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## Present concepts in therapy of decubitus ulcers

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PRESENT CONCEPTS IN THERAPY OF DECUBITUS ULCERS

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## INTRODUCTION

In selecting a subject for a senior thesis it seemed logical that the choice should fall on one pertaining to that field of medicine in which the author is interested. This author also felt that the subject should deal with a problem which would be occasionally encountered in his future practice. The subject decubitus ulcers met these requirements in my particular case.

The problem of decubitus ulcers may seem rather commonplace and unimportant on first thought, but if one makes a careful analysis of the subject one cannot help but be impressed with the fact that this condition constitutes one of the major problems of modern medicine. The purpose of this paper is to explore and evaluate all the current literature on this subject with emphasis on management and prophylaxis, and to present it in a clear and concise manner. While the therapy has been handled in detail an attempt has been made to keep the entire discussion as brief as possible.

## Etiology

It is generally agreed that pressure over the various bony prominences of the body such as the sacrum, trochanter, and ischia, is the most important single factor in the development of decubitus ulcers. These ulcers are primarily found in patients with injury to the spinal cord, but they occur also in those with other severe injuries, such as extensive burns, abdominal or chest wounds and various fractures, particularly in aged individuals, (1), there is no racial difference of occurrence, (2), and decubiti are common in both men and women. Compression of the skin and underlying tissues that overlie the bony prominences reduces the vascularity of these tissues; which if sufficiently prolonged, results in the ulcer. By the same principle, pressure at the ring of a Thomas splint and at the upper and lower edges of a cast in fracture cases will precipitate this condition.

Very little information is available concerning the amount of pressure and its duration required to produce the lesion. Trumble, (3), attempted to obtain quantitative data concerning the duration and amount of pressure tolerated by the normal skin. In his experiments the skin over the dorsum of the foot was used. He found that a boy was able to tolerate a pressure of about 1.5 lbs. per square inch for days without experiencing pain, whereas a man could tolerate roughly only 1.25 lbs. per square inch. Trumble elaborated further, "The surface area of a man 5'8" tall, weighing 150 lbs. is about 2790 square inches. If only one fifth of this area were

available for weight bearing in the recumbent position and the pressure were evenly distributed, it would amount to less than one third lb. per square inch. However, the weight of the body in reality falls heavily on certain points, the combined area of which are very small. These points occur over parts where the skeleton is near the skin surface, ie., the heels, sacrum, posterior superior spines, vertebral spines, scapulae, etc. The skin in these regions bears the weight not only of the part directly above it, but also of other parts which are not adequately supported. The bulky soft parts, the buttocks and calves, deform with pressure, and evade the responsibility of carrying the weight of the tissues directly above them."

There have been two schools of thought regarding the pathogenesis of decubitus ulcers in paraplegia. The neurogenic theory, first proposed by Charcot, (4), advanced the idea that in the paraplegic patient certain abnormal vascular reflexes caused by a disturbance of sympathetic control to the area, produced vascular spasm and resulted in an ischemic necrosis and the development of decubiti. Munro, (5), is one of the more recent proponents of Charcot's views. It was Munro's belief that, "An adequate supply of blood to the skin depends on the integrity of two reflex arcs, which must include at least the spinal cord." He states that bedsores which exist in connection with spinal cord injuries start as pressure sores, "--but develop more viciously and more widely because of the deleterious effect of spinal shock on the local cutaneous vascular reflexes."

Brown-Sequard, (4), originated the opposition's view that decubiti are caused by the application of constant local pressure, associated with loss of motion and of muscle tone. Nearly all recent authors, (6), (7), and (1), have verified this theory. Pressure sores are more frequent in paraplegics, but this is thought to be due to a lack of motion.

Other factors contributing to this condition are hypoproteinemia, old age, general debility, anemia, avitaminosis and malnutrition. Hypoproteinemia is probably the second most important factor contributing to the formation of bed sores. Rudd, (8), noted that the general condition of these patient's was usually poor with extensive generalized muscular atrophy. It was stated in one series of 35 cases, (9), that the plasma protein concentration in each of these cases was below 6.4 gm. per cent. In another series, (10), the average protein level on admission was 6.7 gm. per cent, with a maximum of 8.0 and a minimum of 5.1 gm. per cent. The average hemoglobin on admission was 13.02 gm. with a maximum of 15.8 and a minimum of 10.2 gm. It is obvious, however, that the values for total circulation protein, as well as those for hemoglobin are utterly valueless unless the total blood volume of the patient is also known. That is, a patient with a reduced blood volume may give a normal value for total serum protein and hemoglobin, although the actual values would have been abnormally low. Dehydration with hemoconcentration is probably seen quite frequently in patients with decubitus ulcers.

