Deterioration of the Bedfast Patient

Causes and Effects

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IN RECENT YEARS increased emphasis has been placed on getting patients out of bed as quickly as possible. This early ambulation has been beneficial in preventing deterioration due to inactivity. Programs of early ambulation have usually been carried out most vigorously on the surgical services. On other services, particularly for severe illnesses which have a protracted course, prevention of deterioration of the patient may be neglected. When the patient is critically ill for days or weeks following an injury or is compelled to have bed rest for long-term illness, neglect of his total care will result in his deterioration. Rehabilitation is concerned with the restoration of the disabled patient to maximal independence. Prevention of deterioration during acute disability is an important factor in obtaining maximal recovery and should be instituted as a part of the program of care during any illness, acute or chronic.

Prolonged inactivity due to confinement to bed or lack of normal activity may result in permanent disability and delayed recovery. The basis of the development of functional ability by any organ of the body is use. Within physiological limits, each part of the body increases in functional ability in proportion to the load placed on it. Conversely, inactivity or nonuse results in regression of the part with loss of ability to function. Rest constitutes a period of nonfunction, and during prolonged rest of an organ the progressive loss of ability or deterioration of that organ occurs.

During disease or following injury to a part of the body, the functional capacity of that part is greatly decreased. At such times the normal physiological demands on that part may exceed its ability to respond, and rest is necessary to protect the part against further damage by exhaustion or to preserve homeostasis. Rest in such cases becomes functional by reducing activity to a level within the capacity of the part. Under these conditions the metabolic capacity of the injured organ is adequate to meet the metabolic demands of the decreased activity plus the metabolic demands of the response to the injury. As the organ increases in ability its metabolic reserve increases, and if the load on it is then increased its capacity to function will increase progressively. Although deterioration from disuse is most obvious in voluntary muscle, the same phenomenon occurs in cardiac muscle, the central nervous system, bone, the autonomic nervous system, and other organ systems.

When bed rest rather than rest or protection of only the injured parts is prescribed for a patient with a debilitating disease or following injury, a progressive deterioration of the normal parts of the body takes place while the injured part or parts are protected. During necessarily prolonged immobilization, deterioration may occur to the point that weeks or months of treatment may be necessary to reestablish normal function. Therefore, when rest is prescribed for therapeutic purposes its effect on all parts of the body should be evaluated. Adequate protection must be given to

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the injured part, but activity should be maintained in normal parts of the body to prevent or minimize their deterioration. There are times when normal parts of the patient's body deteriorate faster than the injured part heals. If the activities of the unaffected parts of the patient's body can be maintained during the time that he must remain in bed, his convalescence will be shortened and the cost of his care decreased.

The common kinds of deterioration of patients confined to bed are: (*a*) loss of mobility, (*b*) loss of muscular strength and endurance, (*c*) circulatory deterioration, (*d*) metabolic imbalances, (*e*) ischemic ulcers, (*f*) deterioration of the urinary tract, (*g*) respiratory deterioration, and (*h*) intellectual and emotional deterioration.

Loss of Mobility

In the normal process of breakdown and repair of body tissues there is continuous removal and replacement of collagen fibers. In the subcutaneous tissue, around joint capsules, in muscle planes, and in other moving parts of the body, collagen is laid down as loose areolar connective tissue. This loose connective tissue allows considerable range of motion to occur between the moving parts. If a part of the body is immobilized, the network of connective tissue becomes more dense and limits motion.

Connective tissue is continually reorganizing in structural orientation to provide support for organs and cells. The type of organization depends on the motion in the connective tissue. Collagen normally shortens to the length to which connective tissue is frequently stretched. The shortening appears to be reorganization rather than formation of new collagen.

Where there is considerable and frequent motion, loose areolar connective tissue is laid down. If the part is immobilized, dense connective tissue is formed instead of areolar connective tissue and will cause loss of motion in a few days when normal motion is not maintained (*1*).

Certain factors are known to alter the rate of formation of collagen. Edema due to trauma or to circulatory and lymphatic stasis limits motion and causes fibrosis to occur more rapidly

