

# Stroke Rehabilitation: A Reconsideration of Some Common Attitudes

Thomas P. Anderson, MD., Frederic J. Kottke, M.D.

• Some common, yet erroneous, attitudes and perceptions about stroke still persist. These warrant reconsideration: (1) benefits of stroke rehabilitation (including validity of its basis, life expectancy, adequacy in nursing homes, outcome prediction, cost benefits, and vocational outcome); (2) gait training (including evaluation methods, gait patterns, hand supports, sensory deficits, and types of braces); (3) effects of training on regaining balance; (4) spasticity (as a negative factor, enhancement by spring-action brace, benefit of inhibition training, and importance of antispasmodic drugs); (5) danger of early activity; (6) depression; (7) effects on patients' sexuality; (8) effects of communication impairments on learning abilities as well as effectiveness of speech therapy; (9) application of neurophysiologic principles (regarding decreasing synaptic resistance, applications of principles from cerebral palsy training, and benefits of training for percept-concept-motor function deficits); and (10) research including reliability of past reports and paucity of facilities for new research.

Rehabilitation for completed stroke, like management in other areas of chronic disease, suffers from the long-established misperception that little or nothing can be done for the patient. We have been bound by the concept from 19th century pathology that the lesion defines the patient. This has been taught in acute diagnostic and therapeutic medicine. What is done for the patient is what can be done to the pathology. If the lesion is permanent, nothing can be done for the patient.

From the Department of Physical Medicine and Rehabilitation, University of Minnesota, Minneapolis.

This study was supported in part by the University of Minnesota Medical Rehabilitation Research and Training Center, RT-2, under Rehabilitation Services Administration Grant No. 16-P-S6SIO.

Submitted for publication March 17, 1977.

Although rehabilitation in particular has demonstrated that medicine is more than removal of a pathologic lesion, the attitude is prevalent that in the presence of major pathology, little of value can be accomplished for the patient. Hence, it appears worthwhile to reconsider the appropriateness of some of our common attitudes about completed stroke. Already some older misperceptions have disappeared, for example, the custom of not allowing the stroke patient to sit up

during the first week because it may make the stroke progress. This practice is seldom followed any more unless it is a very slowly progressing stroke.

Another example is the conception that it is the natural history of completed stroke to develop tightness and discomfort in some of the joints of the paralyzed limbs, particularly the shoulder. The incidence of contractures in patients with completed stroke has dropped markedly, probably because range of motion exercises are now taught in general nursing care and no longer as only a part of specialized rehabilitation nursing.

Yet another example is the physician who makes rounds each morning asking the stroke patient to raise the involved lower extremity off the bed while lying supine, using this as the indication for when the patient is ready to start walking training. Fortunately, antigravity strength in hip flexors is no longer considered a criterion for gait training.

The attitudes about stroke and its rehabilitation that will be reconsidered in this paper fall into the following categories: (1) benefits of stroke rehabilitation; (2) gait training; (3) recovery of ability to balance; (4) management of spasticity; (5) psychological aspects; (6) communication impairments; (7) application of principles of neurophysiology to the treatment of stroke; and (8) research in this area. Under each category the attitudes being reconsidered will be presented in italics.

## 1. Doubts About Benefits of Stroke Rehabilitation

*Can rehabilitation management of completed stroke have any efficacy if it is not determined by the anatomic localization of the lesion? One of the important precepts of medicine is to localize the pathology and make a precise diagnosis as the basis for planning treatment. How can rehabilitation of stroke have validity if it ignores these precepts?*

Rehabilitation of stroke is concerned with the restoration and development of physiological and psychological function in order to improve performance and behavior. This requires the evaluation of the remaining capacities of the individual and the enhancement of those functions to the optimal level. Pathology results in deficits in function but the patient survives and improves based on ability to redevelop his/her physiological and

psychological functions. Evaluation of performance and understanding of the potential to further increase that performance provide the bases for planning a rehabilitation program.<sup>1</sup>

