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# DECUBITUS PROPHYLAXIS: A PROSPECTIVE TRIAL ON THE EFFICIENCY OF ALTERNATING-PRESSURE AIR-MATTRESSES AND WATER-MATTRESSES

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*Abstract.* Six hundred patients at risk for pressure sores were randomized in either a control group or one of two experimental groups placed on alternating-pressure air-mattresses and water-mattresses. The groups remained comparable throughout the 10-day study period. Twenty-one patients from the control group developed decubitus ulcers, compared with 7 in each of the other groups. Patient and ward personnel opinions on the acceptability of the three types of mattresses were registered.

*Key words:* Antidecubitus mattresses; Bedsores; Decubitus; Pressure sores; Prophylaxis

A prospective study (5) showed that pressure sore (= decubitus) in hospital patients admitted with acute conditions occurred exclusively in patients who could be identified beforehand as risk patients. The use of a simple risk score system based on age, reduced mobility, incontinence, pronounced emaciation, redness over bony prominences, unconsciousness, dehydration, and paralysis, allowed separation of a group—one-sixth of the patients—among whom 5.8% developed pressure sores, compared with 0.2% of those found not at risk. Identification on admission of such exposed persons will make it possible to supervise them and examine the protective value of prophylactic measures (6).

Various types of mattresses are used in hospitals and nursing homes to prevent pressure sores (1, 2, 3, 4). They are intended to reduce the pressure on bony prominences either by distributing the load more equally or by rhythmic elimination of the pressure on any area.

At the Municipal Hospital, water-mattresses and alternating pressure air-mattresses have been employed. We observed the development of pressure sores in risk-patients nursed on these mattresses and compared the results with a similar group of patients nursed on ordinary hospital mattresses.

## PATIENTS AND METHODS

*Selection of risk-patients*

All patients with acute conditions were evaluated on admission. Those who already had pressure sores were excluded from the study and treated. A few patients refused to participate and some were included without informed consent because they were unconscious or aphasic. The criteria for inclusion in the at-risk group were based on 15 years' experience of dealing with pressure sores in the skin clinic.

The risk score for each was expressed in numerals, 2 for fulfilling an absolute and 1 for a relative criterion (Table 1). Patients with a risk score of 2 or more were considered to be at risk. They were allotted to one of the

Table 1. *Schematic recordings at admission and control assessments*

| Risk criteria and scoring on admission | | Recorded skin changes at assessments | |
|---|---|---|---|
| Absolute (score 2) | Relative (score 1) | Non-decubitus | Decubitus |
| Unconsciousness | Age 70 or over | Normal skin | |
| Dehydration | Reduced mobility | Redness & infiltration | |
| Paralysis | Incontinence | Extravasation | |
| | Pronounced emaciation | | Bullae |
| | Redness over bony prominences | | Black necrosis |
| | | | Skin defect |

Table II. *Distribution of patients according to age and sex*

| | Age, in years | | | | | |
|---|---|---|---|---|---|---|
| | 1–49 | 50–59 | 60–69 | 70–79 | 80 + | Total |
| Control | | | | | | |
| Female | 0 | 2 | 6 | 46 | 47 | 161 |
| Male | 3 | 3 | 11 | 30 | 13 | |
| Air | | | | | | |
| Female | 1 | 4 | 4 | 39 | 45 | 166 |
| Male | 2 | 8 | 8 | 26 | 29 | |
| Water | | | | | | |
| Female | 2 | 1 | 10 | 30 | 39 | 155 |
| Male | 5 | 4 | 18 | 28 | 18 | |

three groups, placed on 1) ordinary hospital mattresses, 2) alternating-pressure air-mattresses, and 3) waterfilled mattresses.

Sample Size Estimation:

The trial was designed as a fixed sample trial with 200 patients in each of the three groups, providing a power of 0.80 of detecting at least a 15 % reduction in pressure sore incidence in one of the experimental groups.

*Prophylactic mattresses*

Alternating-pressure air-mattress is about 2 metres long and consists of longitudinal air tubes connected in two separate series, one consisting of the even and the other of the odd numbered tubes. Each of the two series is inflated and deflated alternately by an electrically driven pump, providing sufficient air-pressure to support the patient on each series of tubes for about 5 minutes. The mattress is placed on top of an ordinary hospital mattress. Its function can be controlled by placing a flat hand between the hospital mattress and the air-mattress to feel if the inflated tube system lifts the patient.

The water-mattress is a box-shaped container 200 by 90 by 15 cm, manufactured as an air-mattress for camping. It is filled with lukewarm water and placed on top of a hospital mattress. Its function is verified by putting a flat hand under the water-mattress to make sure that the points of maximum pressure float about 2 cm above the hospital mattress. If the patient changes position the water content may have to be adjusted by re-filling or by lifting the head of the bed, so that the water is moved distally to keep the patient afloat.