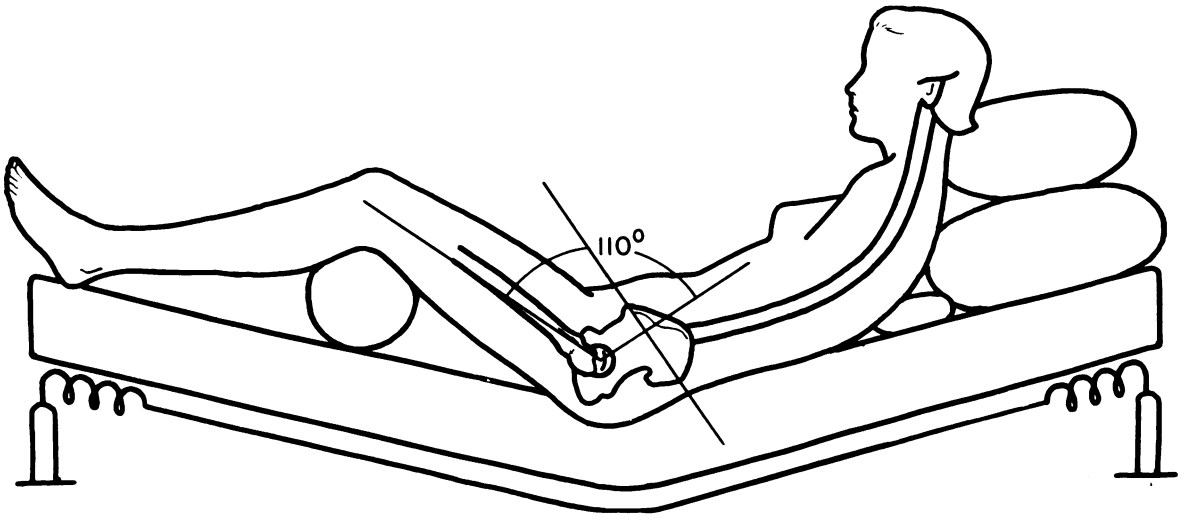

Figure 1. Improper posture in a soft bed contributes to the development of disabling flexion contractures. A pillow or a continuously elevated bed support under the knees increases flexion of both hips and knees. Flexion in the hips is nearer that of the sitting position rather than the 170° of extension required for normal standing. Prolonged flexion of the hips causes contractures and permanent limitation of extension of the hips. Lack of support for the feet results in shortening of the gastrocnemius-soleus muscle groups. Pillows under the shoulders increase thoracic kyphosis and the forward thrust of the head.

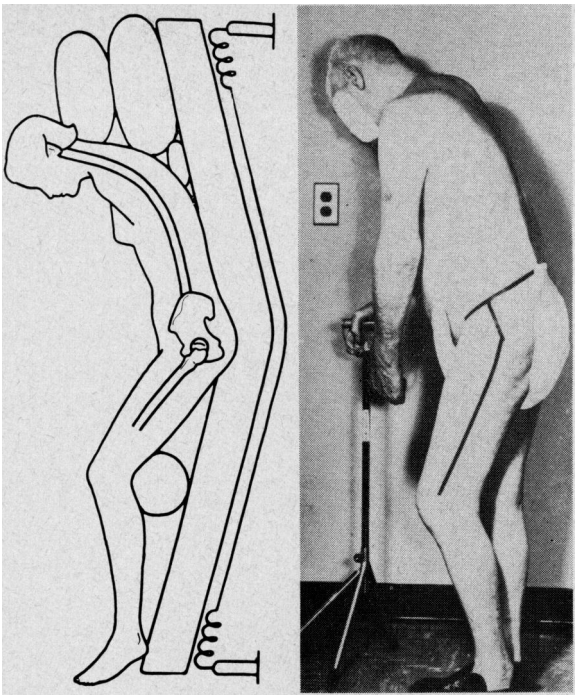

Figure 2. Similarity of the standing posture of a patient who was bedfast for 2 years following a stroke to his poor posture while in bed.
SOURCE: reference 2.

than normally. Following trauma, fibrin precipitates from the exudate which leaks through the walls of damaged capillaries and blocks the extravascular and lymphatic spaces. This interferes with the removal of fluid and results in brawny edema. Recurrent edema or inflammatory exudate secondary to infection increases fibrosis. In normal tissues the changes in collagen occur continually, but the processes of deposition and reorganization of collagen are accelerated following trauma or inflammation.

In an area of trauma, repair of connective tissue occurs in the following sequence. A fibrin clot forms in the area of bleeding or exudation in a few minutes. This provides a matrix on which new collagen is laid down. Reticular fibers appear in the fibrin matrix in 2 to 3 days. Collagen fibers develop on the reticulum anlage in 3 to 5 days. If motion is maintained in the area, flexible areolar connective tissue is formed. Immobilization following trauma leads to the formation of dense fibrosis which may require weeks or months to remove (*1*). By the end of 3 weeks the collagen meshwork has become so strong that it will resist vigorous stretching. Dense connective tissue forms more readily in areas with poor circulation than in areas with good circulation.

Clinical experience has shown that intracapsular or intramuscular contractures are particularly difficult to combat when they occur around certain joints. The following factors are significant:

1. Joints which are not easily moved through the full range of motion when the patient is in bed develop progressive limitation of motion. This is particularly true of the hip which is kept in partial flexion whether the patient is lying on a soft bed, semireclining, or sitting. Pillows under the knees increase the flexion in the hip and maintain flexion in the knee (fig. 1).

2. Any joint which is painful will be protected against moving through the full range of motion unless special exercises are supervised.

3. Weight-bearing joints must be extended fully for normal walking, otherwise great muscular strength is required. Contractures of the hips, knees, or ankles prevent many patients who have muscular weakness from standing and walking.

