The Alpha Response™ Active Therapy range – safety in mind

In the current economic climate healthcare providers face difficult economic circumstances, a situation that is exacerbated by the high cost of treating avoidable accidents and injuries. The management of immobility and the associated pressure ulcer risk is a particular challenge. Guidelines recommend regular repositioning and a pressure-redistributing surface for the protection of vulnerable individuals, yet both have been associated with safety issues. This article examines a new range of therapy surfaces that has been designed to reduce the risk of user error and to redistribute pressure effectively.

Lyn Phillips

KEY WORDS

Alpha Response™
Auto profile technology
Active (alternating) therapy
Pressure ulcers
Safety

Unfortunately, despite advances in healthcare, pressure ulcers remain relatively common (Vanderwee et al, 2007a; Gallagher et al, 2008). It is not unusual for up to one in five patients to be affected and longitudinal surveys suggest little reduction over time (Van Gilder et al, 2009; Bermark, 2010; Phillips, 2010).

Aside from the obvious suffering endured by patients, the financial impact of pressure damage on healthcare providers is also a factor. However, as well as the costs associated with direct wound treatment, there is also the cost of increased length of stay, surgical intervention, extended rehabilitation, loss of earnings and long-term care provision. This 'total healthcare' cost of pressure damage has not been formally calculated in most healthcare services and is often masked by 'silo' or compartmentalised budgeting.

Lyn Phillips is an Independent Clinical Consultant

Where costs are known, they can provide a useful measure against which the true value of preventative healthcare can be calculated. For example, an economic study by Bennett et al (2004), which concluded that pressure ulcer management absorbed up to 4% of the total UK healthcare budget, has recently been incorporated into an economic model developed by the Department of Health (DH, 2010). This Pressure Ulcer Productivity Calculator enables healthcare services to calculate the financial benefit of reducing the number of facility-acquired pressure ulcers, allowing them to track the return on investment in local initiatives, such as educating staff on the use of pressure-relieving equipment and implementing guidelines.

Costs associated with claims for clinical negligence are also on the increase and this will undoubtedly continue as consumer awareness grows. A recent US report analysed negligence claims for over 560,000 'medical errors' and by comparing the treatment costs with a similar non-injured cohort, the authors established that the US spent US$3.9 billion per year treating pressure ulcers (which topped the league table for medical errors) (*Table 1*) (Shreve et al, 2010). These figures do not include the cost of litigation, liability insurance and compensation payouts. By highlighting that over 90% of the ulcers may have been avoided with reasonable preventative care, this study reaffirmed the notion that most pressure ulcers can and should be prevented.

Given this renewed global focus, it is not surprising that pressure ulcers are increasingly falling under the umbrella of 'patient safety'. In the UK the National Patient Safety Agency (NPSA, 2010) lists pressure ulcers as a key quality target in 2010, while in the US, the Institute for Healthcare Improvement (IHI, 2006) launched the Five Million Lives campaign, with pressure ulcers targeted as 'never events'. Investigative methods now include 'root cause analysis' and the routine audit of preventative measures. These methods can expose gaps in the timing and implementation of care (Buttery and Phillips, 2009), and have already demonstrated that mattresses, particularly those that require frequent manual readjustment during use, are more prone to being set up incorrectly, potentially compromising patient safety (Phillips, 2004; Ward, 2010).

Fortunately, recent advances in technology have enabled manufacturers to develop pressure-redistributing products that are not only effective, affordable and easy to use, but which also prioritise patient and carer safety. This article examines the therapeutic and safety features of the *Alpha Response*™ mattress replacement, mattress overlay and seat cushion (*Figure 1*) (ArjoHuntleigh) with regard to pressure

ulcer management. It also considers how this equipment can reduce the risks associated with patient repositioning.

Pressure and immobility

Although the pathophysiology of pressure ulcers is complex and involves many factors, evidence suggests that the prime cause is mechanical load (principally pressure +/- shear). This load, when applied to soft tissue for a sufficient duration, results in muscle deformation, altered transport of nutrients and waste products, and ultimately cell death and tissue necrosis (European Pressure Ulcer Advisory Panel [EPUAP] and National Pressure Ulcer Advisory Panel [NPUAP], 2009; Takahashi et al, 2010). Therefore, it is not surprising that immobility is a key prognostic indicator of pressure ulcer vulnerability (Nixon and McGough, 2001).

