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The Patient with Cardiovascular Disease and Rehabilitation: The Third Phase of Medical Care

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ONE of the most striking developments in recent medical thinking has been the evolution of the philosophy of rehabilitation, or the “third phase of medical care.” The impact of this discipline on medical practice stems from the widespread intensification in contemporary medical teaching of the concept which delineates “the patient as a whole”—his relationship not only to himself, to his family, and to his work, but to the total community.

Development of rehabilitation programs has been paradoxically furthered by the recent advances made in the control of infectious diseases as well as in improved surgical and public health techniques which have extended the life span in this country. As a result, greater numbers of the population will fall into the category of patients with chronic disease. While it is probable that current investigational activities will eventually clarify the etiologic bases and methods of prevention of such entities as arteriosclerosis, hypertension, degenerative neurologic disease and cancer, there is a critical need for salvaging the large numbers of individuals with the residua of chronic disabling disease who now constitute serious medical and social problems. This has significant implications for the patient as well as the community at large.

Rehabilitation was defined at the first (1950) National Conference on Cardiovascular Diseases as “the return of a person disabled by accident or disease to his greatest physical, mental, emotional, social, vocational, and economic usefulness, and, if employable, an opportunity for gainful employment.” In addition, it was emphasized that “it should not be confined to economic or vocational rehabilitation but should aim at the maintenance of the personal dignity of the individual and the expansion of his capacity for living by enabling him to make the best of his physical and mental faculties.” Rehabilitation, therefore, carries the patient from “the bed to the job.”

The relationship of rehabilitation to the patient with cardiovascular disease in its broadest sense is evident. The need for such programs in the disease entity which is first in mortality incidence and high in morbidity with resultant undetermined economic loss becomes clear. In this connection, it is to be noted that industrial absenteeism as the result of cardiovascular disease in the first half of 1952 was preceded in incidence only by respiratory diseases. The need is further demonstrated by the number of patients discharged with diagnoses of cardiovascular disease or its complications from the various services of this Department in 1950; they numbered 158 (49 per cent) of a total of 325 discharges with diagnoses of nontraumatic disease. In addition, there were 151 discharges...
on a traumatic (industrial, traffic, etc.) etiologic basis, making a total discharge number of 476 of which the cardiovascular disease groups comprised 33 per cent. Of the latter, 90 per cent had significant underlying systemic disease which necessitated regulation of the cardiac therapeutic regimen in accordance with the progressive demands of the graduated retraining program.

Rehabilitation in some medical circles has unfortunately assumed a "catch word" connotation. This, at once both the oldest and the newest of the medical disciplines, proposes to effect no miracles but rather attempts to assess and manage the patient from sound bases of medical, physical and occupational therapeutic, speech and hearing, prothestic, psychiatric, vocational counseling, prevocational training, social service, and therapeutic recreational programs. This implies and actually epitomizes in its most cogent fashion the "team approach." It must be strongly emphasized that the leading and cohesive influence must be exerted by the physician, since the basic problem concerns a patient with a disease process. There has been recent consideration of rehabilitation in some quarters as a "paramedical" discipline. Nothing could be further from the truth; nor can it be considered as "glorified social work." Medical rehabilitation has a primary medical basis, and, as a result, the guiding force remains the physician. A rehabilitation program can only be effective if candidates for retraining are properly selected. It is a general principle that patients in whom the underlying disease process progresses at a more rapid rate than the retraining process are not feasible for such programs. Only the physician can determine this. In addition, observation of the patient in terms of cardiac reserve is necessary during the retraining process, particularly during ambulation and exercise phases. This is especially true of the patient with cardiovascular disease.

In rehabilitation, disability of patients with cardiovascular disease may be considered as comprising two main categories: (A) that which results from a complication of underlying systemic cardiovascular disease where the disability is "overt," for example, hemiplegia as the result of a cerebrovascular accident, and (B) that which results from diminished cardiac reserve and which appears in the form of signs and symptoms of cardiac decompensation as the result of activity, either of daily living or occupational. This may be considered as "masked" disability.