*Patients with completed stroke do not live long enough to warrant all the effort and expense of a full, comprehensive rehabilitation program.*

This impression has been supported by a number of opinions: (1) stroke results in sudden death or such severe brain damage that the patient does not survive for very long; (2) nothing can be done to help a patient when brain damage has occurred; (3) neuro-logic deficit results in irrevocable modification in functional capacity. The patient can resume activities only when the brain recovers, therefore this functional recovery occurs spontaneously. (4) Feldman and colleagues reported only slightly more improvement in a full, formal rehabilitation program for stroke patients than under a regime of functionally oriented medical care. They concluded that the great majority of hemiparetic stroke victims could be rehabilitated adequately on medical and neurological wards without formal rehabilitation services, if proper attention is given to ambulation and self-care activity. (5) Waylonis and associates compared two groups of patients in a county hospital. One group had "comprehensive rehabilitation" that consisted of functionally oriented medical management. The control group had not experienced this rehabilitation. These two groups exhibited no difference in the death rate. The percentage of patients who were unable to walk was equally high in both. •Though this study raises a question of what is considered a comprehensive rehabilitation program, this was never defined in the paper.

Other studies<sup>5-10</sup> have shown that stroke patients do survive more than a few short months. Our recent studies<sup>11</sup> on long-term followup and outcome of stroke patients show that 30% of the patients had survived 11 years or more since the onset of stroke. Twenty-five percent of the patients are still surviving. The mean survival time exceeds 7 years. In our outcome studies,<sup>12,13</sup> 70% of the cases had survived 1 to 3 years. Approximately half the cases had survived 3 to 6 years. When survival expectancy is this long following stroke, the living accommodations of the poststroke patients become a major cost factor. The patient who is able to receive comprehensive rehabilitation over a short term and then live outside an institution incurs far less expense than the permanently institutionalized individual.<sup>14</sup>

*A comprehensive rehabilitation center is not necessary for most patients with completed stroke because physical therapy in the nursing home or small community hospital is sufficient rehabilitation for stroke and costs less.*

This attitude has been promulgated by various governmental committees and included in governmental directives regarding Medicare and other health care programs. The desirability of rehabilitation was promoted

by the White House Conference on Heart, Cancer, and Stroke in 1964. The inclusion of payment for rehabilitation services in hospitals, extended care facilities, and nursing homes has resulted in much confusion. Nursing homes and many doctors tend to equate physical therapy with rehabilitation. Since rehabilitation activities are reimbursable, this becomes a highly desirable activity for the nursing home. Physical therapy in the nursing home usually proposes to sustain the level of function and prevent further complications. Relatively few nursing homes have the resources and staff to provide the comprehensive rehabilitation program that actually raises the stroke patient's level of functioning to its optimal level. On the other hand, a comprehensive rehabilitation center moves the stroke patient rapidly from a low level to a higher level of functioning, thus avoiding further institutionalization of the patient. The Joint Committee for Stroke Facilities<sup>15</sup> has prepared guidelines for stroke facilities, indicating what services are needed for various levels of stroke rehabilitation.

*Stroke rehabilitation needs to develop a better scientific base by searching out those factors in, or shortly following, the acute phase which predict whether a patient will do well in a rehabilitation training program.*

To have scientifically developed predictors of stroke rehabilitation outcomes is truly highly desirable, but efforts have been unsuccessful both at Sister Kenny Institute<sup>1</sup> and the Department of Rehabilitation Medicine at the University of Washington.

In both studies, not one single factor would consistently predict whether a patient will do well or poorly in stroke rehabilitation. However, this does not mean every stroke patient must have his chance at rehabilitation. There are some criteria for determining if a patient is a candidate for an evaluation and trial of rehabilitation: (a) Can the patient comprehend either verbal or nonverbal directions? (b) Can the patient follow two-step or three-step directions? (c) Can the patient remember and apply today what he learned yesterday? If a stroke patient meets these criteria, then it requires only about a week of evaluation at a trial in rehabilitation to prove whether he/she is truly a good candidate.