Croce and Beakes, (11), regard severe protein catabolism to be more important than pressure in precipitating decubiti. In another article, (12), comment is made on the frequent presence of anemia as well as hypoproteinemia in their patients. A reversal of the albumen-globulin ratio suggests protein loss. These authors point out the importance of correcting the anemia first: for if this is not done, protein administered to the patient will be first utilized toward the restitution of the hemoglobin.

Senility, (2), with its associated loss of turgor and marked atrophy of the skin also predisposes to bed sores. Anorexia, poor dentures and associated dietary deficiencies are common in the aged. Trauma to the tissue as caused by friction from bed linen, wrinkled sheets and dressings, gritty dusting powder, etc., all may contribute toward ulcer formation. Moisture as in perspiration, urine, or feces will macerate the previously traumatized skin, promoting the entrance of infection.

Decubitus ulcers are found in the following areas of the body, listed in decreasing order of their occurrence, (4), (11), (13) & (14).

Sacral	21%
Trochanteric	19%
Ischial	19%
Calcaneal	10%
Knees	8%
Anterior Superior Spines	6%
Pre-tibial	4%
Malleolar	1%
Miscellaneous	12%



### Pathology

The reaction of the skin first seen in the development of decubitus ulcers is that of a hyperemia following a period of anemia, (15). Pressure on the skin deprives that tissue of its blood supply. With the release of that pressure there is a dilatation of subcutaneous vessels due to an increased irritability of vasomotor endings in the skin, (2). Such a dilation of vessels results in the initial erythematous flush. An absence of the blood supply for 5 seconds will produce a perceptible hyperemic reaction, (6). The duration of the erythema, (6), is directly proportional to the duration of the vasomotor occlusion, lasting approximately 50-75% of that time. The reaction is strictly a local one, and is independent of both the central nervous system and local reflexes.

The initial erythema blanches on repeated pressure, but following long continued pressure there is a vasomotor paralysis and a stasis of blood. This gives the tissues a cyanotic appearance which fails to blanch on pressure. According to one investigator, (2), after the tissues become cyanotic an ulcer is inevitable, whereas, before the stasis of blood occurred there was the possibility of a reversal of the process with the relief of pressure. Edema forms locally and then blebs develop. There is little or no pain associated with this progression. Soon the blebs break down and with continuance of pressure, as well as other etiologic factors of importance, a localized ulceration forms, (6).

The poor vascularization together with an associated pre-dominance of fatty tissue of the areas usually involved, accounts for the low degree of resistance. During the early phase of ulceration there is no evidence of any healing process, but only of extending necrosis, (11). There is excessive loss of protein containing body fluids. Barker, et. al., (16), measured the protein output of the decubitus ulcers in one individual in a 24 hour period, and found that by the Kjeldahl method 50 gm. of protein was lost during that time. Another author, (17), stated that between 50 and 200 gm. of protein can be lost via the decubitus ulcers of an individual in one 24 hour period. He further notes that healing will be impossible unless this loss is replaced by active therapy.

Microscopically there is present a chronically inflamed, non-specific granulation tissue with coagulation necrosis. Venules are engorged, and there is extensive thrombosis of smaller veins as well as of the thickened arterioles, (13). Lymphocytes abundantly infiltrate the area and occasional eosinophiles are also seen. Rarely except in very extensive ulcers are calcific deposits also found.

In almost all decubiti of several months duration the underlying bone is definitely involved, whereas in the more recent ulcers there may be little or no diseased bone. Infection of the bony periosteum is followed by periostitis and subsequently an osteitis in the spongios bone structure.

