Comparison of Capillary Blood Flow Using a Regular Hospital Bed Mattress, ROHO® Mattress, and Mediscus® Bed
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Pressure sores continue to present serious problems in the management and rehabilitation of the acute and chronically ill. The incidence of pressure sores among patients with spinal cord injuries is estimated to be between 24% and 85% (Seymour & Lasefield, 1985). According to Rodriguez, Claus-Walker, Kent, and Stoll (1986), spinal cord injury patients have an already reduced blood supply below their level of injury. This reduced blood supply may cause them to be more susceptible to tissue breakdown from pressure loads over bony prominences.

Severe or prolonged ischemia—any condition that interferes with the circulating peripheral blood flow—produces changes in the normal cell metabolism that lead to the death of the cell. Kosiak (1961) indicated that cellular ischemia caused by external pressures higher than capillary blood flow pressure is one of the primary factors in the production of pressure sores. Kosiak (1961) further found that application of low pressures (70 mm Hg) for 2 hours produced ischemic changes, although application of 35 mm Hg or less of pressure over 4 hours did not produce ischemic changes.

Reulher & Cooney (1981) agreed with Kosiak that there are four critical factors contributing to the development of pressure sores: pressure, shearing forces, friction, and moisture.

Exton-Smith, Wedgwood, Overstall, and Wallace (1982) suggested several factors that increase the risk of developing pressure sores in persons who remain in a prolonged sedentary position. They are advanced age, being underweight or overweight, poor nutrition, anemia, immobility, sensory or motor loss, and presence of tissue fragility (such as a history of previous skin breakdown) or friction (caused by spasticity or shearing forces on the body).

Nursing interventions can be directed toward the prevention of pressure sores and/or treatment of existing pressure sores. For a number of patients with identified risk factors for pressure sore development, conventional nursing interventions are effective in maintaining skin integrity and promoting healing of any existing sores. These interventions require the nurse to spend a minimum of 3 hours per day per patient at risk, and they include maintenance of a clean, dry, moderately moisturized skin surface, and turning and repositioning the patient at regular intervals (Lewis & Collier, 1983).

In some circumstances, however, extraordinary support surfaces may complement nursing interventions. One example of a client who may require a special support surface is a patient with spasticity. Spasticity plays a significant role in the development of pressure sores, because it interferes with proper positioning for pressure relief and increases exposure of the skin surface to friction.

Holley, Long, Steward, and Jones (1979) described research by E.M. Landis, who used the microinjection method for determining directly the mean blood pressure in single capillaries and found average pressure in the arteriolar limb to be 32 mm Hg, at midcapillary region 20 mm Hg, and at the venous limb 2 mm Hg. Most research studies evaluating the effectiveness of pressure-relieving devices measure the degree of pressure exerted by the device on bony prominences. Very often, however, the pressure-measuring technique affects the weight-relieving properties of the cushion, mattress, or bed (Holley et al., 1979).

Perhaps a more helpful method of determining the effectiveness of a device used to prevent and/or treat pressure sores would be to determine blood flow to the area. Laser Doppler velocimetry is a noninvasive blood flow technique used to measure capillary blood flow. “Laser light scattered from tissue in vivo is broadened in line width as a result of the doppler shift produced by moving red cells in the microcirculation” (Stern et al., 1977, p. 441). A laser Doppler monitor is an instrument that continuously applies low-power laser technology to determine blood flow through the skin or other tissue surface. This device makes use of the Doppler principle to monitor perfusion of red blood cells in the microcirculatory bed. The basic concept behind this technique is that the frequency of light back-scattered from moving red blood cells is shifted in frequency by an amount proportional to the velocity of the cells, whereas light scattered from the nonmoving skin tissues is not. These two components of the back-scattered light are collected at the skin surface by a second optical fiber, and guided to an optical detector. A signal processing algorithm combines this spectrum of frequencies and displays a number, which has been shown to be proportional to blood flow in the cutaneous microcirculation. Flow values are displayed in units of millivolts. Thus, the monitor measures decreases and increases in capillary blood flow.

The need for decubitus prevention during confinement for acute medical/surgical problems is becoming a chief concern, especially with the increasing cost of health care. The purpose of this study was to determine the product most effective in preventing decubitus formation and containing costs, if used over time.

Method
Nine subjects with spinal cord injuries without pre-existing pressure sores were used for this pilot study. Each subject was positioned on a regular hospital bed mattress for 1 hour, on a ROHO® mattress for 4 hours, and on a Mediscus® bed for 4 hours.

ROHO® Mattress: The ROHO® is an air flotation system. Soft, flexible, low-pressure air cells are interconnected at their base by air passages, so that they can work together to evenly support the loads placed on them. The mattress is composed of four separate sections attached to each other with Velcro®.

Mediscus® MKV air support therapy (MAST) bed: The MAST system has 21 pliable, waterproof, vapor-permeable air sacs arranged in five sections in the mattress. Each section has its own controllability, pressure gauge, and regulated air flow. Automatic compensator valves ensure constant, regulated air flow, interface with pressure above, and keep capillary closure to a minimum.

For the purposes of this study, 1-hour intervals were used when the subject was...
lying on a surface that exerted more than 32 mm Hg. When comparing the ROHO® mattress with the Mediscus® bed (since the pressures were well below 32 mm Hg), a 4-hour interval was used (Kosiak, 1961). Subjects with spinal cord injuries were used due to their high susceptibility to pressure sores.

One greater trochanter was selected as the study site for each person. The trochanter was free of pressure for at least 1 hour. A baseline capillary blood flow reading was done using a laser Doppler capillary perfusion monitor. The subject then lay on one of the test surfaces for the specified time in an appropriate position. The trochanter was positioned with the subject lying on the monitor. The subject’s hips were placed in 45 degrees of flexion with the trunk.

A capillary blood flow reading was taken after a 1-hour interval on the regular hospital bed; on the ROHO® mattress and Mediscus® bed, a reading was taken after 4 hours. Each subject was positioned on each of the three surfaces. There was sufficient time between each test for the capillary blood flow to return to the baseline reading.

Results
The nine subjects who participated in the study displayed pressures on the hospital bed mattress ranging from 39–50 mm Hg. After being on the surface for 1 hour, the capillary blood flow always decreased by at least two-thirds in each subject. On the Mediscus® bed, the pressures ranged from 20–30 mm Hg. All but three subjects increased their capillary blood flow at least four times after being on the Mediscus® bed for 4 hours. One subject decreased trochanter capillary blood flow by half, and two subjects’ blood flow remained constant. On the ROHO® mattress, the pressures ranged from 21–28 mm Hg and the capillary blood flow over the trochanter always increased at least four times over baseline value.

Discussion
This initial study seems to reveal that the ROHO® mattress and Mediscus® bed are comparable for pressure relief and for improving capillary blood flow. In this time of cost containment and nurse shortages, products for prevention and/or treatment of pressure sores must be viewed critically. When evaluating any pressure-relieving device, it should be rated over a period of time, not judged solely by pressure measurements.

Blood flow measurement provides insight into a patient’s local vascular capability and is a valuable means of determining the benefits of a pressure-relieving device. An unusual finding in this study was that blood flow increased over time when external pressures were continuously applied. No study to explain the increase in blood flow occurred in this pilot project. Future studies are needed to assess this phenomenon, as well as other factors related to capillary blood flow, blood pressure, and temperature, when using regular hospital beds and other support surfaces in rehabilitation nursing.

References