*The great expense of comprehensive stroke rehabilitation is not worth the cost to third-party payers and the government.*

Recent studies by Emler's group<sup>17</sup> and by Lehmann and coworkers<sup>18</sup> have shown that the higher cost during the acute phase of rehabilitation is much more than repaid by the reduced cost of maintenance during the subsequent survival of the stroke patient. Lehmann<sup>18</sup> estimated that if a patient lives in a nursing home for 21 months, the cost is as much as the total cost of rehabilitation plus returning home. Since the survival expectancy of patients following rehabilitation is more than seven years, the savings due to rehabilitation for each patient who is rehabilitated out of the nursing home is about 90 percent of the cost of the nursing home for that period.

However, more studies are needed to collect information and to compare groups that have had stroke rehabilitation

with those that have not. The multiplicity of criteria of dependency and cost of dependency make it necessary to develop data' on each of these parameters before more meaningful generalizations can be made. All the studies to date indicate a significant saving through rehabilitation. Moreover, these studies emphasize that the longer the patient survives, the greater the economic benefit of comprehensive rehabilitation.

*Vocational aspects of stroke rehabilitation have largely been ignored, probably because the prognosis for returning to employment by the rehabilitated stroke patient is so poor.*

Two questions should be kept in mind when considering vocational aspects of rehabilitation for stroke patients. First, how many patients were near, at, or beyond retirement age? Second, is full-time homemaking considered employment? Our outcomes studies<sup>12</sup> on stroke rehabilitation at the University of Minnesota dealt with only those stroke patients in the employment age group up to age 62. Of these, 54% had returned to their usual activity, which consisted of full-time or part-time employment, fulltime or part-time homemaking, or attending school. Of the 46% who had not returned to their usual activity, 12% of the total were not employed, but were active in recreation and hobbies, leaving only one third of the patients who were not employed and not otherwise active.

In another study,<sup>11</sup> all stroke patients, irrespective of age, were followed up. Thirty percent were in full-time employment or housekeeping, and 18% were in part-time employment or part-time housekeeping, leaving only 52% unemployed. Hence, under the broader view of total normal employment, approximately 50% of stroke patients are gainfully employed, dispelling the old perception that few stroke patients can become reemployed.

## 2. Gait Training

*Manual muscle testing is the way to evaluate the patient with completed stroke, to determine potential for gait training.*

Many other examinations will give more information about the involved lower extremity. Active motion of the flexor synergy can be initiated and facilitated easily using the Marie-Foix reflex. Extension of the lower extremity can be facilitated easily by the extensor thrust reflex. Simply standing the patient will sometimes add enough stimulation to the internuncial pool to bring out voluntary motor function that did not occur when the patient was lying supine.

It is important for the stroke patient's morale to have him walk as soon as possible, even with a poor pattern. He can be trained into a better pattern later. The patient can be reassured that he is making gains and progress in alternate ways. Correcting and retraining an old, undesirable pattern is much more difficult than getting the pattern well established initially. Gait drills should be used in a standing position before the patient is actually permitted to start walking.

*To reinforce a sense progress for the stroke patient, it is desirable to reduce the support in the uninvolved hand as quickly as possible during walking.*

Many rehabilitation professionals become confused on this point because it is desirable to progress from the parallel bars to a four point cane so that patient does not use the stable bar to pull himself along with the flexors in the upper extremity. However, it is not desirable to rapidly progress from the four-point cane to a single-ended cane if the gait with the single-ended cane is not as good as it is with the four-point one. The criteria for going without support in the hand are that the gait should be unchanged whether with or without the support and the patient should have reliably stable balance.

*If the patient has impaired position sense in the lower extremity, it is not only difficult to train him/ her to walk, it is also unsafe.*

Such patients may take longer to walk independently, but with continued repetitive training, they can compensate for their lack of position sense and may safely walk alone. However, they need to be trained to be careful during walking because, as for any older patient with poor proprioception, careless inattention may result in a fall.