A. The First Category

Hemiplegia is most frequently due to cerebrovascular thrombosis, followed next in order of frequency by hemorrhage and embolism. Etiologically, in decreasing incidence, it occurs in arteriosclerosis, hypertension, rheumatic or congenital cardiovascular disease. It has been estimated that there are at present in this country approximately a million patients with hemiplegia with varying degrees of disability. As previously indicated, a large percentage of such patients observed on the services of this Department have a degree of underlying systemic cardiovascular disease which requires management in terms of variations in digitalis, diuretic and other therapy to allow for effective participation in the retraining program.

In addition, since mitral valve commissurotomy and other cardiac surgical procedures will become more widely performed, it is anticipated that hemiplegia resulting from the occasional postoperative complication of cerebral embolism will increase the number of potential candidates for rehabilitation training. Three such patients have come under observation in this Department this past year. These were all highly motivated and relatively young individuals with important vocational and household responsibilities. This type of patient makes an excellent candidate for retraining. Clinical observation during the ambulation program indicates that these patients maintained adequate cardiac reserve postoperatively for effective and safe participation in the retraining program.

The early management of the acute cerebrovascular episode primarily involves purely medical and possibly surgical considerations where indicated. Measures in the acute phase are supportive and prophylactic. The efficacy of stellate ganglion block is dubious. A recent controlled study has indicated that there was no significant effect of this procedure on hemi-
plegia. Such studies are needed to clarify this problem since the technic is not wholly innocuous and is apparently widespread in its application. Further understanding of the physiology of the cerebral circulation in man with reference to autonomic nervous system function and other homeostatic mechanisms is required in this respect. Development of the nitrous oxide technic has allowed quantitative observations of cerebral hemodynamics and metabolism as effected by stellate ganglion block, a variety of drugs, and in certain disease states. In addition, a recent report indicates that at a level of exercise of energy cost three times the basal level, cerebral blood flow in normal subjects was significantly increased.

Since it has been suggested that there is a tendency for cerebral vascular episodes to be repetitive, it would appear worthwhile to explore the value of anticoagulant therapy with long range follow-up in a series of such patients, properly selected and excluding those with hemorrhage. To date no study of this nature, adequately controlled, has as yet been reported. With stabilization after the initial insult, management involves graduated sequences of active and passive motion of the affected extremities, ambulation, and speech training if aphasia has supervened. Objectives of early management are the prevention of contractures and deformities. Rehabilitation procedures can begin as soon as the patient regains consciousness when it is relatively certain that thrombosis has occurred. The same applies where hemorrhage is suspected, but here only careful passive procedures, carried out in bed, should be allowed for a period of three weeks. Where the etiologic factor is embolism, active rehabilitation procedures may be started with the return of consciousness if no other systemic contraindication exists.

As already indicated, retraining is not considered feasible where the underlying pathologic process progresses at a more rapid rate than the rehabilitation program. For this reason, the question of case selection is of special importance with reference to cardiovascular disease. Patients in the malignant phase of arteriolar-nephrosclerosis, with involvement of cerebral cortical tissue to such an extent as to preclude adequate mentation and retention, and intracerebral coronary insufficiency or congestive failure are not suitable candidates for undertaking such programs.

The various steps in rehabilitation of the patient with hemiplegia involve a graduated sequence of procedures which carry the patient from the bed through ambulation and activities of daily living which make for self sufficiency and, if feasible, in selected instances through vocational retraining and eventual job placement. Such patients can be evaluated and followed objectively by the use of charts for muscle strength (Brunstrom modification of Lovett method), range of motion (goniometrically determined), and activities of daily living (ADL) for serial analyses before, during, and after such training programs. Using these methods in a carefully controlled study and quantitating the results, it has been shown that a group of patients who had undergone rehabilitation demonstrated an increment of more than 130 per cent in activities of daily living when compared with a control group that had no rehabilitation training. Both series of patients were selected with regard to age, sex, etiology, type of cerebrovascular accident, and especially with regard to time after the acute insult. In addition to the increment in activities of daily living, increases were also noted in range of motion and muscle strength in the retrained group.

The general details of such a rehabilitation program are as follows:

I. Procedures which are started while patient is in bed

1. A foot board or posterior leg splint to prevent foot drop.
2. Sand bags to prevent outward rotation of the affected leg.
3. A pillow in the axilla of the involved upper extremity to minimize adduction and internal rotation.
4. Quadriceps muscle setting of the involved lower extremity to maintain muscle strength.
5. Sitting in bed to help re-establish balance. (This may at first be assistive, but later the
patient may use a sheet tied to the foot of the bed as an aid in doing this himself.)

