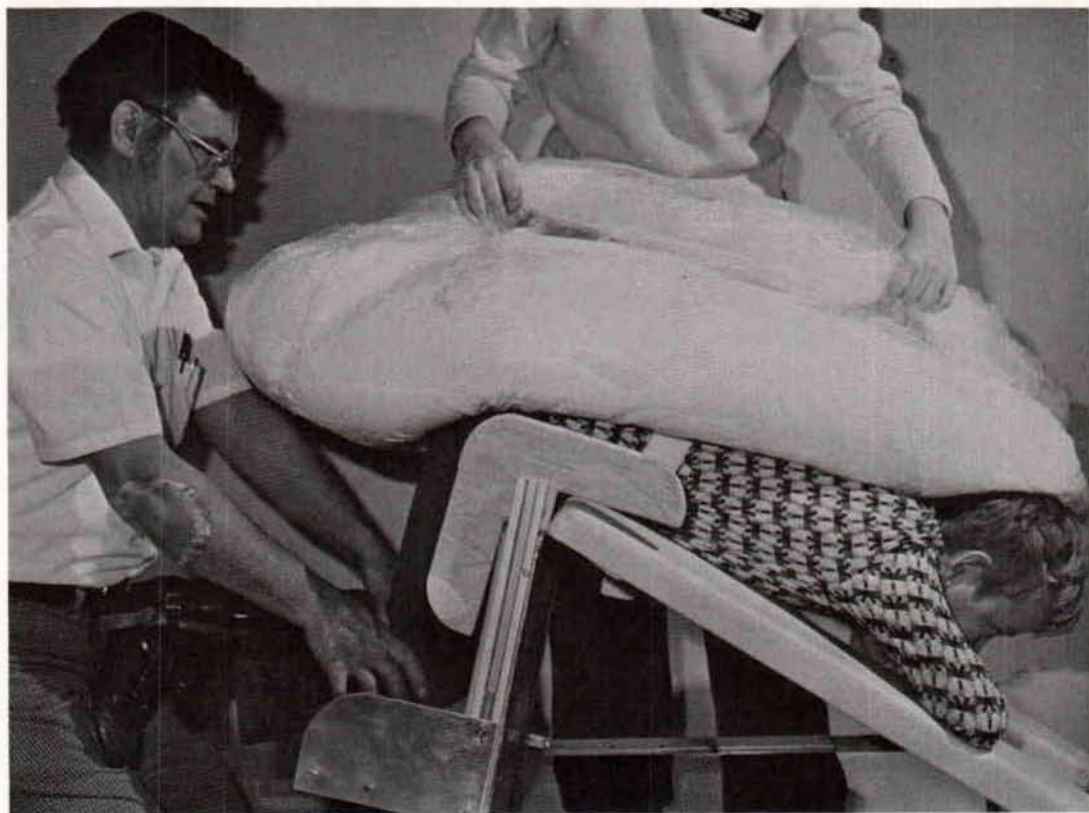


Fig. 5. A PVC bag, one-third full of polystyrene foam beads, is lowered onto the posterior surface of the child and packed around him.



Fig. 6. Exhaustion of air solidifies the bag of beads.

amed. If the impression is satisfactory, the lipstick marks are reinforced with indelible pencil, and the impression is filled with plaster to create the positive model. If it is not satisfactory, air is leaked back into the bag, and the process is repeated.

Measurements are taken of the wheelchair so a properly fitting base will be applied to the seat insert. Other measurements are taken so that rough trim lines may be established at the hamstring tendons and the axilla. Lateral-lateral diameter measurements are taken at the distal thigh, trochanters, waist and axilla for reference during cast modification.

During cast modification, the usual surface defects are remedied, all dia-

meters are brought to measurement, and position inadequacies during the impression stage are now corrected. Plaster is added to create reliefs at the trochanters, ischial tuberosities and coccyx, as needed.

Cotton stockinet is drawn over the finished model, and it is covered (drape and vacuum assist method) with hot 0.5 cm. polypropylene. Rough trim lines are established, and a cast saw is used to cut the shell from the model.