4. Some joints are extremely difficult to stretch. The hip flexors cannot be adequately stretched manually because it is impossible to immobilize the pelvis. The ankle is difficult to stretch when there is an equinus deformity because the shortened triceps surae is such a strong muscle.

5. Contractures developing in the direction of pull of gravity are difficult to stretch out because gravity tends to maintain the shortened position continually and resist the stretching. On the other hand, gravity helps by its continual action to stretch out antigravity contractures.

The deformities of posture which develop in patients with chronic diseases, such as rheumatoid arthritis, stroke, or multiple sclerosis, mirror the improper positions which are maintained in bed (fig. 2). Shortening of the triceps surae prevents ankle extension so that the heel cannot be placed flat on the floor or else causes recurvation of the knee. Unless the extensors of the knee and hip are very strong, flexion contractures of the hip and knee prevent independent walking and require excessive pressure on the joints. Thus, patients with arthritis or hemi-

plegia cannot regain independent ambulation. The rounded back shifts the center of gravity ahead of the normal weight-bearing line and increases the support required of the muscles. Patients fatigue quickly not only because of loss of endurance but, more important, because of the increased muscular work which they must perform. Likewise, shortening of the connective tissue around the shoulder, elbow, wrist, or fingers decreases motion and increases the energy required for activity.

Prevention of contractures is far easier than corrective therapy. Preventive treatment consists of both proper positioning and activity to maintain range of motion.

A bed which provides adequate support in the proper position to minimize contractures should have a bed board, a firm mattress, and a footboard, as shown in figure 3 and described in the following article. This kind of bed decreases the flexion of the hips and rounding of the back and shoulders which occurs in a sagging bed and maintains the postural relationships needed for standing (*3*). Any nonrigid support for the feet, such as a pillow or a poorly supported footboard, allows the feet to assume an equinus position so that contractures may develop in the triceps surae.

Maintenance of the full range of motion of all joints and normal flexibility of soft tissues is an important factor in the prevention of deterioration of the bedfast patient. Joint mobility depends on full flexibility of the surrounding soft tissues. When joints are immobilized the lack of motion in the surrounding joint capsules, connective tissue, and muscles allows fibrosis to tie these structures together tightly. Consequently, joint motion becomes limited and the patient is handicapped. Maintenance of motion of the joints prevents the development of restricting fibrosis.

Active motion, when possible, is the simplest way to maintain mobility. Watson-Jones has stated (*4*): "Every joint which does not need to be immobilized must be exercised actively from the first day of the injury. Failure . . . may be responsible for complications even more serious (than the original injury) because they often remain permanent despite treatment." However, patients cannot be depended on to maintain mobility unless they are given a specific exercise program. Simple calisthenics may be prescribed for the bedfast patient to perform several times daily. Passive motion may be carried out by a nurse or therapist when pain or paralysis prevent active motion.

All joints which need not be immobilized should be moved through the full range of motion at least two times each day. Joints or extremities which need support should be moved passively by a trained therapist. Painful joints, such as in arthritis, frequently can be moved freely if the extremity is supported and moved gently. For such joints, slings, calipers,

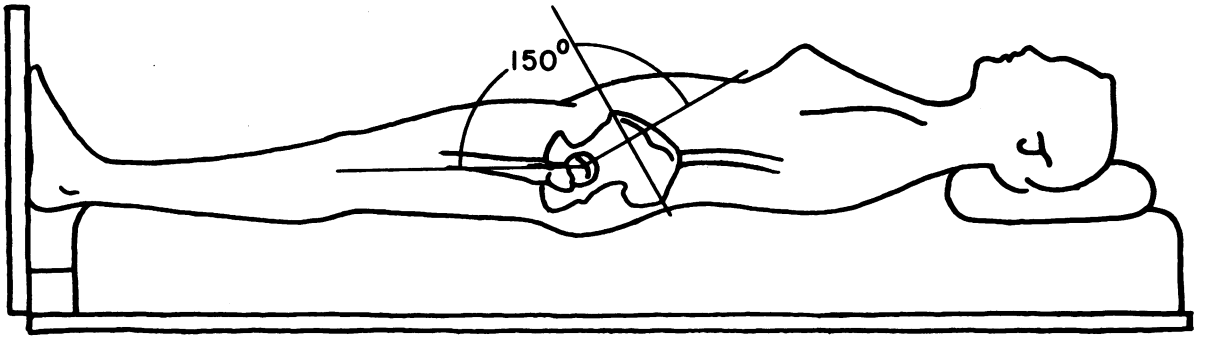

Figure 3. Posture on a bed providing proper support. A firm, flat mattress on a ¾-inch bedboard supports the patient so that the hips are extended to 150° (still 20° less than that in the standing position) and the knees are extended. The footboard, blocked 3 inches from the end of the mattress, holds the feet perpendicular to the legs. The space between mattress and footboard prevents pressure on the heels when the patient lies supine and allows space to maintain correct position of the feet when the patient lies prone.

or other supporting devices may be counterbalanced and suspended from a Balkan frame over the bed so that the patient may carry out passive movement of the supported extremity. Use of a skate board also makes it possible for the patient to carry out motion of the hips and knees with gravity and friction nearly eliminated.

