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Effectiveness of mattress overlays in reducing interface pressures during recumbency

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Abstract—This study evaluates the pressure-reduction characteristics of seven mattress overlays. Thirty subjects were evaluated on each support surface to determine the interface pressures that are generated under the most common pressure sore sites. The results of this study indicate that there is great variability in the effectiveness of traditional mattress overlays. The most effective overlays are the Roho and Akros DFD mattresses; whereas 2-inch thick convoluted foam provides no significant protection for the trochanter when the subjects were lying on their sides (lateral position).

INTRODUCTION

Pressure sore-prevention programs often concentrate significant effort on the selection of an appropriate wheelchair cushion but do not provide adequate guidelines for selecting a support surface for the individual while the person is recumbent (1, 4, 5, 7, 8). Frequently, the person is placed on a piece of 2-inch thick convoluted foam and turned every 2 hours—a practice based on the idea that such care will prevent pressure-induced soft tissue damage. Ingenuity is required in creating a support surface that stabilizes the skeleton while minimizing the pressures in the soft tissue and controlling the shear forces that are generated on the skin surface. The selection of foams, air- and water-flotation systems must be done judiciously to satisfy patient's needs.

During recumbency, the requirement that tissue pressures remain below 30 mmHg becomes very important since the hydrostatic pressure in this posture no longer makes a significant contribution to the forces tending to maintain flow of blood and lymph. Moreover, when a person is recumbent, variability in surface contours is more exaggerated than when the individual is seated. This leads to the need for a support surface that is capable of large deformations without generating large restoring counter forces. The deformation requirements for a bed support surface are dictated by the differences in elevations between the lumbar areas of the back and the coccygeal region and the differences between the waist and trochanters when the person is lying in a lateral position. If the support surface is not able to accomodate deformations of a magnitude permitting prominent areas to sink into the support, then the area available for weight bearing is reduced in the region and the pressures tending to impede the transport phenomena are increased. Although the relative roles of sitting-induced pressure and shear stress in the etiology of pressure sores are a subject of current debate, the controlling shear forces that develop when the body is moved from the lying to the sitting position are also important (3).

METHODOLOGY

To evaluate the effectiveness of commercially available support surfaces in redistributing weight to minimize interface pressures, 30 subjects were selected and evaluated on 7 mattress

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TABLE 1
Body builds of subjects evaluated

	Male	Female	Total
Thin	4	5	9
Average	8	10	18
Obese	1	2	3
Total	13	17	30

overlays with the Texas Interface Pressure Evaluator (TIPE) pressure measurement system (6). The TIPE System consists of a display unit, interconnecting cable, and an extra-large plastic sensor pad. The pad contains a matrix of 144 pneumatically activated switches, each of which is in turn monitored by a light-emitting diode (LED) readout on the display unit. During use, the pad is placed between the patient and the surface being evaluated. It is then inflated with a rubber pressure bulb to open all switches and thus turn off all LED's. The pad pressure is then reduced slowly by opening a relief valve. As the load caused by the body exceeds the pressure holding a particular switch open, the switch closes and the corresponding LED is illuminated on the display matrix. By noting the pressure on the gauge as each light or group of lights illuminate, one can use the TIPE to locate the points of maximum pressure, the pressure gradient, and the body area being loaded.

The 30 subjects for this study were selected from the population available at The Institute for Rehabilitation and Research and the Spinal Cord Unit at the Houston Veterans Administration Medical Center. The subject population was categorized by sex and body build. Body build is defined in terms of age, height, and weight of the individual (2). These data are tabulated in Table 1. The subjects were tested while recumbent in the supine and lateral positions so that pressures could be monitored under the scapulae, sacral-coccygeal area, and either right or left trochanters. The types of mattress overlays that were part of this study are listed in Table 2. A hospital bed with a standard mattress with "staph-check cover" was used as a control surface and as the foundation for all of the overlays.

Subjects wearing loose-fitting clothing were instructed to remove all objects from their pockets and to remove their belts and shoes before being evaluated. Subjects wearing clothing with double seams (e.g., jeans or tight clothes) changed into surgical scrub suits before the test session. The transducer pad was then placed between the mattress and the areas of the subject's body being monitored. Bony prominences were palpated and the corresponding LED's were noted on the data collection form as location references. The magnitude of the maximum pressure at each bony prominence was then recorded. To improve the reproducibility and the accuracy of the pressure measurements, the maximum pressure readings were taken three times and the average of the three readings was recorded for each bony prominence. Standardization in the lateral recumbent position for all subjects was achieved by using a goniometer to position the hips at 45 degrees of flexion. The

TABLE 2
Support surfaces

Standard hospital mattress
Stryker flotation system
Roho mattress
Convoluted foam, 2-inch
Convoluted foam, 4-inch
Akros DFD support system
Gaymar alternating air mattress
Lapidus alternating air mattress