*Spring-action metal braces will eventually have no place in stroke rehabilitation because plastic braces and electrical stimulation foot-drop devices are superior.*

Both of these new developments do offer many advantages, both in lightness and in cosmesis. However, it is questionable whether they are as effective as the spring-action metal brace, such as the Klenzak, in patients who have difficulty with lateral stability in the ankle. An electro-brace which stimulates the ankle dorsiflexors during the swing phase of gait would provide enough proprioceptive feedback to develop the appropriate engram for walking more rapidly than will occur by training in a brace, has not yet been reported.

## 3. Recovery of Ability to Balance

*The patient is not yet ready to sit up in a chair, because he cannot maintain his balance, me impaired sense of verticality comes back in time; training does not have much effect.*

Kottke<sup>19</sup> has pointed out clearly that balance is trained by progression from a broad-base with adequate lateral support to removal of lateral support and narrowing the base so that the patient learns to compensate. The semisitting position, early, strongly stimulates the labyrinthine righting reflex to contract the muscles of the neck to hold the head in an upright position. Maintaining balance has to be relearned. Postponing the relearning does not shorten the learning time. Until the patient has regained the ability to balance and shift trunk posture easily, he/she has not developed the coordination necessary for balancing on the lower extremities or walking. Kottke<sup>19</sup> carefully outlines

the step-by-step progression of training which can facilitate and shorten the time of relearning balancing.

#### 4. Management of Spasticity

*Spasticity is a negative factor which should be eliminated or diminished as much as possible.*

Sometimes, because of interference resulting from spasticity, the necessity for neuromuscular reflex function is not appreciated. The presence of hyperreflexia interferes with normal performance. Normal stretch and postural reflexes are essential for normal performance. The hyperactive reflexes that are such a problem for the stroke patient make standing and walking easier for normal individuals.

For example, the extensor thrust reflex allows us to stand easily without voluntary contraction of the extensor muscles of the lower extremity. It also helps the hemiplegic patient to maintain extension in the supporting extremity when standing and walking. Excessive inhibition of reflex activity decreases the functional capacity and these patients find that they are not able to stand and walk as well if their spasticity is reduced too much. Professionals who demonstrate a negative attitude toward the spasticity of the patient may make it difficult for that patient to accept this spasticity.

*The most important factors in management of spasticity are drugs such as dantrolene and diazepam (Valium) and also intramuscular neurolysis.*

Prior to the development of these newer methods of dealing with spasticity, more attention was paid to other factors which still may be important. If spasticity becomes worse after having been present for a long period of time, a search should be made for those factors which enhance spasticity, such as a painful condition, contracture, inflammatory reaction, anxiety, or tension. Often, if these have been identified and corrected, a pharmacologic or neurolytic approach is not necessary.

*Spring-action braces make spasticity worse.*

This idea was presented by a prominent figure in the early days of the development of the field of rehabilitation. However, a study by Machek<sup>20</sup> in 1958 disproved this statement. Despite Machek's study, there is evidence that this idea persists.

*Inhibition of spasticity through training has been tried but does not help.*

The patient with spastic hemiparesis can, through training, learn to inhibit some of the spasticity. The problem is that this training takes a long time and could not be completed in just the usual 3-to-4-week period of intensive inpatient rehabilitation training.

#### 5. Psychological Aspects

*Keep the stroke patient quiet for the first week or so after onset.*

This old custom probably originated from the same fear of making the stroke progress as the practice of not allowing the patient to sit up. Stimulation from the

environment is necessary to activate the central nervous system, including the internuncial pool in the spinal cord, to permit optimal motor functioning in the paretic extremities. The isolated patient soon begins to experience intellectual regression.<sup>21</sup> Formerly, this was considered a natural accompaniment of stroke, but in actuality it probably is due to the isolation imposed on the patient.