When joints may not be moved because of fractures, any motion must be confined to the soft tissues. In these cases, maintenance of flexibility of soft tissues is especially important. Trauma has caused extravasation of blood into tissue planes. Fibrin has precipitated in the extravascular spaces and has formed networks on which collagen will be laid down. Edema decreases both the flexibility of the tissues and the nutrition of the cells. All these factors tend to produce dense scarring. As a result, motion in joints may be lost, even though no trauma has occurred to the joint surfaces. Heat stimulates increased circulation and increased healing. Massage is useful in these cases to aid venous and lymphatic return, reduce edema, and maintain flexibility in both muscles and periarticular soft tissues. Dense scarring is decreased by daily massage during the period of immobilization, and a greater range of motion is present at the time when bony union has occurred. Voluntary muscle-setting exercises are valuable to maintain the flexibility and also the strength of the muscles.

If a patient is severely ill or has a low cardiac reserve, passive motion is the method of choice to maintain range of joint motion. Daily passive motion increases the metabolic demand very little (*5*), far less than the increase caused by eating, yet if all joints are carried gently through the range of motion twice daily, contractures can be prevented. In patients with acute myocarditis or coronary occlusion, contractures commonly develop in the shoulders, hips, and knees during the acute stage of the disease when the patients are bedfast. Later, during convalescence, these contractures are a handicap to recovery.

Assistive devices may be attached to the bed to increase the patient's activity and independence. A trapeze bar suspended from a jury mast at the head of the bed is of great assistance to the patient when he wishes to move. It also provides exercise for his arms. The bar should be hung in such a way that it is level and will not slip. For the seriously disabled patient a trapeze bar 4 feet long suspended across the bed from a Balkan frame is more valuable (fig. 4). The bar extends beyond the side of the bed and the patient may use it to lift himself from the bed to the wheelchair and back into bed.

Loss of Muscle Strength and Endurance

The strength of a muscle is the maximal tension which that muscle can exert. The power of a muscle is the work which it can do per unit of time. The maintenance of a powerful muscle depends on its exertion of maximal tension at frequent intervals. In response to production of this maximal tension, the muscle fiber hypertrophies and its strength increases (*6*). Only a few strong contractions each day are necessary to maintain the strength of a muscle. However, if these few strong contractions are not produced the muscle gradually loses strength.

Studies have indicated that strength of a muscle can be maintained if there are daily contractions which exert a force of 20–30 percent of maximal tension of a muscle for only a few seconds (*7*). If the tension exerted daily is greater than 30 percent of the maximal tension there will be an increase in strength. A maximal rate of increase of strength occurs when there are a number of 5-second contractions each day at 60–100 percent of maximal tension. On the other hand, if the tension exerted each day is less than 20 percent of maximal tension, there is progressive loss of strength of the muscle until the tension exerted becomes greater than 20 percent of the strength of that atrophied muscle. When a muscle is maintained at complete rest there is a loss of 10 to 15 percent of strength per week of inactivity.

Certain kinds of disabilities produce situations which favor the physiological deterioration of the muscle with rapid development of weakness and atrophy. The inhibition of muscular contraction or joint motion because of pain causes rapid atrophy. Immobilization of a muscle in the shortened position in a cast or splint prevents the development of tension in a muscle and causes atrophy. Immobilized paretic muscles atrophy quickly. A muscle

which is short because of section of a tendon is unable to exert maximal tension and undergoes atrophy.

Endurance of a muscle is to a large extent a problem of adequate circulation to maintain nutrition and remove metabolites. If the circulation of a muscle is not adequate to supply its needs, endurance is poor. Any continuing exercise at more than 5 percent of the maximal strength of a muscle causes fatigue (*8*). The mean maximal tension which a muscle can produce by sustained or repeated contraction over a period of not more than 10 minutes is approximately only 20 percent of the maximal instantaneous tension of the rested muscle. Because circulation through the muscle is an important factor in the maintenance of endurance, the cardiovascular capacity becomes a major factor in determining endurance.

