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Rancho flotation bed

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Physicians and nurses responsible for the management of immobile patients have long been aware of the problems caused by pressure and shear forces over the bony prominences of the body. Although research groups have had great difficulty in attempting to quantify the destructive level of shear forces, several studies (Landis, 1929), (MacLennan, 1942), (Kosiak, 1961) have indicated that pressures of *20 to 30 mm Hg over extended periods* will tend to result in pressure sores.

The phrases "extended periods" and "20 to 30 mm Hg" have been *italicised* because these phrases are the keys to the prevention of pressure sores. There is a relationship between time and pressure such that high pressures can be allowed for short periods of time, lower pressures for longer periods of time, and low pressures for extended periods of time (Lindan, 1965), (Rogers, 1973).

Because of this relationship, it can be stated that pressure sores are preventable. On any ordinary hospital bed, when the patient is moved from one body surface to another repeatedly at not more than two-hourly intervals, ischaemia will not develop. Bridging bony prominences or other susceptible areas with pillows can help to reduce the required turning frequency (Lowthian, 1971).

The major difficulties associated with the turning techniques are the time and physical effort required of the nursing team and the constant need for training in its importance. The cost for all this is substantial but is small when compared to the monetary cost ($5,000–$10,000) and human misery and threat to life of spending several months in a hospital bed to heal a large pressure sore.

Physicians and nurses have resorted to various mechanisms to reduce the manual labour involved in turning the patient and to provide better control of body alignment. Examples are the Roto-Rest (Keane, 1970), the Foster-Stryker turning frame (Ascoli, 1970) and the Edgerton-Stoke Mandeville bed. Many of these mechanisms, however, are complex, resulting in training, reliability and safety problems, and most still require extra nursing time.

Another approach to the prevention of pressure sores is the use of various devices to distribute the pressure in such a way that the resulting lower pressures can be withstood over long periods of time. When a patient is lying on an ordinary bed, the mattress is unable to accommodate the various contours of the body; thus, much of the weight of the entire body is borne by the tissues over the bony prominences. In order to reduce the pressure applied to the bony prominences, devices using such things as sectional foam pads and floating plastic balls (Schetrump, 1972) have been tried.

An ideal distribution of pressure is achieved when the patient is supported by purely hydrostatic forces, i.e. when the patient literally floats in a fluid. If a membrane separating the patient from the fluid is sufficiently thin, the fluid can accommodate all of the body contours. In addition, hydrostatic forces act perpendicular to the surface of the body being supported. Thus, the areas surrounding bony prominences are protected from shear forces along the sides if the separating membrane is loose enough to be free to move with the body.

This concept has led to several types of hospital-type water and other media flotation beds (Hargest, 1969), as differentiated from most home-type water beds in which the patient is partially suspended, as in a hammock, by the inelasticity of the water-filled bladder rather than by true flotation.

The water-flotation beds provide acceptable pressure distribution (Grahme, 1973), (Pfaudler, 1968) however, because the density

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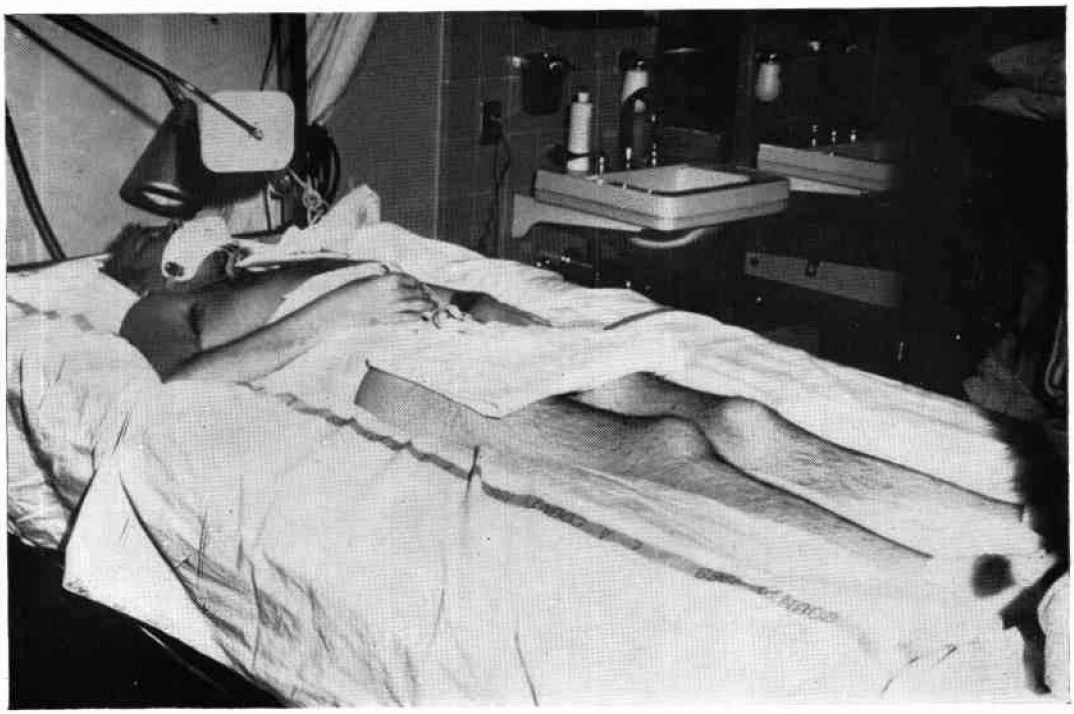