*The depression in stroke is largely due to the insult to the central nervous system and is a part of the natural history of stroke.*

Some stroke patients experience so little, if any, depression that it does not interfere with rehabilitation training. In the field of rehabilitation, rather than depending on a pharmacologic approach to depression, we use success in training as a way of counteracting the tendency to depression.<sup>19</sup> The rehabilitation staff must establish a program within the capacity of the patient, so that the patient experiences nearly continual success. Working just below the peak of ability to perform is the fastest way of increasing the level of performance. It is especially important that each day the patient completes his/her activity with a successful performance. In this way, rehabilitation helps the stroke patient minimize depression.

*We seldom get questions regarding sexuality from stroke patients, because most older persons are just not concerned about their sexuality.*

Several factors probably lead to this erroneous conclusion. The patients sense that the professionals are uncomfortable with sexuality and thus are reluctant to initiate a discussion of the subject. Second, many professionals feel that older people are not concerned about sexuality. Sexuality is a broad term, meaning more than just the actual sex act. It includes the patient's view of his or her role as a male or female. When the professional does question the patient, a variety of concerns is often expressed by the patient about his or her sexuality.

#### 6. Communication Impairments

*Because the patient has impaired comprehension of speech, he will have great difficulty in his/her rehabilitation training.*

The patient who has impaired comprehension of verbal communication (spoken or written) will also experience difficulty in understanding rehabilitation training when presented verbally. However, if the patient's comprehension of gesture, demonstrations, contextual clues, and other aspects of nonverbal communication is unimpaired, then rehabilitation training may still be possible. Experienced professionals who utilize nonverbal communication are the key factor in training the patient with verbal impairment. Some rehabilitation professionals have a clinical opinion, unverified by actual studies, that patients with perceptual-function impairment associated with right hemisphere involvement may have as much or more difficulty in learning as the patient with impaired verbal comprehension associated with right hemisphere involvement.

*Is speech therapy truly effective in stroke?*

A tendency to discredit speech therapy for stroke patients was initiated by the carefully controlled study on the value of speech therapy in severely involved stroke patients by Sarno and colleagues.<sup>22</sup> This investigation showed no significant difference in the communication outcome of the three groups tested: those who received programmed instruction, those who received nonprogrammed instruction, and those who received no instruction or speech therapy. Unfortunately, those who have done the discrediting have forgotten that Sarno and her colleagues were dealing with only severely involved aphasic patients. Sometimes the positive benefits of speech therapy have been overlooked in patients with dysarthria, apraxia, and Schuell's classifications I and II of aphasia. Sarno also emphasizes the importance of speech therapy as a psychotherapeutic tool, because it is one of the most significant supportive types of care the stroke patient receives.

*For the stroke patient with minimal impairments ill communication who desires to return to a high level of functioning, current methods have little to offer.*

A good example of this dilemma is the book entitled *Episode*, by Eric Hodgins,<sup>23</sup> who insisted on returning to his pre-morbid life style of being a writer and public speaker. Most speech therapy approaches are aimed at patients with more extensive involvement. Recently, however, McGraw-Hill<sup>24</sup> produced materials for diagnosis and training of patients who have mild and subtle impairments that show up only in very high-level reading and writing. It will be interesting to see if, through further applications of such training, patients can regain functioning at the same high level at which they communicated before their strokes.

#### 7. Application of Neurophysiology in Stroke Rehabilitation

*Repeated use of the neural pathway decreases its synaptic resistance.*

This hypothesis maintains that repeated use of a pathway decreases its synaptic resistance and therefore makes excitation easier. Kottke<sup>19</sup> has pointed out that this hypothesis does not coincide with the general observation that repeated excitation increases, rather than decreases, the threshold of the excited cell. More plausibly, the proprioceptive feedback initiated by muscular contraction makes it possible for the patient to test and to learn the kind of effort which results in the desired muscular contraction. Since, initially, the effort is great, the overflow may be widespread throughout the central nervous system and the muscular response diffuse. With continued practice through the learning process, the patient refines these movements by reducing effort and focusing on the desired response. As the volitional control improves, the patient learns to inhibit undesirable components of synergic reflexes in order to develop a coordinated motor engram.