6. Speech therapy if the patient is aphasic (where the insult occurs in the dominant hemisphere). This may be done by a speech pathologist, or if not available, by a speech or elocution teacher who often can be recruited from local high schools, or colleges. In this connection, it has been our experience that the prognosis for return of speech is more favorable if the aphasia is of the expressive type. This aspect of retraining should be intensive, especially in individuals who have developed this avenue of communication to a high degree, since in these the speech difficulty is especially frustrating and often leads to significant psychologic overlays which interfere with the rehabilitation program.

7. Pulley therapy to prevent shoulder ankylosis and to aid in the development of reciprocal patterns in the upper extremities. This can easily be managed with the use of a modification of an overhead frame, a clothesline pulley, and a length of clothesline. (In addition, a member of the family or the attendant may be taught to give passive range of motion.) Experience has shown that relative return of function in the affected arm is usually less than in the involved leg. The reason for this is still obscure. Accordingly, emphasis should be placed as early as possible on the use of the unaffected arm; this is especially true of the relatively young patient with rheumatic heart disease. In addition, a triangular arm sling should be used to elevate the affected arm. This is of some aid in minimizing localized edema which frequently supervenes in the extremity.

II. Procedures which are initiated when patient is out of bed

1. When ambulation is started, the patient (a) practices balancing in the standing position; (b) uses parallel bars (two ladderback kitchen chairs on a smooth wood or linoleum surface may be substituted); (c) is taught heel and toe gait to prevent clonus and to re-establish normal walking habits; (d) stresses reciprocal motion in both the upper and lower extremities; (e) uses a short leg brace to correct foot drop (approximately half of cases). In those individuals where the quadriceps muscle of the involved extremity remains poor or at zero level of function, a long leg brace should be considered, with the possibility of an ischial weight-bearing attachment.

2. While ambulation is continuing, the patient is taught how to manage stairs, ramps, and how to enter an automobile or bus.

3. Activities of daily living are also taught. These include: (a) personal care; (b) feeding; and (c) hand activities such as opening doors, operating light switches, and telephone dialing. As aids in these activities, modifications of standard implements have been devised such as a knife (serrated cutting edge) and fork on one handle, zippers instead of laces in shoes and zipper front shirts. For the hemiplegic housewife, slight modifications in the physical aspects of the kitchen can allow for effective functioning. The details of such a retraining program have been fully outlined in a recent monograph, which, in addition, considers other features of hemiplegia as a disease entity.

After a satisfactory score in activities of daily living has been attained by the patient, aptitude testing, vocational retraining, if necessary, and selective placement may follow.

Results obtained with this dynamic approach indicate that the outlook for the hemiplegic patient is far from hopeless, provided intelligent case selection is effected. In our experience, approximately 92 per cent of such patients can be rehabilitated to the point of discharge from the hospital with self-sufficiency in activities of daily living in an average of from six to eight weeks, and roughly one-third of these can be placed effectively in selected vocational activities.

B. The Second Category

The second category of patient with cardiovascular disease for whom rehabilitation has great significance comprises those individuals with hypertensive, arteriosclerotic, syphilitic or rheumatic myocardial and valvular lesions whose cardiac reserve is so diminished that signs and symptoms of decompensation supervene during activity, either of daily living or of occupation. This group would also include
those with iatrogenic heart disease, who fear activity because they have been told by physicians that they suffer from heart disease and should therefore curtail or modify work habits—information often given without specificity. In this connection, it is to be noted that the Work Classification Unit at Bellevue Hospital has demonstrated that a total of 631 adequately studied patients 175 (28 per cent) did not have cardiac disease but had been carried as such for varying lengths of time. Many cardiac patients can work provided careful diagnosis is made, motivation is present, anxiety alleviated, adequate tolerance studies performed, and they are selectively placed in jobs whose demands are matched by their physical capacities. This has been demonstrated by the experiences of the War Manpower Commission, Eastman Kodak Company, Pratt and Whitney Aircraft Company, among others.

Probably the greatest deterrent to a quantitative approach to the problem of these patients has been the lack of objective methods of study within the rehabilitation framework. It is evident that accurate and meticulous diagnosis of the underlying cardiac condition is mandatory. Patients with aortic and mitral stenosis to any significant degree should not be considered for occupational activities in which the public safety might be endangered where sudden syncope may supervene unexpectedly (notably public transportation work, window cleaning, and other scaffolding jobs).