In the at-risk patient population, deep pressure damage can develop within a few hours (Gefen, 2008). As a result, it is increasingly suggested that tissue injury can be avoided by early assessment and relatively simple, but prompt, pressure management (Schoonhoven et al, 2007; NPUAP-EPUAP, 2009; Olshansky, 2009).

Table 1
Ranked cost of 'medical errors' in the USA (Shreve, 2010)

Error type	Per cent of injuries that constitute errors	Number of errors (2008)	Cost of errors
Pressure ulcer	>90%	374,964	$3.9 billion
Post-op infection	>90%	252,695	$3.7 billion
Mechanical complication of device, implant or graft	10–35%	60,380	$1.1 billion
Post laminectomy syndrome	10–35%	113,823	$1.1 billion
Haemorrhage that complicates procedure	35–65%	78,216	$0.96 billion

Avoiding injury: managing the duration and intensity of pressure

While it is acknowledged that pressure ulcer prevention and management require a holistic multidimensional approach, recent guidelines (EPUAP-NPUAP, 2009) describe how both repositioning and the use of specialist support surfaces (overlays, mattresses and bed systems) are most effective interventions when combined.

A repositioning cycle of two hours is often cited as an effective preventative intervention, however, low staff-patient ratios and high patient acuity mean that in reality two-hourly turning is often impossible to achieve (Krishnagopalan et al, 2002; Goldhill et al, 2008).

It has also been identified that simply turning patients more frequently does not necessarily result in a decreased incidence of pressure ulcers (Vanderwee et al, 2007b), and comes with other issues such as reduced patient choice, pain control and adequate rest/sleep periods. By combining manual repositioning with a pressure-redistributing surface, individualised turning protocols are achievable without compromising patient outcomes (Defloor et al, 2006; Krapfl and Gray, 2008).

Less frequent turns also reduce staff exposure to physical injury. This is a significant, yet overlooked issue that does not feature strongly in the wound care literature. James (2010) reports that over time up to one in four UK nurses will be absent through work-related musculoskeletal disorders, accounting for 40% of all sick leave. Half of these injuries

Figure 1. *Alpha Response*™ therapeutic mattress replacement and overlay with Auto Profile Technology.

will be associated with patient handling. Put into financial context, this equates to more than 1.0% of the healthcare budget for an average sized service.

Any strategy that reduces the need for physical intervention, without compromising patient outcomes, will reduce the risk of injury. A further consideration is that nurse-related interventions are not cost neutral. In real terms, although the patient outcomes are broadly similar, physical interventions (e.g. turning, repositioning and mobilising) have been identified as costing approximately twice as much as the use of technology (e.g. pressure-redistributing mattresses and seat cushions) (Schuurman et al, 2009).

Role of the support surface

Pressure-redistributing support surfaces are primarily described and differentiated by their mode of action. Essentially, there are two classifications: 'active' (alternating) and 'reactive' (constant lower pressure). Although both have been designed to redistribute pressure, they do so in different ways. The *Alpha Response* range provides efficient pressure redistribution in either mode, the selection being determined by clinical assessment and the goals of therapy.

Reactive support

Reactive support surfaces are defined as 'powered or non-powered with the capability to change load distribution properties only in response to applied load' (NPUAP, 2007). This means that the pressure remains constant unless the patient is repositioned. This modality attempts to address areas of high contact pressure, typically over bony prominences, by redistributing the body mass over a larger surface area. It is achieved by the processes of immersion and envelopment. Examples of reactive support surfaces vary from high specification foam mattresses, which are commonly used in first-line prevention, to more sophisticated powered devices. As the support surface is soft, more of the body comes into contact with it, which means that mass is more evenly distributed and contact pressures fall.

Reactive surfaces have been identified as particularly effective in the management of patients with intractable pain and/or sensitivity to movement, or for those with improving independent mobility. The reactive mode is also very useful as a temporary measure when undertaking nursing procedures such as wound care, toileting and repositioning.

Any strategy that reduces the need for physical intervention, without compromising patient outcomes, will reduce the risk of injury. A further consideration is that nurse-related interventions are not cost neutral.