The patient who must remain in bed for a prolonged time should be given resistance exercises to do. A few strong contractions of a muscle each day are adequate to maintain the size and strength of a muscle. Pulleys or other exercise apparatus attached to the Balkan frame enable the patient to exercise the muscles of his unaffected extremities. A trapeze bar can be used to exercise the arms and shoulders and to assist the patient to transfer from bed to chair (fig. 4). Sit-up or pushup exercises can be used to strengthen the arms and trunk. Assistive or resistive exercise apparatus can also be adapted for the lower extremities for the period of time that the patient must remain in

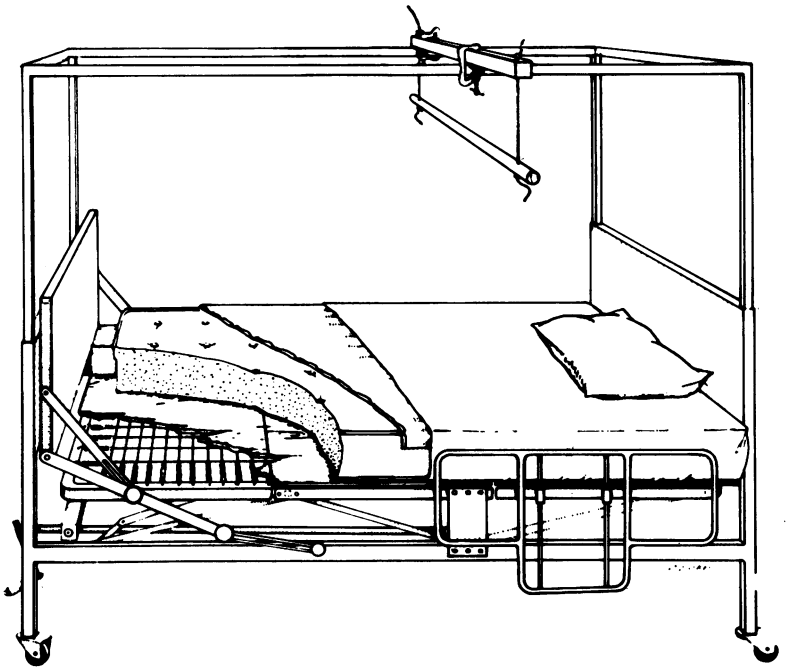

Figure 4. A fully equipped physiatric bed to maintain and assist the severely disabled patient. A hinged bedboard over the spring provides a solid support for a firm mattress. An alternating air-pressure pad over the mattress automatically redistributes the weight of the patient on a 5-minute cycle to prevent ischemic ulcers. The footboard is blocked 3 inches from the edge of the mattress to provide space for the heels. A half-length side rail protects the patient from rolling out of bed and provides a handgrip for him to use when sitting up. A 4-foot trapeze bar mounted on a Balkan frame enables the patient to shift laterally in bed or lift himself into a wheelchair beside the bed. Resistance exercise equipment or assistive devices may be attached to the Balkan frame.

bed. Nevertheless, the patient should not remain in bed longer than necessary. He should be transferred to a wheelchair and begin standing and walking as quickly as his condition allows.

Circulatory Deterioration

Changes in cardiovascular performance are often the most dramatic of the deteriorative changes due to bed rest. Through the autonomic nervous system the circulation adapts to the stress that is placed on it. Injury, disease, or fever make the circulation less able to adapt to stress and hasten deterioration. The adaptability of the circulation to the upright posture deteriorates quickly with bed rest. Taylor and associates (*9*) noted that when healthy young men were put to bed for 21 days there was a deterioration of the cardiovascular ability to respond to the upright posture, which was not regained until more than 5 weeks after activity resumed. In these men a relative tachycardia developed after 21 days of recumbency, and a pronounced tachycardia appeared when they were tilted to 68° on a tilt table. There was inability to maintain the blood pressure when erect, although the signs of strong activity of the sympathetic nervous system—palmar sweating, pallor, and restlessness—were present. The restoration of the cardiovascular system to its normal adaptability required from 5 to more than 10 weeks.

Older patients or patients who have been ill may show more rapid deterioration and recover more slowly. Painful congestion of blood in the feet and legs, vertigo, and fainting are common when a patient assumes an erect position after only a few days in bed. Prolonged bed rest always causes these symptoms. The painful tingling and burning of the feet and legs may prevent the patient from resuming full activity for weeks after prolonged bed rest. In older patients the reestablishment of the orthostatic reflexes may occur quite slowly and delay the return to normal activity.

As the patient remains bedfast, the cardiac rate at rest increases progressively. In healthy young men confined to bed, the cardiac rate at rest increased by approximately 0.5 beat per minute per day (*9*). After 3 weeks of bed rest these young men showed an increase of cardiac rate, during moderate work, of 40 beats per minute greater than before bed rest. They required from 5 to 10 weeks of conditioning before the cardiac rate during work returned to that prior to the prolonged bed rest. This progressive increase of cardiac rate at rest and the greater tachycardia during work indicate progressive decrease of ability of the cardiovascular system to function. The increased rate must be substituted for the diminished power of the myocardium and diminished vasoconstriction. During tachycardia the heart has less time to recover and fatigues more quickly. With this decreased cardiovascular reserve, the ability to do muscular work is greatly reduced. The ability to walk at 3.5 miles per hour on a 10 percent grade was decreased to 25 percent of normal after 3 weeks of rest in bed (*9*).

