The Use of Dynamic Alternating Pressure Seat Cushions for the Prevention and Treatment of Pressure Ulcers
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INTRODUCTION
Since the late 1970’s there has been lively debate in the field of pressure ulcer management with regard to the clinical practice of providing seat cushions to patients vulnerable to, or suffering from, sacral or ischial pressure ulcers. Keane observed in 1978 that many paraplegic patients had two choices; permanent bed rest or sit on a chronic non-healing ischial wound and continue to enjoy reasonable life activities; neither option coming close to a reasonable solution. Today, experts remain somewhat divided in their outlook and their stance stems largely from their own clinical experience and the field in which they practice. For example a clinician dealing with reconstructive myocutaneous flap repair on pressure ulcers that repeatedly break down may take the position that all wounded patients should remain in bed, and non weight bearing, until an early wound has closed. By contrast the clinician that cares for the active young disabled may have to take a more pragmatic approach to the holistic needs of the individual. In between these two extremes lie a whole range of patient circumstances where a patient with a wound may want, or need, to spend part of the day in a chair, albeit for a restricted time. These needs are primarily driven by quality of life priorities where the patient expresses the right to choose between optimum wound healing and their desire to work, socialise and carry out activities of normal daily living. It is those patients who either chose to sit in a chair or for whom an holistic assessment suggests the benefits outweigh the risks to the wound that benefit from and deserve, the very best in pressure relief.

THE PHYSIOLOGICAL BASIS TO ALTERNATING PRESSURE
Keane’s early observations prompted a piece of work which has perhaps revolutionised the way such patients are managed today. Keane reflected on past physiological studies by Kosiak (1958) and Houle (1969) and concluded that the only reasonable likelihood of restorative perfusion could be obtained by periodic pressure removal as demonstrated by a slatted alternating device. Further investigation of the literature elicited the concept that pressure per se was not the issue as the human body, a terrestrial being, was constantly exposed to high pressures but suffered no ill effects provided normal spontaneous movement was unimpeded. Keane also postulated that the main damaging effect may not be pressure at all, and goes on to suggest that the critical factor may be the gradient at which the pressure is applied causing “compression tension and distortion in the deep tissues”. He also proposed that surfaces that attempt to reduce the force by means of constant low-pressure immersion, e.g. foam or static air, may “remove the natural stimulus to produce thickened protective skin” hence can actually heighten the individual’s risk of future tissue breakdown.

The premise posed by Keane, and work that followed, had followed a logical physiological argument, that the type of seat cushion which will provide the very best pressure relief is one that regularly relieves pressure to the tissues rather than one that applies continual pressure which, even if low, is still high enough to cause capillary closure.

The basic principles of alternating pressure are firmly grounded in normal human physiology; the body has evolved to experience periods of vessel occlusion followed by swift removal of pressure as a result of spontaneous movement. This pressure removal, providing it takes place several times each hour, results in hyperaemia of the previously occluded vessels and a rapid normalisation of the microcellular environment. Therefore, pressures applied to the tissues need to either be frequently relieved, or be so low as to avoid capillary closure. However, studies have shown that to avoid closure of the venules, constant pressures less than 10mmHg may be required (Figure 1).

![Figure 1 Capillary blood pressure (Mean)]

Unfortunately in the seated person this is almost certainly unobtainable. When seated the surface area supporting the body weight is reduced to approximately 8%, hence pressures at the cushion/subject interface are some of the highest seen in testing and by far exceed capillary closing pressure (Figure 2).
For this reason, vulnerable individuals such as spinal-injured patients are required to perform either frequent lifts, i.e. every 20 minutes, or to perform forward weight shifts; both procedures effectively reduce pressure over the vulnerable ischial area even when seated on a static pressure reducing surface (Figure 3).

However this discipline is not practical for most patients and alternative strategies need to be considered. In effect, these strategies may include enforced bed rest, nurse-assisted repositioning when seated, or the use of a pressure relieving support surface.

SUPPORT SURFACE SELECTION

Static pressure relieving cushions

Unfortunately static support surfaces, no matter how efficient, cannot be relied upon to lower interface pressure sufficiently to enable full capillary flow, yet these are commonly prescribed as preventative aids. This can result in vulnerable individuals cycling through repeated tissue breakdown, treated with enforced bed rest, and enduring all the psycho-social implications associated with a diminished quality of life. To illustrate, in 2002 Dr James Zoller reported a prevalence of tissue damage in 80% of surveyed wheelchair users all of whom were using some form of static pressure redistributing cushion e.g. Gel, Modular air. By contrast, Zoller’s survey demonstrated that when wheelchair users were provided dynamic alternating therapy the situation was distinctly improved; is this modality a viable alternative?

Alternating pressure cushions

Keane, once again, lead the field in this area by researching and developing a device capable of adequately off-loading the tissue while maintaining postural stability. Though not elegant, the Keane Reciprocating Wheelchair Seat (a modified, padded, toilet seat!) was used successfully for many years to protect and treat highly vulnerable patients and operated by means of an alternating cycle of pressure application and removal. Keane observed that provided the tissues were off-loaded at intervals sympathetic to normal physiological requirements, that is less than every 11.6 minutes, tissue damage did not occur. He also observed that granulation tissue was not affected by short periods of pressure and that healing could continue without recourse to bed rest.

Today, most plastic surgery units continue to see pressure ulcer patients who have been seated on static cushions and have recurrent wounds yet, if they are permanently disabled, they cannot be expected to spend their life in bed. Given the Keane experience, and solid physiological basis to his tenet, why is there a reluctance to prescribe new and innovative...
Alternating pressure seat cushions, particularly as contemporary engineering has provided highly practical, yet effective, devices?

