# Evaluation of a range of hospital replacement mattresses

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A combination of physical measurement and clinical testing was used to evaluate a range of pressure-reducing replacement mattresses, which had met tender specifications, in order to reduce the number available for selection in the purchasing process. Factors considered included mattress price and expected life-span. The results presented have supported a purchasing decision to replace mattresses but care should be taken in adopting these findings in a different context from that of a district general hospital. Optimum performance was found in one mattress replacement (Pentaflex).

**Mattresses; Pressure-relieving devices; Pressure ulcers**

Pressure ulcers are caused by the combined effects of pressure, friction and shear.[1] Their aetiology is complex and remains uncertain, but constriction of small blood vessels at or near the surface contributes to tissue injury and necrosis. Pressure-redistributing beds, mattresses and overlays are believed to prevent both initial development of pressure ulcers and the deterioration of established ulcers.[2] A systematic review of reliable evaluations of pressure-relieving beds, mattresses and cushions in pressure ulcer prevention is under way;[3] however, the standard hospital mattress is now known to be less effective at preventing ulcers than some low-pressure foam mattresses.[4]

Pressure-reducing foam mattresses can reduce average pressures between the body and the mattress by using basic design principles. The minimum achievable pressure depends on the patient's mass and the contact area, but this will increase if weight bears directly upon bedframe support joints (known as 'bottoming out'). Static foam mattresses are considered for general use where the target pressure lies above this minimum pressure. The target pressure is the pressure required by a given patient's individual circumstances and is a theoretical quantity closely related to capillary closing pressure. In practice it is sufficient to classify target pressure into levels of risk of pressure ulcer formation. Risk assessment tools are available for this classification. For patients who are at low or medium risk there is a need for a high quality mattress.

The Altnagelvin Area Health and Social Services Trust is the largest acute hospital trust in the Western Health and Social Services Board area of Northern Ireland, covering a population of 274,500. As the trust had scheduled a large-scale mattress replacement programme in early 1998, it was decided to review the pressure-relieving properties of a range of 12 foam mattresses: full details are available on request. The methodology used in 1993 by the

**Fig 1. The wooden hemisphere indentor, prior to loading a replacement mattress**

**Fig 2. The complete apparatus: indentor, 30kg weight, and the Oxford Pressure Monitor**

REFERENCES
1. Jay, E. How different constant low pressure support surfaces address pressure and shear forces. *J Tissue Viabil* **5:** 4, 118-122.
2. Dealey, C. Mattresses and beds. *J Wound Care* **4:** 9, 409-412.
3. Cullum, N., Deeks, J.J., Fletcher, A.W. et al. Pressure-relieving beds, mattresses and cushions for the prevention of pressure sores. In: *The Cochrane Library*, Issue 4, 1998. Oxford: Update Software.
4. Effective Health Care. The prevention and treatment of pressure sores: how effective are pressure-relieving interventions and risk assessment for the prevention and treatment of pressure sores? *Effective Health Care* 1995; **2:** 1, 1-16.
5. Medical Devices Directorate. *Evaluation PS1: 1-24.* London: Department of Health, 1993.
6. Bain, D. Testing the effectiveness of patient support systems: the importance of indentor geometry. *J Tissue Viabil* 1998; **8:** 1, 15-17.

**Table 1. Peak pressures on loaded mattresses, in order of peak pressure at the start of the experiment ($t_0$). Type 2 was discontinued during the research (arbitrary units)**

| Type | Peak ($t_0$) | Peak ($t_{24}$) | Inc ($t_{24}$) (%) | Peak ($t_{48}$) | Inc ($t_{48}$) (%) |
|---|---|---|---|---|---|
| 6 | 106 | 99 | -6.6 | 110 | 3.8 |
| 12 | 109 | 102 | -6.4 | 124 | 13.8 |
| 2 | 117 | 112 | -4.3 | 131 | 12.0 |
| 10 | 127 | 133 | 4.7 | 128 | 0.8 |
| 7 | 131 | 116 | -11.5 | 110 | -16.0 |
| 11 | 136 | 144 | 5.9 | 112 | -17.6 |
| 4 | 142 | 153 | 7.7 | 159 | 12.0 |
| 8 | 143 | 137 | -4.2 | 194 | 35.7 |
| 13 | 143 | 138 | -3.5 | 153 | 7.0 |
| 5 | 144 | 134 | -6.9 | 143 | -0.7 |
| 1 | 161 | 160 | -0.6 | 155 | -3.7 |
| 3 | 172 | 175 | 1.7 | 194 | 12.8 |
| 9 | 180 | 172 | -4.4 | 161 | -10.6 |