*Because of the confusion caused by many "systems" of reeducation and training used in cerebral palsy, there is a need for a well-organized approach to stroke.*

This need has now been well met by Kottke's chapter in Licht's text.<sup>19</sup> Kottke says that the types of therapy to be utilized can be divided into phases depending on the state of

the neuromuscular function of the patient: (1) activation of nonresponsive muscles; (2) reinforced feedback; (3) inhibition of muscles not in a coordinated engram, and (4) improving performance of the engram.

*A study has been reported that training for perceptual-motor-function deficits was not effective for rehabilitation of patients with completed stroke.*

This study by Taylor and associates<sup>25</sup> does not mean that treatment of perceptual and cognitive deficits utilizing many principles and materials developed by Dr. A. Jean Ayers is totally ineffective and not indicated for adult left hemiparetics. It simply means that during a brief, intensive, comprehensive rehabilitation program, the patients receiving this type of training did not make any more rapid progress in learning activities of daily living than did the control group receiving only conventional ADL training. More beneficial effects might have been shown if the special training had been carried on for a longer period of time (even following discharge from inpatient rehabilitation training) and other outcome criteria had been used rather than speed of learning ADLs. The old adage that skill in any performance is developed most rapidly by the successful practice of that performance is also supported.

#### 8. Research

*Statistical studies on stroke vary so in their results that they are obviously not reliable.*

Even the studies elaborate in the details recorded about stroke patients, have not been specific about the inclusion of transient ischemic attacks (TIAs). Since TIAs constitute approximately 50 percent of all strokes, it is highly important to know, in a series reported, whether they have been included or excluded. Thus rehabilitation professionals continue to use the term "completed stroke" leaving no doubt that TIAs are not included.

*Most significant research on completed stroke rehabilitation has already been done.*

This is untrue. Many areas still have had little if any work done. For example, consider visual-field deficits in stroke. What is the natural course of these? How much of the improvement is due to spontaneous recovery, and how much is the patient learning to compensate? How effective is this training when the patient uses denial about the deficit?

In another area, most rehabilitation professionals are aware that some perceptual motor deficits can improve with training in adult hemiparetics long after the period of spontaneous recovery. Ayers, using some of her materials employed with hemiparetic children, has made an early attempt to begin such a study, but this field is generally still open for investigation (unpublished data).

#### Conclusions

As the field of rehabilitation for stroke patients progresses and better understanding of stroke patients and the rehabilitation process develops, the need to reexamine

and reconsider the principles and attitudes with which these are approached becomes more critical. Though this paper covers only a few items each for a few categories, hopefully it will stimulate continued search for further uncovering of misperceptions regarding stroke rehabilitation.

#### ADDRESS REPRINT REQUESTS TO:

Thomas P. Anderson, M.D.  
Department of Physical Medicine and Rehabilitation  
University of Minnesota  
Minneapolis, MN 55455