In general this is the pathological picture of decubitus ulcers,

## Bacteriology

A multitude of microorganisms has been described, all of which have been found that causative agents of infection in decubitus ulcers. The role of these organisms becomes increasingly important when there is evidence of a spreading infection or a systemic reaction. The necrotic skin and underlying tissue is readily contaminated by the diversified bacterial flora of the skin, anus, and urinary tract, and furnishes an excellent environment for a luxuriant bacterial growth, (18). Both aerobic and anerobic organisms can flourish within this medium. The *Staphylococcus aureus*, (18), seems to be the predominant aerobic invader. Other common aerobic microorganisms in the order of their occurrence, (10), (11), and (12) include: hemolytic and nonhemolytic *Streptococci*, *Escherichia coli*, *Proteus vulgaris*, *Bacillus pyocyaneus*, and various diphtheroids. Microaerophilic *Streptococci* were frequently found on anerobic studies, (18).

### Preoperative Therapy

In the treatment of pressure sores preoperative therapy is quite frequently synonymous with the conservative or medical treatment of this condition. Some authors, (13), have reported that as high as 30% of their patients have recovered completely on a regime such as the one which follows.

First of all, pressure over the area of the sloughing ulcer must be relieved. This is accomplished by frequent turning of the patient, and by numerous devices which alternate or distribute the pressure over a greater area of the body. The most commonly used device for this purpose is the rubber air ring. A variety of sizes can be obtained to fit the individual need.

Most of these patients are in a state of chronic malnutrition and thus must be put on a high calorie, high protein, high vitamin diet. One clinician, (6), proposes that as high as 3,500 calories per day be given. The food must be well prepared and well flavored to combat anorexia. In severe cases 5-10 units of regular insulin may be given 30 minutes before each meal to stimulate the appetite and thus the weight gain. Extra nourishment may be given between meals and at night. A good appetite and a gain in weight are definite prerequisites to surgery. Gordon, (19), proposed the following average daily diet:

Protein_____	134.8 gm.	Phosphate_____	2.131 gm.
Niacin_____	18.22 mgm.	Fat_____	93.8 gm.
Iron_____	17.15 mgm.	Riboflavin____	4.467 mgm.

Carbohydrate	_____337.9 gm.	Vitamin A	_____7530 I. U.
Vitamin C	_____378.2 mgm.	Calcium	_____1.669 gm.
Thiamine	_____1.926 mgm.	Calories	_____3444

A protein intake of at least 125 gm. per day should be given. Where protein anabolism cannot be restored through oral feeding, the diet should be supplemented by parenteral alimentation with amino acids or protein digests. Where the hemoglobin and erythrocyte count are found to be low, numerous whole blood transfusions should be given, (10), (11), both before and after surgical repair. It is important that the total serum protein and the hemoglobin be obtained frequently to be able to evaluate the status of the patient. Langston, (20), states that he has had success with the use of Testosterone propionate in doses from a minimum of 25 mgm. three times per week to a maximum of 100 mgm. per day, to stimulate the appetite as well as to provide a protein sparing action.

To combat hypovitaminosis in the patient with bed sores a supplemental multivitamin preparation is given daily. One author, (13), suggests that 25 mgm. of soluble vitamin B<sub>12</sub> be given daily to stimulate the appetite. It was previously presumed that the vitamin C level might reach such a low point that healing would be retarded. Crandon and Lund, (21), however, have shown in an experiment on a human subject with a pure vitamin C deficiency, that a wound will heal properly although the ascorbic acid level of the plasma is zero for as long as 44 days. Gibbon and Freeman, (6), found that in their series of 26 cases the plasma vitamin C levels ranged from 0.19-0.78 mgm per cent with an average of 0.48, whereas in

11 normal controls the range was 0.65 - 1.42 mgm. per cent with an average of 0.96 mgm. percent.

It is essential in the preoperative care of these patients that the infection be cleared and that the ulcers be debrided of all necrotic and sloughing tissue. The ulcer may be cleansed with soap and water, Phisoderm, or hydrogen peroxide solution. The actual debridement may be mechanical or chemical. Streptokinase-dornase, trypsin, and full strength Dakin's solution have been used in the chemical debridement, (13), (22), and (10) but it is yet too early to fully evaluate the use of the first two compounds. Good granulations are attained through the use of continual wet dressings, using normal saline, dilute acetic acid solution, or dilute Dakin's solution. To prevent irritation to the surrounding tissue particularly when using Dakin's solution, one author, (12), suggested covering that tissue with zinc oxide ointment, or some other bland preparation. If the ulcer shows a marked tendency to bleed during debridement, Burston, et. al., (23), propose the use of topical thrombin sprayed to the area, followed by a dry gauze pack, or else packing the bleeder with oxycel gauze.