When it is necessary to keep the patient in bed, it is important that rest be confined only to the parts of the body requiring rest. Activities such as calisthenics, resistance exercises, and occupational therapy may be prescribed to keep the unaffected parts of the body active enough to prevent deterioration and to stimulate cardiac function. If the patient is transferred to a chair several times a day, this helps to maintain the postural and vascular reflexes. If the patient has been restricted to a recumbent position for a prolonged time, reestablishment of the orthostatic vascular reflexes will require time. It is most convenient to condition patients to the upright posture by placing them on a tilt table, which is tilted at an increasing angle for a period of 10–20 minutes as the patient's tolerance increases. When the patient can tolerate 20 minutes of standing on the tilt table at a 70° angle, he then can begin to stand in parallel bars and proceed from there to retraining in ambulation.

Occupational therapy of varying degrees of stressfulness may also be used to condition the patient. Numerous studies of the cardiac requirement of various occupational therapy activities have been reported which can be used both for testing the cardiac tolerance of patients and for progressively increasing their activity in order to develop myocardial endurance (*10*, *11*).

Metabolic Imbalances

Immobilization produces a disturbance of metabolic balances. The breakdown of protein and excretion of nitrogen have been reported to be increased during immobilization by a number of investigators who have found nitrogen losses of 1 to 2 grams per day in normal persons and much greater losses in abnormal states, as indicated in the following table.

Subjects	*Nitrogen loss per day (grams)*	*Source*
	2.3	(*12*)
Normal persons	1.59	(*13*)
	1.76	(*14*)
Fasting persons	12.0	(*12*)
Persons with fractures	8.13	(*12*)

After a period of 7 weeks of immobilization, a recovery period of 7 weeks was necessary before the normal subjects regained the nitrogen which had been lost.

A negative calcium balance also develops with bed rest. In a 7-week period of bed rest, 13.1 grams of calcium were lost. In the first 3 weeks of activity after the bed rest, an additional 4.4 grams of calcium were lost. This calcium is removed from bone which does not receive stress from the weight of the body or the pull of the muscles. Months or years may be required to restore the structure of osteoporotic bone following a period of immobilization. In recent studies using X-ray microdensitometric methods it has been possible to demonstrate measurable loss of calcium from the os calcis of normal young men immobilized for less than 1 week. ("The Effect of Bed Rest on Various Parameters of Physiological Function. XII. The Effect of Bed Rest on Bone Mass and Calcium Balance," by F. B. Vogt and associates.)

Other electrolytes have also been reported to go into negative balance merely from immobilization. All of these metabolic studies emphasize the profound effect on homeostasis at any time that a patient is immobilized. In all cases it has been observed that trauma, infection, or inflammation increase the negative balances.

Prevention of metabolic imbalances requires mobilization of the patient. Activity in bed, or better, transferring a patient to chair activities and to ambulation as quickly as possible is important in order to stimulate metabolism to restore normal balance. Abramson and Delagi (*15*) have shown that osteoporosis occurs even when patients are standing regularly if there is not muscular tension exerted against the bone as an additional stimulus to bone metabolism.

Ischemic Ulcers

Decubital or ischemic ulcers develop over body prominences or areas where pressure is great enough to prevent the flow of blood through the tissues (*16*). Malnutrition of the cells as a result of this ischemia causes death and sloughing of the tissues of the compressed area.

The common sites of ischemic necrosis when a patient is lying supine are over the sacrum and the heels (fig. 1). Prolonged sitting causes necrosis of the skin under the ischial tuberosities. In the lateral recumbent position excessive pressure is exerted beneath the trochanters, the femoral condyles, and the malleoli.

Ischemic ulcers occur most frequently in patients who are unable to move or who have areas of analgesia. Normally, dangerous ischemia is avoided because pain arising from the ischemic area causes the patient to move to relieve the pain. If the patient has an area of analgesia, pain is not present as a warning signal and ischemia may persist until necrosis occurs. Debilitated patients, paralyzed patients, and patients in casts or traction may develop ischemic ulcers because they are unable to turn or relieve the pressure. These patients present difficult nursing problems. To prevent a dangerous degree of ischemia the pressure should be relieved not less frequently than once each hour. To turn a disabled patient each hour requires a great deal of time of the nursing staff.

The use of special beds, such as the Foster bed or the Circ-O-Lectric frame, frequently are inadequate to prevent ischemic ulcers because even when patients are on these devices they are not moved frequently enough to prevent dangerously prolonged ischemia. The Stryker and the Foster frames were devised to enable a nurse to turn a patient more easily so that he would be turned frequently. To place a patient on a frame and not turn him, however, defeats the purpose of the apparatus and decubiti still develop.