A rough, oversized cut-out is made in an "Ethafom" block, and the shell is foam mounted in the block, using a two-part isocyanate foam. The posterior incline of the back of the shell is usually less





Fig. 7. Child with severe cerebral palsy assuming a typical unsupported, kypho-scoliotic sitting position.

than 10 degrees.

When fabrication has reached this stage, the child is brought in for fitting. With the child positioned in the rough shell, final trim lines can be established and optimum attachment points determined for lap belt, apron, head support, etc. The X-rays are very helpful in determining the best location for supporting panels on scoliotic patients.

## RESULTS

As of March 1, 1978, we have fitted 156 Sitting Support Orthoses. Of this



Fig. 8. Child shown in Figure 7, now in the Sitting Support Orthosis.

total, 133 were for children or adults with cerebral palsy, and 23 were for children with advanced Duchenne Muscular Dystrophy.

The Sitting Support Orthosis has been very successful in several ways. The system has proven capable of providing the stabilizing support necessary for a near-normal sitting posture (Figs. 7 & 8). Head control or position is nearly always improved, sometimes dramatically.

The orthosis usually improves the child's comfort and position to the point that the intensity of reflex patterns and abnormal muscle tone are reduced. Stability provided by the Sitting Support Orthosis frees up the child's hands in some cases where they would otherwise be used

for support. This also means the child does not have to try to pay attention to so many things and can better concentrate on such things as head control, communicating, or learning in the classroom. The orthosis has also greatly improved or simplified the sometimes very difficult task of feeding these children.

Quantifying the effect of the "Gillette" Sitting Support Orthosis on the long term development of spine deformity is obviously very difficult and not yet possible. We are currently only reporting examples of immediate improvement in sitting posture and spine alignment. Figure 9 is the A-P X-ray of the spine of a child with cerebral palsy. Figure 10 shows spine alignment for the same child in the Sitting Support Orthosis.

Figure 11 is the lateral X-ray of a child

with advanced Duchenne Muscular Dystrophy. The belly-on-thigh posture illustrated in this X-ray is very unfunctional and uncosmetic. Figure 12 is the lateral X-ray of the patient in his Sitting Support Orthosis. Figure 13 is a photograph of the patient in his orthosis. The muscular dystrophy patients are very pleased that the orthosis helps them regain a more normal sitting stature and report easier breathing due to less crowding of the abdominal cavity. The upper thorax and shoulders are free enough to aid in elbow control, hand placement, and head placement.

## DISCUSSION

The Sitting Support Orthosis must fit quite closely to be effective. The child

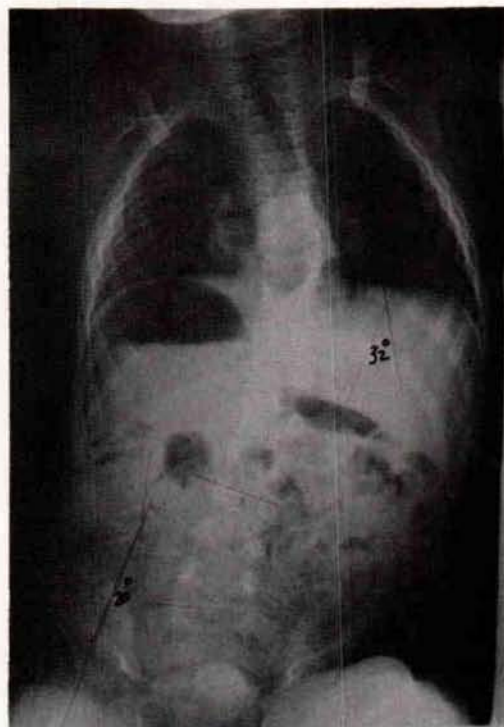


Fig. 9. The A-P X-ray of a child with severe cerebral palsy.