TABLE 3
Statistical significance of pressure differences on mattress overlays versus standard hospital mattress

Mattress Overlay	Trochanter, p^*	Scapula, p^*	Sacral-Coccygeal, p^*
Stryker flotation system	0.1	NS	0.1
Roho mattress	0.005	0.005	0.005
Convoluted foam, 2 in	NS	NS	0.1
Convoluted foam, 4 in	0.1	0.005	0.005
Akros DFD support	0.005	0.005	0.005
Gaymar alternating air mattress	0.05	0.005	0.005
Lapidus alternating air	0.025	0.005	0.005

Analysis of pressure differences among three pressure sites was conducted using Student's t test. p = Level of significance; NS = no significance. * Degrees of freedom for t test, $\upsilon = 29$.

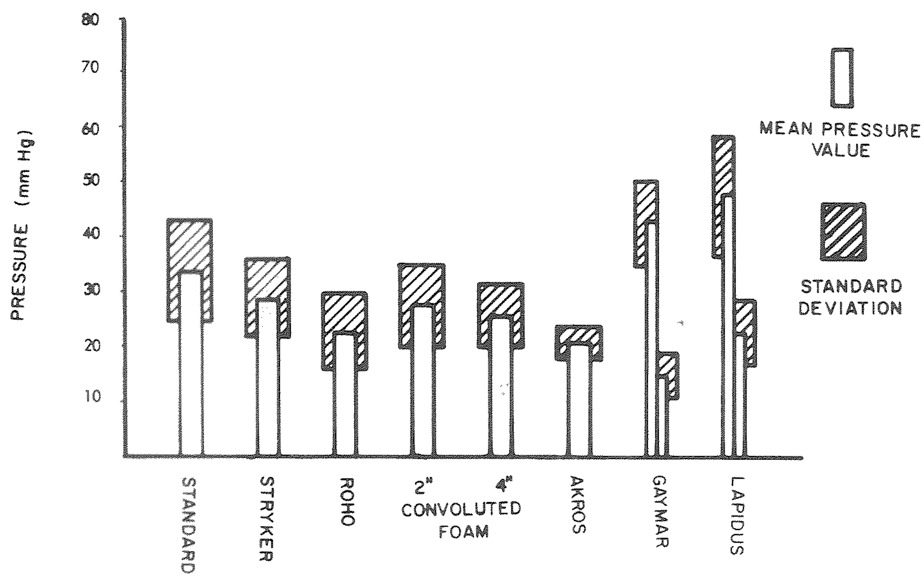

FIGURE 1
Pressure under sacral-coccygeal region while subjects lay in supine position on 7 different mattress surfaces.

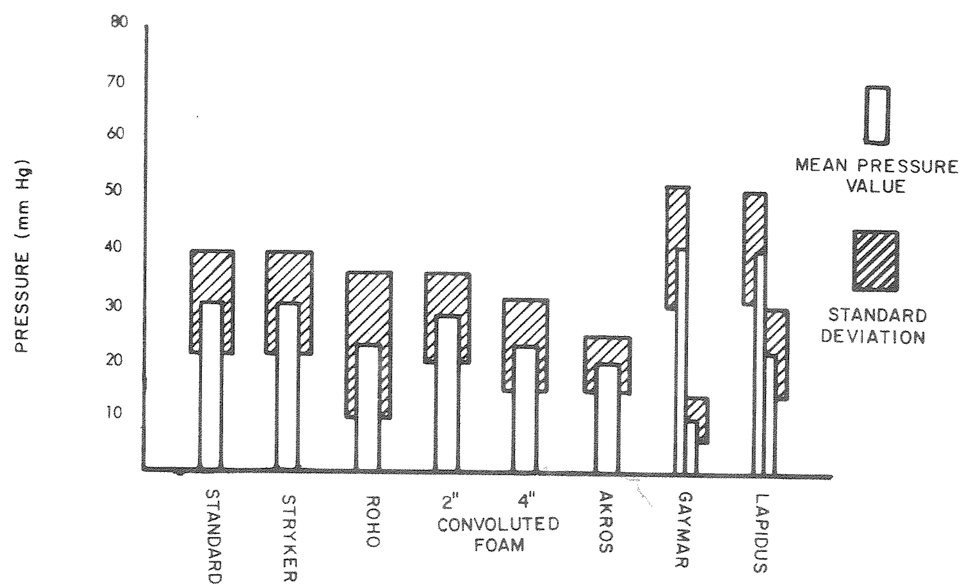

FIGURE 2
Pressure under scapula while subjects lay in supine position on 7 different mattress surfaces.

trunk was positioned perpendicular to the support surface and parallel of the long axis of the mattress. Each subject was instructed not to move while the readings were being taken. While scapular and sacral pressure measurements were made, the subjects' arms were placed flat along their sides.