Automatic shifting of the weight of the pa-

tient at regular short intervals is even more effective than the use of a Stryker or a Foster frame. The alternating air-pressure pad which automatically shifts the weight-bearing area under the patient on a 5-minute cycle has proved to be an effective apparatus (fig. 4). This pad is composed of parallel rows of plastic tubes approximately 1 inch in diameter. Alternate tubes are connected together, and they inflate and deflate on a 5-minute cycle. This change of distribution of pressure under the patient prevents prolonged ischemia of any area and the development of ischemic ulcers.

Patients who have poor nutrition for any reason have increased susceptibility to ischemic damage. Patients with low serum proteins have impaired cellular nutrition. They are especially vulnerable to ischemic necrosis. These patients should be placed on a high protein diet to improve their protein metabolism and to increase the rate of healing of ischemic ulcers.

Since these decubiti are the result of ischemia, the most satisfactory method of treating them is the stimulation of circulation. The ulcer should be relieved of all pressure. Wet or greasy dressings which macerate the skin should be avoided. Radiant heat from a light bulb or heat lamp increases the circulation and aids healing. Ultraviolet radiation stimulates healing in two ways:

1. An erythemal dose of ultraviolet causes prolonged vasodilatation in the area.

2. Ultraviolet radiation is bactericidal to organisms growing on the surface of the ulcer. When infection is suppressed by daily ultraviolet radiation, epithelialization occurs more rapidly.

Friction massage around the decubitus following ultraviolet irradiation decreases edema, increases lymphatic and venous drainage, and prevents fibrosis of the subcutaneous tissue beneath and around the ulcer.

Urinary Tract Dysfunction

When a patient is immobilized in a recumbent position there is a disturbance of the function of the urinary tract. The renal pelvis remains distended when assistance is not obtained from gravity for adequate drainage. The stasis of urine in the renal pelvis coupled with the increased excretion of calcium results frequently in the formation of renal or bladder calculi.

The presence of stones in the renal pelvis causes damage to the epithelium of the pelvis. The presence of a stone or epithelial changes in the renal pelvis provides a nidus for the rapid formation of more stones. Stones may be passed into the ureters causing ureteral colic or obstruction, the development of hydronephrosis, and damage to the renal parenchyma. Likewise, immobilization frequently causes formation of stones in the bladder. Here again the stones cause irritation of the mucosa and produce chronic cystitis and an increased tendency for stone formation. The necessary instrumentation may cause further trauma or introduce infection which increases the problems of management. As a consequence of the damage to the urinary tract, these patients have persisting medical problems of the urinary system which may never be adequately corrected.

In addition to complications which may cause permanent damage to the urinary system, immobilization in bed also causes temporary problems of dysfunction. It is more difficult to void in a supine position than in an upright position. Immobilization in bed decreases the irritability of the bladder so that voiding reflexes may not be initiated or emptying may be incomplete. If the patient cannot void he must be catheterized. Bladder distention followed by overflow incontinence may also occur. Again the patient must be catheterized to relieve the distention and overflow incontinence. Incontinence due to disorientation secondary to immobilization in bed may also necessitate catheterization.

Even with careful aseptic precautions, patients who are catheterized repeatedly or who have an indwelling catheter soon develop infections in the bladder which frequently lead to pyelonephritis or recurrent bouts of bacteremia and fever. The nursing care required for maintenance of the hygiene of the catheterized bladder is time consuming and expensive.

Many of these problems can be solved by the reestablishment of normal or reflex voiding. When the patient is erect and active again, reflex stimulation of urination is improved, emptying is more complete, and prolonged stasis is avoided. Patients become more alert and aware of bladder sensations so that incontinence

is controlled. When catheterization is no longer necessary, the urinary infection may be cleared by antibiotic treatment. Therefore, restoration of the patient from his bedfast state to the erect position is an important aspect of management of urinary tract dysfunction.

Respiratory Complications

The bedfast patient has diminished ventilation. He not only has a diminished tidal volume and minute volume but takes deep inspirations less frequently than when he is up and active and, as a consequence, does not re-aerate collapsed alveoli. Lack of re-expansion of the atelectatic alveoli produces a progressive congestion in the dependent parts of the lungs. Because of this, patients who are maintained recumbent are more susceptible to respiratory infection.

Recumbency also increases the incidence of pulmonary embolism. The inactivity, particularly of the lower extremities and the partially flexed position of the hips and knees, produces stasis in the veins of the pelvis and the lower extremities. Compression behind the knees (fig. 1) increases this stasis. Phlebothrombosis may be a consequence of prolonged immobilization in bed. The bland thrombi which are not tightly adherent to the walls of the veins may break loose to produce pulmonary emboli and pulmonary infarcts. Embolism is most likely to occur when a patient who has been inactive for a number of days is allowed to sit and stand.

Bronchial hygiene also is diminished by immobilization in bed. Although the bronchial cilia help to move bronchial secretions toward the trachea for expulsion by coughing, this transport through the smaller bronchi and bronchioles is assisted by gravity as the normal individual changes position frequently and even more by coughing. During immobilization and decreased respiratory activity, stimulation which would produce a cough reflex is reduced. Likewise, changes of position in relation to gravity which may also stimulate coughing or aid movement of secretions are reduced. As a consequence, clearance of secretions from the bronchial tree is reduced and atelectasis of larger segments of the lung is likely to occur. The poor posture of the patient slumped in bed in figure 1 decreases respiration by interfering both with diaphragmatic and costal motion so that the respiratory exchange is decreased.