Fig. 1. Original prototype MUD bed built at Rancho Los Amigos Hospital. The photograph was taken during initial trials under actual conditions and shows the first patient to benefit from this device.

(mass per unit volume) of the human body is approximately the same as water, the patient must float almost totally submerged. This has been known to cause hallucinations owing to the feeling of weightlessness and respiratory problems (Pfaudler, 1968) probably due to the "hunching" of the shoulders which usually occurs when the body is submerged. Lying prone is impossible and catheterisation over the tub side may be difficult. Also, experience at Rancho Los Amigos Hospital has indicated that hip and knee flexion contractures may form more easily in submerged paralysed individuals because the stronger flexor muscles tend to dominate when the body is submerged.

In order to overcome these problems, the Rancho Flotation Bed was developed at Rancho Los Amigos Hospital (Reswick, 1972). It is basically a flotation bed, similar to a water flotation bed, but using a fluid of density 2 (twice as heavy as water). Thus, it provides all of the advantages of a water flotation bed, but since the human body weighs only one half as much per unit volume as the fluid in the bed, the patient floats half submerged. The patient being well above the edge of the bed can see around him and gravity acts with the fluid to keep the body in horizontal alignment. Catheters drain well, having only a down-hill path. Hip and knee flexion contractures as well as the possible cause for the respiratory problems encountered on the water flotation bed are avoided. The fluid is contained in a vacuum-formed plastic tub covered by a thin, oversized plastic sheet. It is heated to a temperature of 85-90 degrees Fahrenheit, by an electric unit on the underside of the tub. Figure 1 shows the first patient, a recent quadriplegic, in the original prototype bed built at Rancho Los Amigos Hospital.

The fluid which makes this possibe is a colloidal suspension of pulverised Bayrite and water which is kept homogeneous by the addition of a thixotropic clay called Bentonite. The mixture is similar to oil-well drilling mud, which leads to the nickname, "MUD Bed". The relatively few other chemical solutions which have a density of 2 tend to be either too reactive (harmful to the skin) or to have other undesirable properties.

The first prototype bed was placed in a ward in Rancho Los Amigos Hospital three years

Fig. 2. Production model of the MUD bed manufactured by Gaymar Industries, Buffalo, N.Y. and marketed as the HDF(R) Bed.

ago. As of this writing fifteen such beds are being used in the Spinal Injury Service, the Burn Service and the Spinal Injury Readmission (Pressure Sore) Service. The beds are now being manufactured commercially[1] and a number are currently in use in other hospitals. Figure 2 shows the commercially available bed.

Clinical Experience

Over 200 patients, with the majority presenting severe pressure sores at time of admission, have been treated on Rancho Flotation beds at Rancho Los Amigos Hospital with no occurrence of new pressure trauma and with general improvement of existing ulcers. The case records of two of these patients may serve as examples of the use to which these beds have been put:

Case No. 1: L. G. is a 19-year-old male who sustained a gunshot wound on 12 July, 1971 leaving him a complete T8 paraplegic. He was treated at a local hospital for his spinal injury and for lacerations of the liver, jejunum and oesophagus. His post-injury course included a bronchial-pleural fistula and required a gastrostomy and a feeding jejunostomy. He was transferred to Rancho Los Amigos Hospital on 12 November, 1971. Upon arrival, several of his operative wounds and drain wounds were still unclosed superficially and he had a left anterior chest wound that was granulating but the depth of which could be observed. He had a large sacral pressure sore, a large right trochanteric pressure sore, and a smaller left trochanteric pressure sore. He also had a peno-scrotal fistula. On 23 November, 1971 he was taken to the operating room where he had closure of his sacral and right trochanteric pressure sores and skin grafts applied to the clean granulating areas in his left trochanteric pressure sore. After surgery, he was initially treated in a standard bed with bridging and turning, but this proved unsatisfactory as his left anterior chest wound began increasing in size and depth and he developed an oedematous, swollen scrotum. An urgent call was made for