After granulation has begun, the use of furacin, tyrothricin or bacitracin ointment topically has been suggested, (4). The recent use of the new antibiotic Polymyxin B in this capacity has also been encouraging. Burston, et. al., (23), recommended that the skin surrounding the ulcer be painted with compound tincture of benzoin to toughen it. They also advocated that the area be dressed as

follows, "A hole the size of the bedsore is cut in the center of an abdominal pad which is applied to the area. Additional padding can be added as needed to take the pressure off the area, each pad having a slightly smaller hole than the one below it. Use no tape to hold the dressing in place. When necessary a diaper is used to anchor the padding." Another author, (7), felt that following debridement the wounds should be left open to the air and sunlight as much as possible. He used only sufficient ointment to prevent the light dressing from adhering. If the ulcer is small, superficial, and not infected, it will probably heal with the use of ultra-violet radiation and one of the blend ointments, ie., chlorophyll or cod liver oil ointment.

Systemic penicillin and sulfonamides should be started 1-2 days before surgery and continued for several days thereafter. In treating ischial ulcers Blocksma, (24), recommends the use of sulfasuxidine orally for one week prior to and following their repair.

Any urinary infection present must be cleared and the patient should be catheterized with a retention catheter before surgery. Some authors, (4), and (13), suggest that these patients be put on complete tidal drainage before surgery and that it be continued for several days post-operatively.

The entire lower bowel is thoroughly evacuated the day before operation, using numerous enemas, (25) and (10).

With this regime many of the small bedsores will heal completely, and the deeper, more severe ulcerations will be prepared satisfac-

torily for surgical repair. One important problem which arises in those lesions that heal spontaneously, is the high recurrence of ulcers arising in the old avascular scar tissue. This incidence of recurrence is much higher than in those which have been surgically closed.



### Surgical Repair

During the past ten years it has been found that the surgeon has much to offer the bed sore patient. It was in 1938 that Davis, (26), who was one of the first to tackle this problem surgically, extirpated scars from spontaneously healed ulcers to prevent recurrences. It was during World War II, however, that radical repair of these lesions was initiated, particularly on the paraplegic war casualties. Barker, (16), as well as Lamon et. al., (27), were two of the earliest (1945) to try actual excision of decubitus ulcers in paraplegics. Since that time there has been a rapid progression in the surgical approach to the problem. One of the more recent steps taken was the plastic closure of the excised areas by flaps, (11), (25), and (18), and finally one of the newest procedures to be included in the operative technique is that of osteotomy, first attempted in 1947-1948, (28), (29), (24).

It has been proved that by following several basic principles in the surgical technique one attains a much higher percentage of recovery and a far lower incidence of recurrence than is possible under conservative management. These principles as clarified by Gelb, (13), are as follows: "1. Complete excision of the ulcer and the surrounding scar. 2. Excision of the regional new bone formation together with the underlying bony prominences. 3. Closure of the operative defect by procedures that will provide a pad of skin and subcutaneous tissue over the original ulcer site and avoid a suture line over the former ulcer." White and Hamm, (25), add to the last factor that unless good approximation of the skin

margins is attained without undue tension the results are apt to be disappointing. A fourth principle that has been suggested, proposes that a free skin graft be applied at the point from which the pedicle flap was taken.

Surgical repair should be attempted as soon as the various factors contributing to the origin and extension of the ulcer have been corrected in the preoperative management. A general anesthesia is usually used in these patients, although some authors have repaired ulcers without an anesthetic agent in their paraplegic patients where the involved area is totally lacking in sensation. White and Hamm, (25), propose the use simply of barbiturates and morphine sulfate in their paraplegic cases. Gelb, (13), on the other hand states, "Anesthesia is used routinely, as the operative procedure is frequently prolonged, and shock producing. It is preferable to have patients asleep when bone is resected. The endotracheal route using nitrous oxide or ether, and oxygen has been the anesthesia of choice." Another author, (19), uses pentothal induction, followed by nitrous oxide if electrofulguration is used, cyclopropane if not. It seemed that most clinicians continued to feel that they had the greatest margin of safety using ether.