**Table 2. Peak pressures on loaded mattresses together with cost, life-span (guarantee period) and estimated price per year (1999 UK prices)**

| Type | Pressure at onset | Pressure relief | Cost (£) | Life-span (years) | Price/year (£) |
|---|---|---|---|---|---|
| 6 | 106 | 99 | 145 | 2.5 | 58 |
| 7 | 131 | 116 | 135 | 1.5 | 90 |
| 12 | 109 | 102 | 144 | 4 | 36 |

UK Medical Device Agency (MDA)[5] in a similar evaluation was chosen. All the mattresses evaluated in the MDA study showed a significant reduction in peak interface pressure compared to the standard NHS contract mattress. However, since that time, some models have been discontinued and a number of new models have become available. It was therefore decided that a new study was required. All the mattresses studied were available under a purchasing contract that was effective from November 1, 1996 to December 31, 1999.

## Method

Mattresses were subjected to 48-hour indentor testing[5] and, for a small subset, 24-hour patient compliance in the clinical situation for a one-week period.

### *Indentor tests*

Mattresses were loaded using a specially manufactured wooden hemispherical indentor (diameter 20cm) (Fig 1). This was fitted with a short stump-and-pipe arrangement that was constrained to move vertically in a guide-channel (Fig 2). The pipe (mass 355g) and hemisphere (mass 1920g) carried three 10kg weights (32.275kg in total).

Pressures were measured using the Oxford Pressure Monitor (OPM), which was calibrated at the outset by the manufacturer's recommended method. The 12 monitor sensors were taped to the apex of the hemisphere prior to loading. The load was applied to all mattresses in the same position, that is, centrally 650mm from the mattress end, over three days. The interface pressures were recorded on three occasions, as follows:

- Immediately after applying the load
- The apparatus was left in place for 24 hours and the pressures again recorded
- The load was then removed and the mattress was allowed to 'recover' for 24 hours. The load was then re-applied and the pressures again recorded, once each time.

All results were recorded on to standard data collection forms and subsequently analysed using Microsoft Excel. Both absolute peak pressures and the percentage change relative to the initial readings were determined. Science students from Oakgrove Integrated College in Londonderry were involved in taking the readings, none having any knowledge of the mattresses prior to testing. The loading data were used to reduce the number of devices to be included in the clinical evaluation by rejecting those mattresses that performed poorly.

### *Clinical evaluation*

Mattresses which achieved a high ranking in the indentor testing were placed in the clinical setting for a one-week period in a coronary care unit, a general care of the elderly ward and a general acute surgical ward. They were in constant use during the week-long test by patients in the three wards. The aim was to gather opinions on their performance in practice and perceived comfort from a variety of clinical subjects. Patients were asked about mattress stiffness (hard or soft), ease of movement while on the mattress, and general satisfaction with regard to comfort. These data were collected in an informal interview carried out by one of the authors. The purchasing decision was based on indentor testing, clinical evaluation and price. Account was taken of manufacturers' guarantee period as a measure of mattress life-span. For confirmation, a number of other major users were consulted.

## Results

The 12 mattresses provided varying pressure-relieving properties. Peak OPM readings from each sensor on each of three occasions indicated level of pressure relief, a low 'peak pressure' indicating a high level of pressure relief (Table 1) .

The process of exclusion to find a subset suit-

able for clinical evaluation showed that Type 3 (standard NHS issue) performed poorly. This was therefore used only as a baseline for comparison. Types 1 and 5 refer to two sides of the same mattress: this device was intended to be matched for patient weight, on a case-by-case basis, the 'heavy' and 'light' sides being placed uppermost for heavy patients and lighter patients respectively. This was agreed to be impractical for use in a large and busy clinical situation and discarded. Types 9 and 13 generated high initial pressures and were removed. Production of Type 2 mattress was discontinued by the manufacturer during the research.