Table III. *Weight distribution in the three groups according to a clinical estimate*

| | Under-weight | Normal weight | Over-weight | Not noted |
|---|---|---|---|---|
| Control | 26 | 73 | 60 | 2 |
| Air | 36 | 69 | 59 | 2 |
| Water | 40 | 51 | 61 | 3 |

Table IV. *Risk-score distribution of patients*

| Risk-score | Control | Air | Water | Total |
|---|---|---|---|---|
| 2 | 94 | 96 | 69 | 259 |
| 3 | 38 | 35 | 36 | 109 |
| 4 | 18 | 18 | 24 | 60 |
| 5 | 8 | 11 | 19 | 38 |
| 6 | 3 | 3 | 6 | 12 |
| 7 | 0 | 3 | 1 | 4 |
| Total | 161 | 166 | 155 | 482 |

*Observation protocol*

As previous observations indicated that most sores started soon after admission we examined the patients on alternate days for the first 10 days. One of us (K. E. A., O. J., or S. A. K.) assessed the condition of the skin on the shoulders, spine, sacral region, buttocks, hips, and heels. Skin changes were recorded on a form for computer analysis according to the descriptions in Table I. Bullae, black necrosis and skin defects were evidence of pressure sores and were treated, while the patient was exempted from further study. At each visit the assessor noted whether the patient was confined to bed, able to sit for 2 hours a day, or could walk around. No special nursing instructions were given. The initial assessment and frequent visits by the dermatologists made some of the staff more aware of the risk of pressure sores.

At the end of the 10-day observation period we decided, together with the patient and the ward personnel, whether further use of a prophylactic mattress was advisable.

The acceptability of the mattresses was evaluated by using questionnaires to be completed by 1) the patient, and 2) the ward personnel at the end of an observation.

*Analysis of data*

Differences in rates of pressure sores, drop-outs, risk factors, skin changes, and acceptability of the mattresses in the three groups were tested for significance by $\chi^2$-test.

## RESULTS

Among the 600 risk-patients selected from a total 3 571 emergency admissions, 118 dropped out during the first 24 hours before the first dermatologic inspection. This did not impair randomization. Of the remaining 482 patients 166 were kept on ordinary mattress, 166 on air-mattresses and 155 on water-mattresses.

Table V. *Occurrence of pressure sores in the three groups*

| | |
|---|---|
| Control | 21 patients |
| Air-mattress | 7 patients |
| Water-mattress | 7 patients |

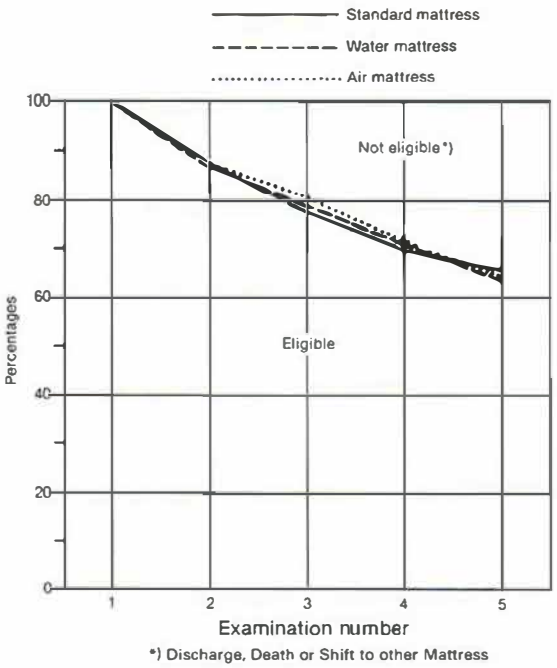


*Fig. 1.* Decrement in study population during observation period, distributed by type of mattress.

The results of randomization are shown in Tables II, III, and IV. The distribution showed no significant difference between the three groups according to age, sex, body weight, or risk score.

Many observations were abandoned before the scheduled 10 days because the patient 1) died, 2) developed a pressure sore, 3) was discharged from the hospital, or 4) refused to continue in the study. Taking into account the reduced size of the study population during the observation period, no significant difference was found between the groups (Fig. 1).

Confinement to bed was equally common in the three groups (Fig. 2). Partial confinement to bed was defined as more than 2 hours out of bed daily, sitting in a chair.

Decubitus developed in patients in each group, significantly more frequently in the control group than in the two groups using a prophylactic bed ($p<0.01$). Twenty-one pressure sores occurred in the control group, versus seven in each of the other two groups (Table V). This study does not support any choice between air- vs. water-mattresses.

The majority of decubitus sores were located on the sacral region and buttocks and no significant difference in the distribution was found between the groups.