THE EVIDENCE REVIEWED

In the healthy individual, tissue is continually exposed to alternating periods of very high pressure which is redistributed by the normal physiological behaviour of spontaneous movement, even during sleep. Normal microcellular responses have been demonstrated in the laboratory and have been replicated by means of replacing spontaneous movement with an alternating pressure device. This device is placed beneath an immobile subject and has been shown ‘provide a superior match between oxygen supply and demand at sites where pressure might still be allowed to persist’ and to promote the effect of lymphatic propulsion both of which are essential elements in tissue viability. While this evidence may hold true for a laboratory experiment, it is essential to consider a wider range of evidence before making an informed decision as to whether any single device is suitable for both prevention and treatment of seating injury; there should be no distinction between the two requirements as both are dependent upon adequate tissue perfusion.

In the laboratory

Interface pressure tests show that an innovative alternating cushion device (Aura Logic cushion, Huntleigh Healthcare) provides regular intervals of very low interface pressures for a significant portion of each alternating cycle (Figure 4).

Figure 4 Comparative pressure relief index for the Aura Logic seat cushion

The pressure relief index indicates that for a whole range of different subjects (age, weight, BMI etc.) pressure relief below 30mmHg was achieved for around 23% of the time. This is likely to be more efficient than side/forward leaning for a few minutes, 3 times per hour. But does this efficiency in the laboratory translate to improved clinical outcomes?

Prospective clinical outcome studies

Alternating therapy was rigorously tested in a randomised controlled clinical study (RCT) comparing two different alternating mattresses and seat cushion combinations. This study took place over two years and recruited vulnerable patients with existing tissue damage. The outcome showed both dynamic alternating cushions to be useful tools in providing 24 hour care for the seated patient. Wounds progressed to healing and no device associated deterioration was observed. The common theme for both seat cushions studied was their ability to regularly and reliably off-load the tissue allowing reperfusion of previously compressed tissue.

A further RCT of an alternating seat cushion showed again that wounds, even severe wounds, can progress toward healing while still allowing the patient to partake in daily life. Patients were able to extend their time out of bed and while their morale improved so may their overall health - digestive, urinary, respiratory and circulatory systems are all affected by bed rest.

Clinical outcome in the naturalistic setting

Finally, the ultimate test for any therapeutic device is how it fairs among the most challenging individuals in a naturalistic setting such as those not under the close scrutiny and control of a formal study. While this type of data is not tightly controlled in terms of scientific integrity it does demonstrate other elements of seating that are critical to overall success of a therapeutic device when exposed to all the normal environmental pressures of active life.

The first evidence presented reflects on a three year experience of an alternating seat cushion, the Aura Logic Cushion between 1998 and 2001. Ninety four patients, across 55 acute and community settings, were evaluated retrospectively using contemporaneous clinical audit data. The patients reviewed were elderly (mean age 76 years), were high to very high risk of pressure ulcer development or had extant wounds (n=53, 56%). The surveyed population used the cushion for an average of 19 days and 93% either showed wound improvement or status quo, with the latter case most likely dependent upon a shorter evaluation period.

The second piece of evidence is based upon a questionnaire survey designed to elicit user experience of an alternating pressure cushion used to manage patients with all grades of spinal cord injury. In this survey the allocation time was much longer, mean days 271.5 and was therefore able to demonstrate a higher number of respondents reporting a positive outcome in terms of healing. The findings are presented below.

General facts:

- 80% of spinal cord injury (SCI) patients will get a pressure ulcer.
- 30% will have a recurrence.

Findings on allocation of a dynamic cushion – sample size n = 55:

- 80% had existing wounds, spent much of the day in bed, had pain and a poor view of life.
Dynamic cushion used for:

- Mean days 271.5
- Range 18 – 550

OUTCOMES

- 27% reported their concern and effects on work reduced or eliminated
- 84% reported concern or effects on activities of daily living reduced or eliminated
- 82% reported the effects on social activities were reduced or eliminated
- 91% said their concern about pressure ulcer risk was reduced or eliminated
- 24% having pain said this was reduced or eliminated
- 30% said their overall outlook on life was improved
- 56% reported ulcer improvement
- 18% reported ulcer closure
- Incidence of new wounds was reduced from 80% to 9% in this highest risk population

Perhaps the most significant outcome was the of quality of life improvement with these seat cushions that allowed clients to increase their chair time from an average of 3.8 hours to 8.5 hours! This alone had a significant reported effect on the quality of life.

Taking all the evidence into account it has become clear that there is a realistic alternative to the option of restrictive bed rest, ‘revolving door’ reconstructive surgery or enduring a persistent chronic wound and this rests upon a well designed alternating pressure seat cushion. The design needs to accommodate a range of individuals, be sensitive to the issues of postural stability and have sufficient inflation pressure and cycle times to provide a physiologically normal microcellular environment in the immobile individual.

The knowledge gathered from physiological research, field trials and user feedback has been critical in steering the advanced design of the Aura Logic cushion. This device incorporates all the essential features necessary to off-load the tissues, while maintaining postural stability, and has been shown to be an equally useful prevention and treatment modality. It is therefore strongly recommended that alternating seat cushions should be made available to vulnerable persons who have the right to enjoy a good quality of life without compromise to their health.

REFERENCES

7. West J et al. The effects of a unique alternating pressure mattress on tissue perfusion and temperature. European Tissue Repair Society meeting. 1995
9. Data on file
12. Data on file