While there have been isolated observations reported of experiences relative to employment of cardiac patients, these have been from a comparatively restricted industrial medical point of view. However, the most carefully analyzed data are those reported by the Work Classification Unit established as a functional component of the Thursday Night Adult Cardiac Clinic of the Third (NYU) Medical Division at Bellevue Hospital in 1941; this was supported for a time by the New York Heart Association. This cooperative venture proved to be a prototype of the Work Classification Units which are now becoming established not only in other cardiac clinics in New York City but throughout the country. While the patient population (631) analyzed may not be truly representative, basic observations relative to etiology, duration of employability, effect of employment on cause of heart disease, absenteeism, and other relevant matters, have been made by this group. Emphasis by this Unit has been placed, as previously indicated, on the relatively high percentage (28 per cent) of patients who had been carried as “cardiacs” for a number of years with resultant interference in work patterns, and who, upon careful examination, were revealed not to have heart disease. It is possible that the source of patient referrals will condition figures such as these since only 5 per cent of a total of 250 patients surveyed by the Work Classification Unit in Cleveland, Ohio, were carried as cardiacs who, after careful evaluation, were found to be free from cardiac disease. It is obvious from this that adequate diagnosis, in which all known technics are employed, should be the basis for any rehabilitation program.

The need, however, for an objective clinical measure of cardiac reserve in the patient with valvular or myocardial damage is great since the universally employed functional and therapeutic classifications of the Criteria Committee of the New York Heart Association, while subserving an extremely useful function, still depend considerably on the clinician’s judgment and, furthermore, do not attempt actually to assess the patient’s ability to do work of known energy cost. In addition, important psychological factors are difficult to estimate.

Laboratory technics involving cardiac catheterization are widely being utilized to study basic hemodynamics in normal as well as cardiac subjects. Such studies have resulted in clearer understanding of cardiovascular function and have had great influence in the development of the newer cardiac surgical technics. Patients with indwelling arterial and venous needles, or catheters, mouthpieces, or other similar appliances in place, who are lying on an x-ray table in a darkened room peopled by anywhere from four to six busy investigators and who are asked to pedal a bicycle at a cadenced rate, will hardly present a truly basal picture for purposes of job placement. While rises in pulmonary artery pressure measured by
means of the catheter may indicate the earliest sign of encroachment upon cardiac reserve, such methods are not feasible for routine clinical use for purposes of rehabilitation. To this end it would appear that the energy costs of specific standardized activities for the cardiac patient might be useful as a possible starting point. The assessment of actual work capacity may be very difficult to measure exactly, and can be dealt with indirectly by a knowledge of the approximate physiologic stress resulting from a given physical activity. This stress may be judged from the rate of energy cost required to accomplish the activity which may be of daily living or occupation. As far as is known there is no detailed information relative to this available, although a short abstract has indicated the energy cost of groups of cardiac subjects during three levels of bicycle ergometer exercise. There is apparently no reference in the literature relative to energy cost of activities of daily living or occupation for the cardiac subject. There is some information for normal subjects relative to energy cost involved in standardized laboratory activities (bicycle and treadmill) in the American literature and for that involved in actual jobs in the lumbering and shipbuilding industries, as well as in laboratory bicycle exercises, in the Swedish literature. Studies of similar nature involving certain occupational activities with tuberculous patients as subjects have been reported.

Housewives, who constitute the largest segment of the working cardiac population, have apparently been overlooked in programs of rehabilitation. As far as is known, there have been no energy cost studies reported for such patients. The need here is critical, since the woman with cardiac disease continues, of necessity in many instances, to do kitchen and housework. Such programs should consist of retraining as well as the development of energy conserving methods for the performance of routine household duties and design of household and kitchen equipment. To this end, a model kitchen, first assembled by the New York Heart Association, was made available to this Department for both patient training and research.

In view of the foregoing, studies of oxygen consumption, using both the closed respirometric, as well as the open (Douglas bag and Scholander gas analysis) technics in both normal subjects and cardiac patients under a variety of standardized activities, were undertaken. Oxygen consumption was calculated in milliliters per kilogram of body weight at normal temperature and pressure and referred to resting metabolic oxygen consumption. All subjects were carefully evaluated; hematologic, respiratory or endocrine dyscrasia which would have interfered with oxygen consumption precluded selection for study.