Where the ulcer is small and the skin is loose and flabby, the repair can be accomplished simply by undermining in all directions and drawing the skin margins together with suture, (25). Where there is difficulty in approximating the skin edges without

tension several investigators advocate the use of skin grafting. They differ to a certain extent on the type of graft to be used, but most men, (29), (6), and (13) felt that small, full thickness grafts were preferable to the split thickness type. In addition these men believe there is a definite place for similar grafting in the larger ulcers prior to radical resection to prevent the severe loss of protein. Bors and Comarr, (29), state that in their series of 250 such cases, they've found that the full thickness grafts are resistant to infection and quite economical to use, for the combined area of the grafts need not exceed 6-8% of that of the ulcer to provide sufficient seeding. Gibbon and Freeman, (6), on the other hand, criticize the use of grafts to close these lesions, for an avascular scar is always present in the areas not grafted, and furthermore the various bony prominences must be covered with not only skin but also a fat pad and connective tissue to prevent an immediate recurrence.

In the large ulcers the repair is quite similar to that of the small size. Some degree of shock is unavoidable despite numerous transfusions in the closure of these bedsores. Therefore, patients in a debilitated state should not be subjected to such a procedure. Radical excision on the entire lesion with all of its pockets of disease and scar tissue is of paramount importance. One clinician, (7), maintains that any instrument which touches the external surface of the ulcer should be discarded and should definitely not be used following excision, in the actual closure of the wound.

All investigators agree that absolute hemostasis and avoidance of hematoma formation is essential to good primary healing. They do not agree, however, on the means of attaining this end. The time taken to prevent hematoma formation is well spent. Most men agree that electrofulguration speeds up the operation considerably, as there is no tying-off of all bleeders. There is little difference in the rate of healing when using electrofulguration, as compared with fine cotton, (6). Some believe that fine silk is adequate, (16), though others have found that there is a lesser amount of foreign body reaction with fine cotton, than with fine silk, (27). A fourth group, (30), use fibrin foam soaked in topical thrombin solution to stop all oozing.

Since it is generally impossible to bring the adjacent skin edges together in the large ulcers despite extensive undermining and mobilization, it becomes necessary to bring a flap of tissue into the wound to close the defect. This flap of tissue must contain not only skin, but the subcutaneous tissue as well, including an adipose layer. Most men, (13), (25), (6), now use a pedicle flap from an area adjacent to the wound rotated into the operative site. In this way the entire repair can be done in one stage, whereas, if a pedicle or tubular flap is brought in from a distance, the procedure must be done in two stages. In some of the original work on pedicle grafting, Croce and Schullinger, (32), brought several long angular flaps with relatively narrow bases into the excised wound. The more recent literature, (6), however, recommends

the use of a wide-base rounded pedicle graft. The reason for the wide-base is to promote better vascularity to the graft.

Several observers have noted the futility of rotating the pedicle flap over a bony prominence which remains to reproduce the same mechanical pressure that created the original bedsore. It is even more useless if the bony prominence has become diseased. Blocksma and Kostrubals, (24), found that in 51.8% of their cases there was degeneration and / or fibrosis of bone; in 24.1% there was actual osteitis and / or osteomyelitis; and, in 24.1% no diseased bone was found. For this reason the surgical technique had to be altered to the extent that adequate resection of all diseased bone must be done before closure of the wound. Of course each ulcer must be treated individually; but usually, in sacral ulcers, only portions of the outer table of the sacrum need be removed; in trochanteric, only the trochanter needs be excised, but in ischial ulcers the ischial tuberosity, the superior and inferior ischial rami and most of the inferior pubic ramus are removed. Muscle is then sutured into the cavity left after bone resection.

Before closing the operative site a penrose drain is placed through a separate stab wound near the periphery, deep into the ulcer, (16), (32). In the closure the subcutaneous tissues and the skin are sutured as separate layers. Chromic oo, #80 cotton, or 28 gauge steel wire interrupted sutures are used subcutaneously, (27), (4), (32), and ooo silk or 32 gauge steel are used to close the skin. Heavy tension sutures may be needed to approximate

the edges.