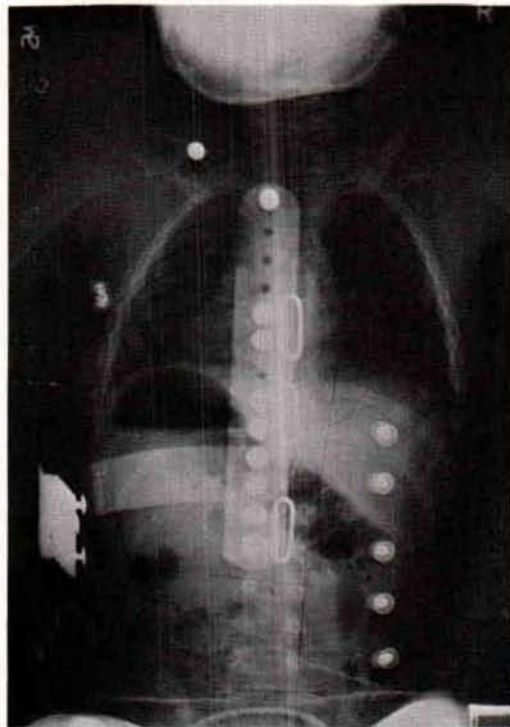


Fig. 10. The A-P X-ray of the child shown in Figure 9 and his Sitting Support Orthosis.





Fig. 11. Lateral X-ray of a patient with advanced Duchenne Muscular Dystrophy. Even this poor belly-on-thigh posture required the two-handed support of his mother anteriorly.

will not fit in his orthosis when bundled up in heavy winter clothing. Sometimes it is advisable for the child to be in his orthosis during school bus rides, and the temperature may be quite low. The orthosis can be accommodated under a winter coat by using a larger size or making simple adaptations. The orthosis is outgrown usually between eleven and twenty-five months after fitting.

The involvement and cooperation of the entire health team creates an overall equipment system which works because the various components are compatible,

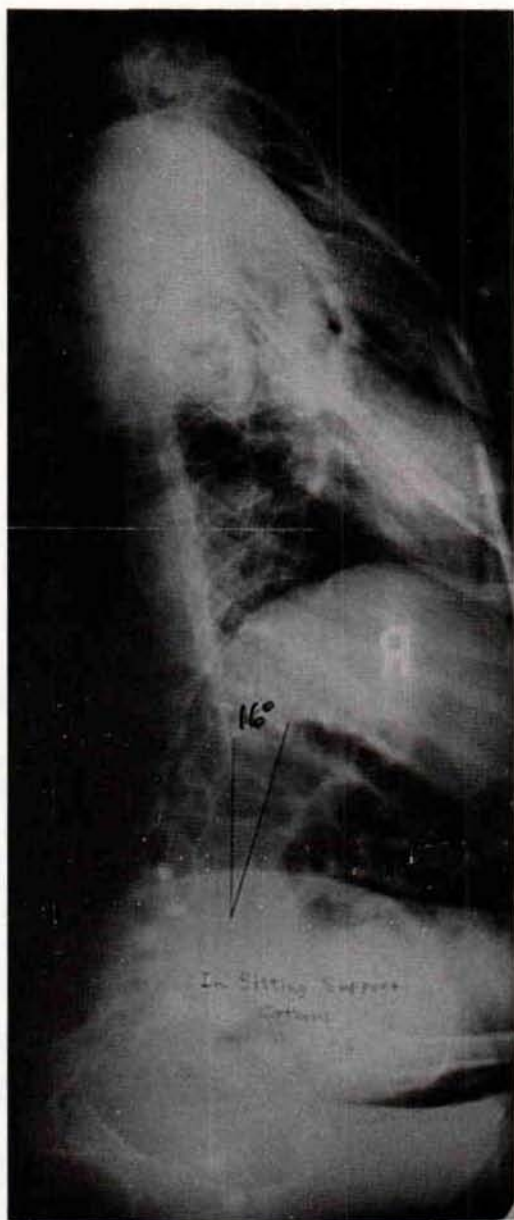


Fig. 12. Lateral X-ray of patient shown in Fig. 11 in his Sitting Support Orthosis.

and the important problems in the child's life are recognized and dealt with. Figure 14 is a photograph of a child with cerebral palsy and his Sitting Support Orthosis, wheel chair, and lap board with