Mattresses that produced an increase in pressure over the 24-hour loading period were then discarded (Types 4, 10 and 11). Type 8 performed poorly after the rest period and was also discarded.

The remaining mattresses (Types 6, 7 and 12) (Table 2) were all deemed suitable for further testing and these three mattresses were selected for clinical evaluation for a one-week period. All three performed satisfactorily, and one patient in the coronary care unit expressed an interest in purchasing the mattress.

Finally, price was examined in the context of the manufacturers' guarantee to give an indication of mattress life-span. Care must be taken when interpreting manufacturers' guarantees in this way to reflect product life. The guarantee periods may have introduced variation but they were the only proxy available and were genuine warranty periods. On the basis of these findings, we recommended Type 12 for purchase (Pentaflex, Huntleigh).

### Discussion and conclusion

Basic equipment such as mattresses is usually selected by drawing up a tight specification and carrying out a tendering process, with the final decision being based primarily on price. However, significant variation in pressure-relieving properties exists between the different brands, even after a specification has been met, and this leads to uncertainty in the purchasing process.

The purchasing decision reported here was based on indentor testing, clinical evaluation and price. Account was taken of the manufacturers' guarantee period, as a measure of mattress life-span. For confirmation of general satisfaction with the mattress in terms of user response, manual handling and reported problems, a number of users from other major acute hospital trusts were consulted.

The evaluation method described by the Medical Devices Directorate[5] has been criticised as it recommends a non-physiological hemispherical indentor, and excludes dynamic mechanical factors such as repetitive or shear loading.[6] However, in view of the limited laboratory facility available, and the fact that a prior tender specification had been met, we suggest that this approach reduced uncertainty in the purchasing process and introduced an element of scientific appraisal that has enhanced the purchasing decision. However, care should be taken in using the findings in a different context. ■



The Editor welcomes information on resources, organisations and new products. This issue features some recent developments, compiled by Diana Da Silva

## NEW PRODUCTS ON DRUG TARIFF

Vernon Carus has announced additions to the *Drug Tariff:* Cellona Undercast Padding Bandage, now available in three sizes – 7.5cm, 10cm and 15cm – forms excellent self-conforming undercast protection for skin and bony prominences.

The Paranet sterile paraffin gauze 10cm dressing is suitable for a range of superficial wounds and injuries. Made from 100% cotton, it is available in strips, single and multi-piece dressings and can be cut easily to the required shape. *Details from Louise Wilson on 01772 744493.*

## OVERLAY SYSTEM

Pegasus Egerton has launched a new modular mattress overlay system that offers an alternating-pressure mattress and low-air-loss overlay with optional alternating-pressure seating system and generic power unit. The Pegasus Aircare system has removable washable covers and is 'user-friendly', lightweight and easy to attach to existing bed mattresses. It is designed for patients who have some mobility or can be repositioned but are at risk of pressure damage or have superficial sores. *Details from customer services, tel: 023 9278 4200.*

## SCAR RESEARCH

The Scar Information Service is launching a major research project into keloid and hypertrophic scarring. As part of the project, members of the public who have keloid or hypertrophic scars are being asked to fill in a simple self-completion questionnaire. *Details, posters and copies of the questionnaire from the SIS, tel: 0845 1200022.*

## WET WRAPPING FOR ATOPIC ECZEMA

Tubifast Wet Wraps are a treatment for atopic eczema that is especially helpful at night. Two layers of Tubifast bandages – one wet and one dry – are applied over an emollient. Tubifast Wet Wraps fit every part of the body, are more comfortable than flat bandages and give complete freedom of movement. They can be used for children as young as three months and can be used all over the body or on isolated areas. The product is available on prescription in lengths of 1m, 3m and 5m and in four different sizes for arms, legs and body cover. *Videos and books for children and parents to aid application are available free from Seton Healthcare, tel: 01565 624 154.*