The pressure sore incidence by mobility status according to type of mattress was significantly reduced for patients with restricted mobility, if placed on one of the special mattresses (Table VI, $p<0.01$).

Calculating the incidence of decubitus sores by initial risk score, we found an increasing incidence as the risk score increased, but the differences between the mattress groups were significant ($p<0.05$) only for the low-risk groups, as seen in Table VI.

The patients' and nurses' opinions about the different mattresses were registered when ever possible. Table VII shows the opinions given, related to the number of responders.

The staff found the water-mattress significantly less acceptable because of increased bed weight and greater effort required to turn the patients for hygiene and change of bed-linen. From the patient's point of view the water-mattress was significantly less acceptable than the standard mattress; some did not like the occasional glugging sound, some felt insecurely supported.

Generally speaking, the staff accepted the air-mattresses, but some patients found the fully distended tubes hard as bars to lie on, and some complained about noise from the motor.

Few objections were raised against the normal hospital mattress.

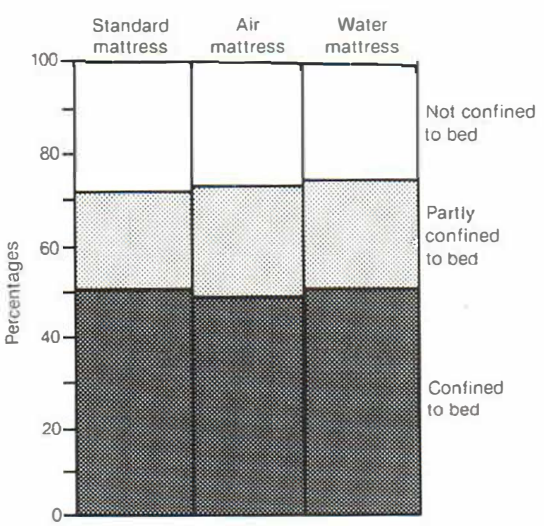


*Fig. 2.* The patients' confinement to bed during observation period, distributed by type of mattress.

Table VI. *Incidence of decubitus ulcers in selected groups, distributed according to type of mattress (95 % confidence limits in parentheses)*

| Bedding | Age | | Mobility | | Risk score | | |
|---|---|---|---|---|---|---|---|
| | 0–79 | 80+ | Normal | Reduced | 2 low | 3 medium | >4 high |
| Control (ordinary mattress) | 7 (2.9–13.9) | 23 (13.4–36.0) | 3 (0.1–17.2) | 15 (9.7–22.8) | 12 (6.0–20.0) | 8 (1.7–21.4) | 24 (10.3–43.5) |
| Prophylactic (air or water) | 5 (2.5–9.5) | 3* (0.8–7.7) | 3 (0.3–8.7) | 5* (2.6–8.7) | 2* (0.7–6.0) | 3 (0.3–9.8) | 9 (4.2–17.7) |

* $p<0.05$ compared with the control group.

## DISCUSSION

Our data demonstrate that the two different prophylactive mattresses reduced the incidence of decubitus when used right from admission to the hospital, but no difference in effect was found between the two types.

Any prophylactic regimen has to be combined with the ordinary ward routine and must be accepted by the patients, the nurses and their assistants in order to function properly. The opinions expressed by the patients and the ward personnel in our study reflect this problem.

Even though the mattresses we worked with gave some protection, they did not solve the problem. Other types of mattresses and special beds may be more effective and should be evaluated in controlled trials. One argument for the two systems used in our hospital is that they are not very expensive. The water-mattress costs about £20, while the alternating-pressure air-mattress with pump costs about £200. Both need to be checked frequently. The air-mattress requires a constant supply of electricity and the membrane of the mattress and connecting tubes is easily punctured. The noise of the pump can be a disturbance to other patients on the ward as well as to the actual risk-patient. The water-mattress is heavy to transport, slow to fill and to empty with a hose and ward personnel complain of difficulties in nursing and lifting patients. Many patients have difficulty in getting accustomed to them and feel insecure when they are unable to sit up and have a sensation of "floating". For the unconscious and paralytic who are constantly prostrate, a water-mattress can be the better solution.

After completing the controlled trial we noticed that the pressure in the canals of air-mattresses can vary considerably and the maximum pressure may be less than 70 % of what the technical specifications indicate. This may have impaired the prophylactive effect for some of the patients.

Table VII. *Opinions on mattresses*

| | Staff satisfied | Patient satisfied |
|---|---|---|
| Ordinary mattress | 74/90 (82 %) | 72/84 (86 %) |
| Alternating-pressure air-mattress | 94/103 (91 %) | 71/103 (69 %) |
| Water-filled mattress | 63/101 (62 %) | 56/97 (58 %) |

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