The dressing utilized is of several layers of gauze, over which mechanics cotton waste is placed and the entire dressing held securely in place with adhesive to maintain firm pressure.

Much more information on the actual surgical technic in each of the types of decubitus ulcer could have been presented, but this was not considered to be within the scope of this thesis. Many of the references cited in this section contain this data on technic.

### Postoperative care

One of the most important factors in the care of these patients postoperatively is the relief of pressure on the operative site. This is achieved through the use of large bulky dressings and frequent turning from the prone to the supine position. Turning the patient every 2 hours after the first 24-48 hours is adequate, (6), and it is advantageous to use the Stryker frame for this purpose, (14).

Penicillin is given intramuscularly one day before surgery and continued for 10 days thereafter, (6), (19), (24). The amounts by various authors vary from 150,000 units every day to 800,000 units per day. Although penicillin as well as other antibiotics and sulfa were formerly used locally, such use has now been discontinued. It has been recommended by several authors, (14), (24), that sulfas be taken orally in addition to the penicillin therapy. Sulfasuxidine is frequently used in this capacity. Terramycin and Chloromycetin in 500 mg. doses every 6 hours has also been advocated, (13). Despite antibiotic and chemotherapy one can anticipate a low-grade fever for the first few days postoperatively, (14).

The dressing is kept on until the site is well healed, with moderate pressure being maintained via adhesive. Most authors, recommend the first change of dressing on the third or fourth day, with subsequent daily changes, (16), (24). On these occasions the area of closure or graft is cleaned with hydrogen peroxide, dried

with ether and a dry pressure dressing of mechanics waste is applied. The area should always be checked for collections of serum or blood under the flap and when found these must be aspirated, (19), (24), (6). This should be aspirated through the flap, not between the sutures, as such collections prevent approximation of the two tissue surfaces and thus retard healing.

Drains at the operative site should be loosened on the third or fourth day and totally removed by the fifth day, (16), (12). Sutures should be removed in 7-12 days, (27), (13), (6), depending upon the individual situation. Tension sutures are usually taken out 2 weeks postoperatively, (12).

Although some authors feel that retention catheterization at the time of surgery is adequate, (14), (13) several advocate tidal drainage to be initiated preoperatively and continued for 6-7 days after repair, until the patient can be reasonably active in bed, (12), (10). Tidal drainage should always be maintained until the patient needs no longer be kept on his abdomen.

The patient is placed on a low residue diet preoperatively, (14), and this is continued until the fifth to the seventh postoperative day. At this time regular bowel movements are encouraged with an enema, (12). A few authors use constipating drugs during the first postoperative week such as paregoric, (24), or codiene sulfate, (10), but most feel that such medication is not needed.

Ambulation by wheel chair is begun in 3-4 weeks, and gradually increased over the next few weeks until complete ambulation is attained, (14), (13).



## Results

The results seen in the management of bedsores is, in general, quite satisfying. Regardless of the therapeutic method employed, constant vigilance must be maintained in order to pick up any recurring or new ulcers. In those lesions which have healed spontaneously, the incidence of recurrence is much higher than in those closed surgically, for reasons which have been considered elsewhere in this paper.

Most investigators, (4), (20), (13), report primary healing in their operative repairs in 65-80% of cases of all types, with satisfactory, (although probably delayed), healing in 90-95% of their cases. Breaking these figures down into percentages of cure in each of the most common types of ulcers, one obtains the following statistics for satisfactory healing, (4), (13), (20):

Ischial	95%
Sacral	90%
Trochanteric	88%
Miscellaneous	90%

Hematoma formation, despite careful hemostasis is still the most frequent complication mentioned in the literature, (13), (4), (25), followed quite closely in incidence by the collection of serous fluid under the pedicle flaps. These must be adequately drained by aspiration and by the use of a penrose drain in the operative site, respectively, or healing will be delayed. The third complicating factor is actual dehiscence of the wound,

which then requires secondary closure. Others, not so frequently seen, include abcess formation, cellulitis, sinus tract formation, and necrosis of the suture line, with or without total loss of the flap. These latter complications mentioned are quite rare since antibiotic therapy has been used routinely to prevent infection.