It has been demonstrated, for example, that both cardiac and noncardiac subjects expend less energy, as measured by oxygen consumption, in using the bedside commode for defecation than in using the bedpan. For the use of the commode the energy cost was at a level of three times, while the use of the bedpan was at a level of four times the resting oxygen consumption. This difference was statistically analyzed and a p value of less than 0.001 (computed according to Fisher and Yates) derived, which indicates that the difference was highly significant. In addition, the cardiac patient and the normal subject did not significantly differ with regard to the energy cost for performance of these activities. These data would appear to substantiate by objective physiologic evidence the clinical impression of the deleterious effects of the use of the bedpan and would appear to add to the significance of the recently advocated "armchair" treatment of acute coronary thrombosis.

Step walking on a staircase (six steps, each 7 inches high; total vertical height for one trip, 42 inches) was chosen as a basic task for exploration since this represents an activity requiring no learning or training and is one which is essential in the daily life of every individual employed outside the home who depends on public transportation to get to and from his place of employment. Inability to perform this important ambulatory function would place an almost insurmountable barrier in the path of occupational rehabilitation, particularly in the group of patients that come under observation in this Department.

In a series of over 50 cardiac subjects of all
etiology and ranging in functional classification from I through III, the performance of level walking and graduated stair walking (round trip) activities under standardized conditions was at a level of energy cost as measured by oxygen consumption ranging from 6.6 to 72.5 ml. per kilogram of body weight (approximately 2 to 24 times above the resting metabolic rate). Most of the cardiac patients, including those classified as III, could perform these activities without serious difficulty. All cardiac subjects observed in these studies were compensated and on adequate maintenance regimens. The results again compared very closely with those obtained with 44 noncardiac subjects.

The significance of these findings lies in the fact that very few actual working activities other than exceedingly heavy labor require a sustained output of more than two to four times the resting energy metabolism. It has been pointed out that work may be considered moderate when its cost is three times that of the basal rate, and strenuous when the cost increases to eight times the basal rate. It might be postulated, therefore, that these patients have a good to excellent potentiality for work of moderate energy cost, other factors such as motivation and aptitude being equal.

Similar studies have been performed in our occupational therapy shops for standardized activities involving the upper extremities and trunk musculature. These were designed to bring into function the major muscle groups. The subject was required to (1) cut a piece of pine board of standard dimensions into three outlined pieces by hand crosscut saw, (2) file and sand the cut edges and outside surfaces of the three pieces of wood, and (3) assemble the three pieces into a stool after boring holes with a hand drill and placing four screws by manual screw driver. These activities were designed for the purpose of analyzing a prototype sedentary, semiskilled set of activities. Oxygen consumed above resting metabolic requirement for each of the procedures was (1) sawing, two to two and one-half times, (2) filing and sanding, one and one-half to two times, and (3) assembling, one and two-tenths to two times. Here again no significant differences between the cardiac subjects and the control group were noted. In this series of studies the problems of motivation and purposeful activity have been obviated in large measure, since the end product was a useful and desirable object which the patient took home for use. Sex differences in energy cost were noted since in the female subject the energy cost was at a slightly higher level than in the male subjects. Apparently these were related to the unfamiliarity of the female subject with tools. The data derived indicate that the energy expenditure for a typical sedentary, semiskilled activity is not significantly demanding and that the patient who is classified as I–III can perform them without difficulty.

In the cardiac kitchen energy cost studies have been performed with standardized floor mopping and water-pail lifting and carrying in groups of compensated cardiac women, with noncardiac women of the same age serving as controls. These activities did not require specific skills or training, since they were routinely performed in any kitchen and, indeed, had formed an important pattern in the daily existence of all the subjects studied. The results indicate that the compensated cardiac woman is no less efficient in performance of these activities than the noncardiac. In addition, variations in the methods of performing the same work have revealed technics of energy conservation. The data appear to indicate that kitchen activities for the average cardiac housewife should be limited to those requiring a lower energy cost level than approximately 15 ml. of oxygen per kilogram of body weight (roughly five times the resting rate) for short periods of activity, since most of the cardiac patients developed signs or symptoms during the performance of activities with an energy cost above this level. Extension of such studies is important since this will provide safe work plans for maximum efficiency of cardiac women working in the kitchen.