[1] HDF(R) Bed, Gaymar Industries, 701 Seneca Street, Buffalo, N.Y. 14210.

the Rancho Flotation Bed on 6 December, 1971. He was placed on the bed the same day, lying supine on his recently closed sacral pressure sore and was not turned at night. His worsening condition stabilized and he was nursed on the MUD bed until 16 February, 1972, at which time his sores had healed such that a more needy patient could be put on the bed. His skin was totally healed by 30 June, 1972.

Case No. 2: C. W. is a 16-year-old who had a motor-cycle accident on 15 April, 1973, leaving him with a fracture dislocation at T7-T9 and a dislocation with complete spinal injury at T12. He also suffered from a cerebral contusion with coma, a possible cardiac contusion, a right pneumo-thorax and a left haemo-thorax. He was treated in an acute hospital and was put into halo-femoral traction on 11 May, 1973. The initial traction of 50 pounds was later reduced to 15 pounds at either end. He was transferred to Rancho Los Amigos Hospital on 30 May, 1973 and placed on a standard bed with 20 pounds traction on the halo and 30 pounds on the femoral pins. Upon admission he had a sacral pressure sore which was approximately 3.3 cm diameter and 0.9 cm deep. Because of the difficulty in caring for his skin while in traction, he was placed on a MUD bed on 5 June, 1973, lying supine, directly on the sacral ulcer. By 17 July, 1973 his sacral ulcer had healed to approximately 0.5 cm diameter and 0.1 cm deep. Since his spine had now stabilized and his traction been removed, he was removed from the MUD bed on 20 July, 1973 so that a more needy patient could use it.

Discussion

Much clinical experience with the beds has been gained. Perhaps the most significant aspect of experience has been that patients, admitted with sacral pressure sores, have had these sores heal while they lay supine directly on the ulcer without the need for turning. Not having to lie prone has a tremendous effect on the morale of the patient and on the time and energy required to provide the nursing care needed for any sore to heal. When dressings must be changed, the patient can easily be turned by one nurse (since his centre of gravity and the long axis of his body are at the level of the surface of the fluid). When the patient is turned on his side, a sacral sore can be completely exposed for nursing care. Also, since the patient is not totally submerged, he can be easily laid prone when desired.

Features of the bed design which one might envisage to be troublesome have generally caused few problems. The thin polyvinyl-chloride (PVC) membrane covering the fluid is occasionally punctured causing the fluid to leak slowly, however leaks can be patched permanently using standard surgical tape found on the ward. No completely ideal cover material has yet been found. Even though PVC has a low rate of water vapour transmission, the large surface area does allow sufficient evaporation to require the occasional addition of water followed by hand mixing of the mud to keep it a uniform fluid consistency. Because the fluid is twice as heavy as water, the bed is heavy, weighing approximately 1200 pounds. On a hard level surface however, one nurse can handle the bed on its smooth castors. Additional help is needed only for ramps, door sills or carpeted areas. The fluid basis of the bed, while preventing shear forces, also prevents the use of unilateral traction, although 5 to 7 pounds of uncounter-balanced traction have been used with no problem. Above that level, the traction simply tends to pull the patient to that end of the bed. Patients with counter traction are, however, much more easily cared for in a flotation bed than in a standard bed as turning is not required. The Trendelenburg position for providing opposing traction force or positioning for respiratory drainage is not possible as gravity will always keep the fluid surface horizontal. Since the bed cannot be "rolled up" for sitting, foam bolsters or pillows are used to prop the patient up when needed.

Summary

The Rancho Flotation Bed provides hydrostatic support with maximum pressures over bony prominences of 15 to 25 mm Hg (measured with a pneumatic pressure transducer). This is generally below the levels normally quoted as conducive to the development of ischaemia. Clinical experience has shown the bed to be a successful aid to nursing by eliminating the need to turn the patients for pressure reasons, allowing patients with pressure sores to remain in a position which is more comfortable and more suitable for other nursing care. It also makes it easier for nurses to handle patients in order to care for the pressure sores.

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