### Prophylaxis

Just as in nearly all other disease conditions, prevention of decubity is much easier than their treatment. Very likely the most important prophylactic measure is the relief of pressure, particularly over bony prominences. Toward this end a variety of mechanical contrivances have been devised. Some of the more elaborate devices include an electric lift, (33), an oscillatory bed support, (34), a bed of sawdust, (35), and a pneumatic mattress, (36), each of which is designed to alternate pressure over various areas of the body. Other methods used in the relief of pressure include skeletal suspension of a limb, or the clavicles, or such, with Kirschner skeletal nails. The Stryker turning frame is occasionally used too, (30), for with this apparatus one attendant unassisted can turn the patient from the supine to prone position in about 3 minutes. Turning by this method is not accompanied by pain as is manual turning. The most common method of relieving pressure over one of the prominences, as stated previously, is through the use of the various types of "doughnuts", (air rings). These are simple to use, and are far less costly than any of the other apparatuses.

A second factor in the prophylaxis of pressure sores is the maintainance of an adequate, high protein, high vitamin diet. Gelb, (13), emphasizes this point is stating, "Particular attention must be paid to the patient's nutrition, for without it all attempts at either prophylaxis or treatment fail".

Frequently the patient is in a poor state of nutrition. In these cases it has been proposed by several authors, (37), (2), (19), that one should correct the patient's anorexia by giving 5-10 units of regular insulin subcutaneously 30 minutes before each meal. Meals must be palatable, well flavored, and sufficient in calories protein and vitamins to prevent debility and cachexia. The morale of the patient is very important in the maintenance of a proper nutritional state, for as Shonyo, (7), points out, "The loss of appetite from discouragement and anxiety cannot be countered for long merely by tonics and parenteral feedings.

The care of the skin is also important in the prevention of pressure sores. Daily baths followed by alcohol and mineral oil backrubs and considered by all to be essential. One clinician, (2), proposes that all points of pressure be washed with tincture of green soap followed by alcohol and then ether. Thereafter, calamine varnish is applied locally to the areas and allowed to dry. Photographers rubber cement is also applied and allowed to dry. He feels that such a protective covering is pressure proof, bacteria proof, and moisture proof. Other authors have not yet commented on this method. It is essential, however, that proper hygiene of the skin be carried out, (13 ), for this will prevent maceration and contamination by urine and feces. All extraneous moisture must be controlled.

Urinary infections in these individuals, particularly in the paraplegics are quite common. Furthermore, since these

infections contribute to a poor general condition, they must be brought under control early with suitable chemotherapeutic or antibiotic agents.

A relatively new concept in the prevention of bedsores in the type of patient who is especially prone to their development; ie., paraplegics, is the prophylactic resection of the various bony prominences involved. There has been very little elaboration on this procedure, but good results have been attained, (38).

Following such a plan as has been clarified here should be sufficient in providing satisfactory prophylaxis against decubitus ulcers.

## Conclusions

The therapeutic management of pressure sores has been successful because, greater attention is now paid to the general nutritional status of the patient, because surgical closure of the ulcers has become an established practice, and because improved methods of carrying out the surgical handling of these patients have produces results which reduce the incidence of recurrence or other complications.

It has become evident to the profession that the nutrition of the patient is just as important as pressure as a cause of bedsores. Both of these factors must be taken into consideration in the management before one can hope for healing of the ulcer.

In the operative repair of the lesions several principles have been observed which must be followed if successful treatment is to be achieved. These include: 1. Complete excision of the ulcer and associated scar tissue; 2. Resection of all new bone formation as well as the bony prominence underlying the ulcer, particularly, if these are infected; 3. Closure without tension of the wound by procedures which will provide a pad of skin and subcutaneous adipose tissue over the ulcer site avoiding a suture line directly over the former ulcer.

It is quite apparent that the role of antibiotics in the control of infection and the resulting reduction of complications is essential to good healing.

The final factor to consider is simply that prevention of

bedsores is far easier than their repair.

With these factors in mind one should be quite successful in treating this condition, having few recurrences or complications, but a high frequency of satisfactory healing.

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