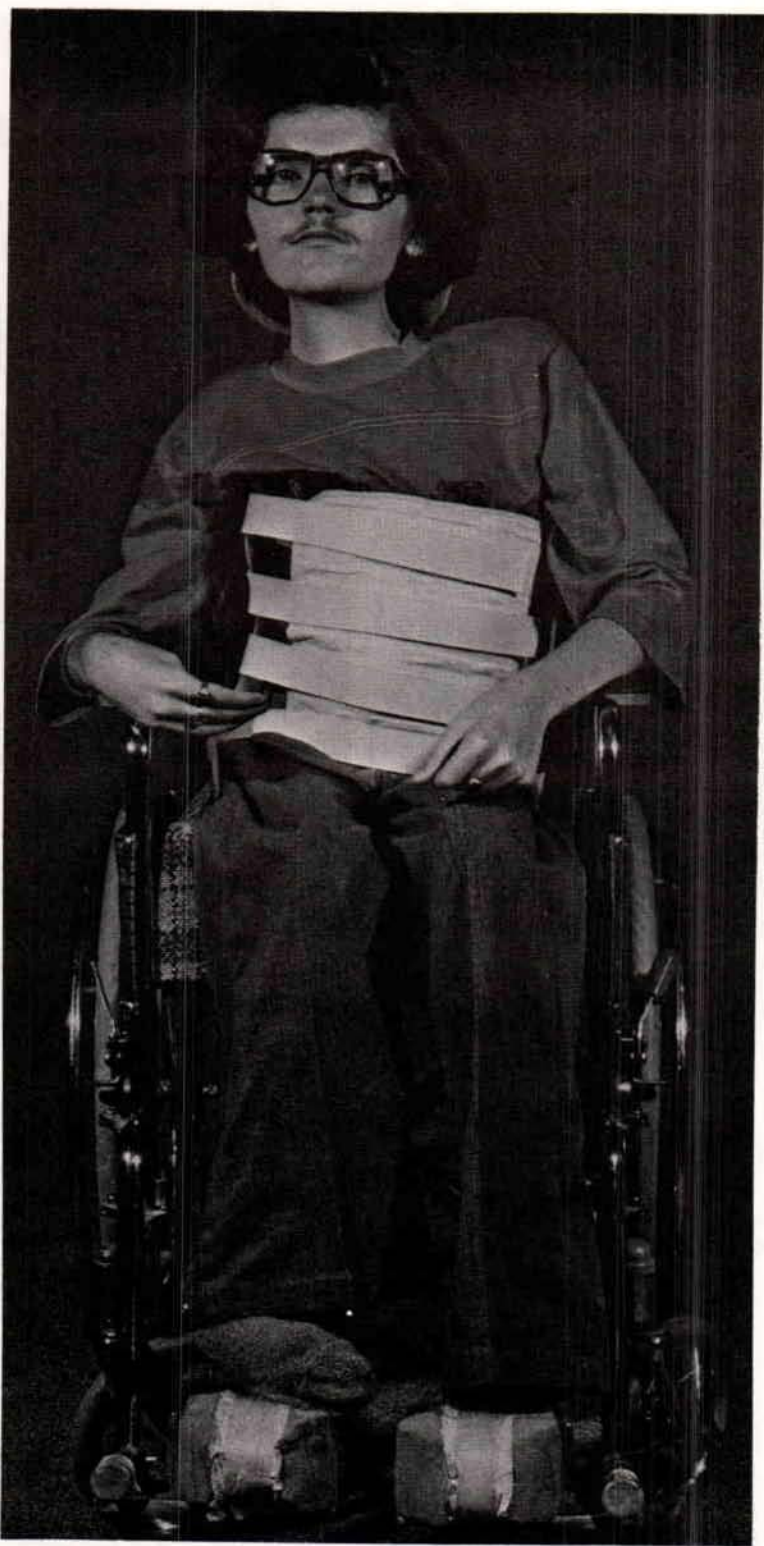


Fig. 13. Patient with advanced Duchenne Muscular Dystrophy in his Sitting Support Orthosis.