In an effort to develop a simple objective method of screening which might serve as a possible aid in the determination of functional capacity for rehabilitation of the cardiac subject, it has been recently demonstrated that there is a high degree of positive correlation between the normality of the resting ballisto-
cardiogram (Dock type) and ability to do work of known moderate to marked energy cost (up to 24 times above the resting level) in a group of 51 cardiac patients. Application of the chi-square test to a two-way grouping of the results (excluding borderline and indeterminate cases) showed that the difference in ability to expend energy at known levels between patients with normal and abnormal resting ballistocardiograms was highly significant ($p$ value of less than .001). It is to be understood that no claim is made for quantitation since qualitative observations only were made of the normality or abnormality of the ballistic pattern, using the accepted criteria as outlined in the literature.

The value of the ballistocardiographic method, however, may be limited to those cardiacs who are less than 50 years of age, since it is well known that the ballistocardiogram becomes abnormal with increasing age. This is in accord with the conclusions of others. These age changes are not clearly understood, but the general consensus is that factors other than cardiac may play a role in their production.

Findings such as these may allow for more accurate classification and vocational placement of cardiac patients, since the studies show that under the conditions observed, a normal resting ballistocardiogram in the cardiac patient is very frequently associated with the capacity for moderate to marked energy expenditure. On the other hand, an abnormal resting ballistocardiogram gives no consistent information in this regard. This suggests that the resting ballistocardiogram, when normal, may be (a) a useful tool in evaluating the functional or working capacity of certain groups of cardiac patients for rehabilitation purposes and vocational guidance, and may serve as (b) a screening device for finding those cardiacs, other factors such as psychologic, motivation, and aptitude, being considered, who possess the functional capacity to perform jobs or activities whose energy requirements are known or can be estimated from physical-demands analyses. However, in view of the increasing incidence of abnormality of the resting ballistocardiogram in older age groups, for practical purposes its usefulness may be limited to that segment of the cardiac population under the age of 50 years—a not too inconsiderable group—who are, by virtue of being younger, more suitable for rehabilitation.

Using the methods outlined above and making an attempt to match the capacities of the patient with carefully reviewed physical demands of given selected jobs after aptitude, interest, motivation, and psychologic factors were analyzed, placements have been made of cardiac patients through the J.O.B. Committee—the job finding organization in this Department. Patients with what might be called "intractable iatrogenicity" have not been considered good candidates. It is of interest to note that greatest success has been with smaller industrial organizations where there were no organized medical departments. Rejection of the cardiac patient by larger industries appeared to be on factors other than those endogenous to the patient. Here, questions of seniority, other union practices, workmen's compensation, and other insurance implications seemed to mitigate against acceptance of the worker with cardiac disease for employment. The work experience of those cardiac patients who were selectively placed, usually in jobs which were related in some degree to past vocational experience, has been good to date. Follow-up studies are in progress.

Thinking relative to employment of the cardiac patient must be on a practical and realistic basis, since experience has shown that this problem is minimized in a situation where the labor supply is in short supply, while the converse holds true where the labor supply is adequate. As yet there is no mandatory legislation in this country as exists in England where industry is required by law to hire a certain percentage of disabled personnel. It is to be hoped this will never be necessary. In general, it might be said that American industry has had good experience with the employee whose cardiac disease has been discovered after some years of employment during a company medical survey. Selective placement within the company in a type of work more suited to the cardiac status has often been effected. It is the new employee with heart disease who applies for a job who has experienced the greatest dif-
difficulty in being accepted by industry, especially during times of full labor supply.

Current clinical experience indicates that the assignment of a specific functional classification is often conditioned by the physician’s own fears and prejudices about the patient’s ability to do work, to say nothing of the latter’s anxieties and exaggeration of symptoms. The frequency with which disabling cardiac neurosis (superimposed on nondisabling organic disease) is met with in the cardiac clinic is proof enough of this and is one of the greatest obstacles to the rehabilitation of the cardiac patient. It is hoped that explorations such as those indicated above, as well as the extension of the Work Classification Unit concept into more cardiac clinics, will eventually afford objective information which may aid in refining the functional classification of cardiac patients for more intelligent rehabilitation purposes.30

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