#### References

1. Anderson TP, Bourestom N, Greenberg F R, Hildyard VG: . Predictive factors in stroke rehabilitation. *Arch Phys Med Rehabil* 55: 545-553, 1974
2. Birch HG, Proctor F, Bortner M, Lowenthal M: Perception in hemiplegia: I. Judgment of vertical and horizontal by hemiplegic patients. *Arch Phys Med Rehabil* 41:19-27, 1960
3. Feldman DJ, Lee PR, Unterecker J, Lloyd K, Rusk HA, Toole A: Comparison of functionally orientated medical care and formal rehabilitation in management of patients with hemiplegia due to cerebrovascular disease. *J Chronic Dis* 15:297-310, 1962
4. Waylonis GW, Keith MW, Aseff JN: Stroke rehabilitation in midwestern county. *Arch Phys Med Rehabil* 54: 151-155, 174, 1973
5. Boyle RW, Scalzitti PD: Study of 480 consecutive cases of cerebral vascular accident. *Arch Phys Med Rehabil* 44:19-28, 1963
6. Eisenberg H, Morrison JT, Sullivan P, Foote FM: Cerebrovascular accidents: incidence and survival rates in defined population, Middlesex County, Connecticut. *JAMA* 189:883-888, 1964
7. Lowenthal M, Tobis JS, Howard IR: Analysis of rehabilitation needs and prognoses of 232 cases of cerebral vascular accident. *Arch Phys Med Rehabil* 40:183-186, 1959
8. Whisnant JP, Fitzgibbons JP, Kurland LT, Sayre GP: Natural history of stroke in Rochester, Minnesota. 1945 through 1954. *Stroke* 2:11-22, 1971
9. Matsumoto N, Whisnant JP, Kurland LT, Okazaki H: Natural history of stroke in Rochester, Minnesota, 1955 through 1969: extension of previous study, 1945 through 1954. *Stroke* 4:20-29, 1973
10. Stammer J: Epidemiology of cerebrovascular diseases, In De Forest RE (ed): *Proceedings of the National Stroke Congress: Rehabilitation— Management— Prevention*, October 29-30-31, 1964, Chicago, Illinois. Springfield, 111, Charles C Thomas 1966, pp 24-37
11. Anderson E, Anderson T, Kottke F: Maintenance of gains achieved during stroke rehabilitation. *Arch Phys Med Rehabil* 58:345-352, 1977
12. Anderson TP: Stroke evaluation of its quality by assessing patient outcomes. *Arch Phys Med Rehabil* 59:170-175, 1978
13. Anderson TP: Quality of rehabilitation: Evaluation by assessing patient outcomes (submitted for publication)
14. Kottke FJ: *Historia obscura hemiplegiae*. *Arch Phys Med Rehabil* 55:4-13, 1974
15. Peszczynski M, Benson DF, Collins JM, Darley FL, Diller L, Greenhouse AH, Katzen FP, Lake FL, Rothberg JS, Waggoner RW: Report of Joint Committee for Stroke Facilities — II. Stroke rehabilitation. *Stroke* 3:373-407, 1972
16. Lehmann JF, DeLateur BJ, Fowler RS Jr, Warren CG, Arnhold R, Schertzer G, Hurka R, Whitmore J J, Masock AJ, Chambers KH: Stroke rehabilitation: outcome and prediction. *Arch Phys Med Rehabil* 56:383-389, 1975
17. Emler HE Jr, Williamson JW, Dittmer DL, Davis JR: Estimated health benefits and costs of post-onset care for stroke in a three state area: Minnesota, North Dakota, and South Dakota. Prepared by Analytic Services Inc, in cooperation with Interstudy American Rehabilitation Foundation
18. Lehmann, JF, DeLateur BJ, Fowler RS Jr, Warren CG, Arnold R, Schertzer G, Hurka R, Whitmore J J, Masock A J, Chambers KH: Stroke: does rehabilitation affect outcome? *Arch Phys Med Rehabil* 56:375-382, 1975
19. Kottke FJ: Neurophysiologic therapy for stroke. In Licht S (ed): *Stroke and its Rehabilitation*. New Haven, Elizabeth Licht Publisher, 1975, vol 12 of Physical Medicine Library, pp 256-324
20. Machek O: Is elastic bracing contraindicated in spastics? *Arch Phys Med Rehabil* 39:245-246, 1958
21. Mossman PL: *A Problem-Oriented Approach to Stroke Rehabilitation*. Springfield, Ill, Charles C Thomas, 1976
22. Sarno MT, Silverman M, Sands E: Speech therapy and language recovery in severe aphasia. *J Speech Hear Res* 13:607-623, 1970
23. Hodgins E: *Episode; Report on Accident Inside my Skull*. New York, Atheneum Publishers, 1963
24. Raygor A (ed): *Basic Skills System*. New York, McGrawHill Book co, 1970
25. Taylor M, Schaeffer NJ, Blumenthal FS, Grisell J L: Perceptual training in patients with left hemiplegia. *Arch Phys Med Rehabil* 52:163-169,