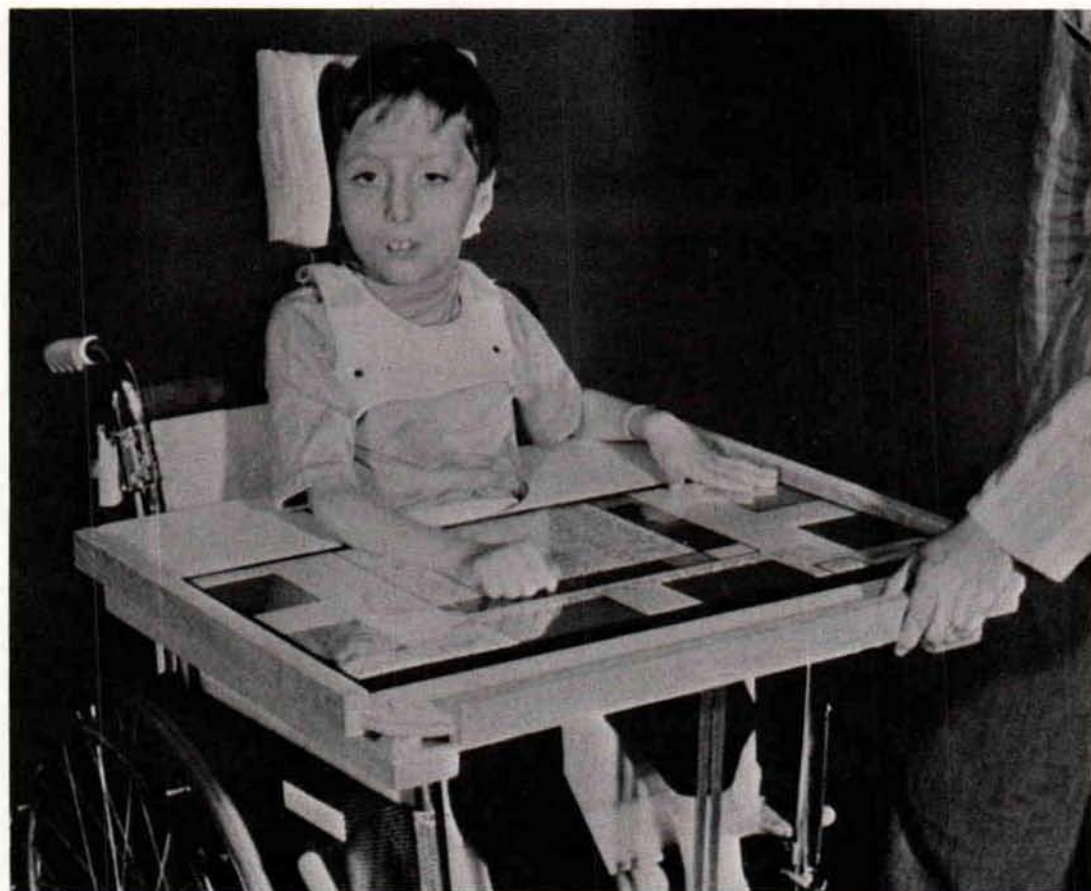


Fig. 14. Child in his wheelchair with Sitting Support Orthosis, lap board, and communication system.

in-laid communication figures.

Our most enthusiastic response and encouragement and many valuable design suggestions have come from the parents, teachers, therapists, nurses and other people who teach or care for the child in the community. These people who live or work with the child on a daily basis know better than anyone the current effect of treatment on the total child.

#### ACKNOWLEDGEMENTS

The authors wish to acknowledge the important contributions to this development made by Fran Hollerbach, Mary Hatung, Scott Weber, Gene Berglund, Arturo Vazquez Vela, and other Orthotic

and Prosthetic Laboratory staff members; Jan Headley, former Rehabilitation Director; Diane Twedt, Rehabilitation Therapy Supervisor; Karen Beck, Martha Talmadge, Marilyn Kochsiek, Sue Swanson, Collette Carlson, and Lee Schuveiller, Rehabilitation Therapy staff members; Dr. Thomas Comfort, Dr. Lowell Lutter, and Dr. John Lonstein, Gillette orthopedic staff members; and Dr. Richard Zarling, neurologist, Fairview Hospital. Photography is by Gordon Dunn and Ken Jandle. The manuscript was typed by Linda Frattalone.

<sup>1</sup>Gillette Children's Hospital, St. Paul, Minnesota