Mechanical resistance to breathing is greater when a patient is supine or slumped than when he is sitting erect (*17*). Slow passive motion of the extremities causes little or no increase in tidal volume, minute volume, or respiratory frequency (*5*). Active motion of the extremities which does not require support of the extremity likewise has less influence on respiration than the psychic influence of those activities.

Correction of the respiratory complications of bed rest is handled best by getting the patient up in a chair to increase the ease of respiration and stimulate the depth of respiration. Even more beneficial is the increased respiratory activity associated with ambulation.

Intellectual and Emotional Deterioration

Progressive intellectual and emotional deterioration occurs during prolonged bed rest. Multiple factors contribute to this psychological deterioration. The relative isolation of the patient from intellectual stimulation, the sensory deprivation, the forced dependency that promotes the development of a progressively increasing dependency, and the loss of a personal sense of worth are psychological values difficult to counteract while the patient is restricted to bed. In geriatric patients further problems of impairment of cerebral circulation associated with the progressive deterioration of the cardiovascular system result in a progressive dulling of the intellect and, frequently, in increasing confusion. With the confusion comes disinterest in eating and loss of attention to bladder and bowel continence.

The patient experiences not only a deterioration in intellectual performance but a progressive decrease in emotional stability. The multiple problems are mutually reinforcing. Restriction of activity results in progressive loss of interest. Likewise, the restricted activity which causes discomfort from increasing impairment of joint motion and weakness from deterioration of muscular strength makes activity more difficult for the patient and contributes to the progressive cycle of greater restriction of activity and progressive psychological deterioration.

Intellectual and physical activities such as

those provided through occupational therapy, social activities with visitors, intellectual stimulation from reading, television, and radio stimulate an increasing response from the patient and help to maintain his level of performance. However, none of these are as effective as release from bed and the restrictions of four walls by transfer to a wheelchair or resumption of ambulation.

Summary

Efficient rehabilitation of the severely disabled patient is possible only if deterioration is prevented and the patient's abilities are preserved. Prolonged inactivity in itself causes deterioration of many organ systems. Rapid deterioration of neuromuscular, skeletal, cardiovascular, respiratory, urinary, and intellectual function occurs. Bed rest for patients with disabilities of long duration may produce deteriorative changes which permanently disable these patients or greatly delay their recovery.

Intelligent use of activity to maintain the abilities of the unaffected parts of the body together with adequate protection for the involved parts of the body will decrease the time required for restoration of the patient to maximal usefulness.

Nursing Care

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THE RESIDUAL disabilities and secondary deformities which occur in patients with chronic disease or long-term illness present an ever-increasing challenge to nursing service personnel in the hospital, nursing home, or the patient's home. Prevention of deterioration is not an easy task, and it still requires considerable study. However, to what extent can we ask the patient to suffer long hours of pain and discomfort, extended hospitalization, or permanent disability developed because of inadequate nursing care?

Successful physical restoration of a person who has been forced to inactivity because of some long-term disease process may be hindered or enhanced by the nursing care which he receives during his prolonged course of treatment. The development of contractures in the upper and lower extremities of the patient following a stroke, the hip flexor tightness after periods of bed rest (fig. 5), still occurs far too frequently for nursing to consider its job well done.

The coordination of physical and occupational therapy with nursing service leaves much to be desired in many institutions and home-care programs. Patients are spending several hours in therapy having extensive exercises and painful stretching for tightened musculature developed because of poor positioning and lack of consideration for range of joint motion. For the remaining 21 or so hours the patient may be left in his bed without supportive measures to maintain his lower extremities in the normal alignment to which the therapy is aimed. Hence, his therapy program is defeated. Nursing alone is not liable for this inadequacy of communication—all members of the participating team must share this responsibility.

One of the most fundamental physiological laws is that the functional efficiency of an organ or system improves with use and regresses with disuse. Everyone is familiar with the increasing power and efficiency of skeletal muscles which result from usage and the atrophy which takes place in muscles whose motions are prevented by paralysis.

The results of deterioration of the bedfast patient have been emphasized in the preceding article, which mentions significant studies relating to patient care. These have definite implications for nursing.

The alert, intelligent, and capable nurse understands the physiology of disuse, is familiar with current research regarding patient care, and practices nursing measures that prevent deterioration of the bedfast or immobile patient. This nurse understands the ministrations needed by the patient, provides assistance when the patient cannot do for himself, and encourages and teaches him self-care toward independence when she recognizes his readiness and motivation for increased activity. The following are nursing measures, some old and some new, which will aid in the prevention of the deteriorative process.

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