RESULTS

Figures 1–3 show the mean maximum pressure and standard deviation of the maximum pressure measurements under the trochanter, sacral area, and scapulae for each of the mattress overlays. For the Lapidus and Gaymar, both the high and low readings in the cycle are represented on the graphs, although only the low reading is used in the statistical analysis.

An analysis of the differences between the pressures measured on the standard hospital mattress and the mattress overlays was conducted using Student's t test; the levels of significance obtained are summarized in Table 3. When compared to the standard mattress, there is a signifi-

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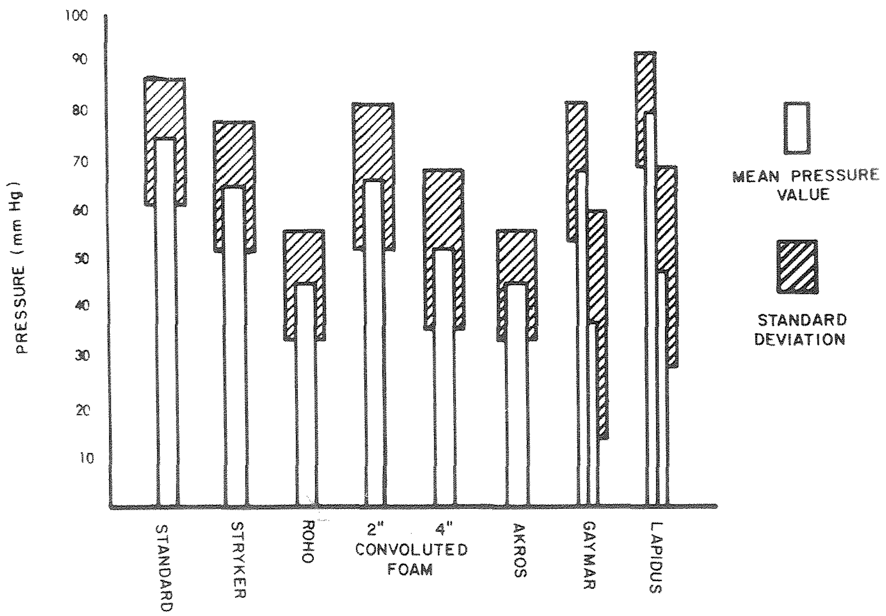

FIGURE 3
Pressure under trochanter while subjects lay in lateral position on 7 different mattress surfaces.

cant pressure reduction and redistribution of pressure away from the trochanters for all of the therapeutic mattresses except for the 2-inch convoluted pad. A greater difference was observed for the Roho and Akros overlays. Under the sacrum there is also a significant difference between the overlays and the standard mattress.

When comparing differences in the pressures generated under the trochanter and sacrum in females and males, the females had generally lower maximum pressures than the males; however, there was no significant difference in the magnitude of the interface pressures under the scapulae. The pressure data generated for thin, average, and obese subjects demonstrated the same trends; in fact, the relative effectiveness of each of the overlays was independent of the body build of the user.

CONCLUSIONS

All the therapeutic mattresses except the 2-inch convoluted overlay appear to be signficantly more effective in producing lower pressures than the standard mattress, especially under the trochanters.

The Roho and Akros mattresses are more effective in reducing the maximum pressures than the other therapeutic mattresses tested. The performance of these overlays appears to be independent of the body build of the subjects tested.

REFERENCES

1. BENNETT L, DAVNER D, LEE BK, TRAINOR FA: Shear vs. pressure causative factors in skin blood flow occlusion. *Arch Phys Med Rehabil* 60 (7) 309–314, 1979.
2. DIEM K, LENTNER Z: *Scientific Tables: Average Weights for Adults* (7th ed.). Basel, Switzerland: Ciba-Geigy, 1973.
3. DINSDALE SM: Decubitus ulcers: role of pressure and friction in causation. *Arch Phys Med Rehabil* 55 (4): 147–152, 1974.
4. FISHER SV, SZYMKE TE, APTE SY, KOSIAK M: Wheelchair cusion effect on skin temperature. *Arch Phys Med Rehabil* 59 (2): 68–71, 1978.
5. GARBER SL, KROUSKOP TA, CARTER RE: Systems for clinically evaluating wheelchair pressure-relief cushions. *Am J Occup Ther* 32: 565–570, 1978.
6. KRUSKOP TA: *A Guide for Using the Texas Interface Pressure Evaluator.* Stafford, TX: TK Applied Technology, 1983.
7. NEWELL PH, JR, THORNBURGH JD, FLEMING WC: The management of pressure and other external factors in the prevention of ischemic ulcers. *ASME Trans J Basic Engr D* 93 (3): 590–596, 1970.
8. NOBLE PC: *The Prevention of Pressure Sores in Persons With Spinal Cord Injuries.* World Rehabilitation Fund, 1981. (Int. Exchange of Info. in Rehab., Mono. No. 11.)