The downside of all reactive surfaces is that pressure is not totally relieved and may not be low enough to prevent capillary occlusion in high-risk patients without relatively frequent repositioning. There may also be issues with the patient not being able to reposition themselves on very soft surfaces, given the lack of stability. The effort of getting off a system with a high level of immersion and envelopment has been compared to attempting to climb out of water (Takahashi et al, 2010).

Active therapy

Active therapy support surfaces are powered air-filled mattresses, overlays and seat cushions that typically have a series of adjacent cells. These systematically inflate and deflate underneath the patient at regular intervals. Alternating the areas of off-loading at a frequency which mirrors the movements of an able-bodied person means that previously compressed blood vessels can reopen, tissues can reperfuse and the risk of ischaemic injury is reduced.

Given that some patients with underlying disease may have slower reperfusion indices, the design goal of an active system is to off-load the tissue with pressures falling as low as possible for as long as possible, without compromising comfort. This is based upon the principle that flow can increase significantly (Massey, 1983; Mayrovitz et al, 1993) in a fully opened vessel, compared to one that is semi-occluded.

Active systems that are able to perform within these parameters have been shown to be beneficial in terms of blood flow (Goossens and Rithalia, 2008), lymph flow (Gunther and Clark 2000) and clinical outcomes in high-risk patient groups (Phillips, 2000; Still et al, 2003; Finnegan et al, 2008; Malbrain et al, 2010).

Even if the patient is immobile, active support surfaces enable a periodic and frequent relocation of pressure. Therefore, they are considered to be the support surface of choice for patients who cannot be regularly repositioned (EPUAP-NPUAP, 2009).

Mattress replacement or mattress overlay

The *Alpha Response* system is available as either a mattress replacement or as a mattress overlay, providing a practical solution for a range of clinical applications and budgets, including home care. The mattress replacement has a top layer of air-filled cells supported by an inflated sub-base which fits directly onto both static or profiling bed frames, while the mattress overlay is fitted on top of an existing base mattress.

While both options provide excellent pressure-redistribution, it is important to note that the performance of the overlay is, in part, determined by the supporting properties of the base mattress. If the quality is in any doubt, the *Alpha Response* mattress replacement would be the preferred option. To put this in context, a major randomised controlled clinical trial of almost 2,000 subjects compared the performance of active overlays with active mattress replacements (Iglesias et al, 2006). Although a similar number of pressure ulcers developed in each group, they occurred 10.64 days sooner in the overlay group, attracted significantly greater costs and left more patients dissatisfied with their care. This economic analysis suggests that a mattress replacement would prove more

cost-effective in 80% of cases, despite a higher initial acquisition cost.

The role of the bed frame

Alpha Response therapy surfaces have been designed to fit a wide range of bed frames from domestic divan beds to multi-sectional electric profiling bed frames such as the Enterprise® 9000 (ArjoHuntleigh). The advantage of using these latter systems in combination with a therapy surface is that the profiling action of the bed frame can reduce the shear forces associated with sliding down the bed, and also significantly reduce the need for repeated lifting or 'boosting' of the patient back up the bed, which is a frequently observed manual handling risk (*Figure 2*).

Additionally, the introduction of patient-controlled handsets has brought a level of independence not possible with non-powered bed frames. Even small adjustments in the backrest angle can have a significant impact on pressure over the sacral region (Oertwich et al, 1995). By educating and empowering patients to make small but clinically relevant positional changes, the risk of tissue injury may be reduced. Unfortunately, this independence is less of an advantage, and may be even hazardous if the therapy surface is one that requires carer intervention to reset the internal cell pressures on the pump each time the patient changes from a sitting to a lying position, or vice versa.

Manual or automatic therapy surface

When a patient is initially placed on a specialist support surface, or when he or she is changing between lying and sitting positions, an adjustment based on body-mass distribution (weight and position) is required to optimise the pressure-redistributing properties of the device and to avoid 'bottoming out' (where the support surface fails to lift the patient clear of the bed base). This can be achieved automatically or manually.

Automatic systems optimise internal cell pressures by continually or periodically adjusting the amount and pressure of air in the system. This ensures that the patient is correctly supported and is receiving active therapy without the need for manual readjustment or intervention. This automatic function also avoids the risk of user error through incorrect selection (Phillips, 2004; Ward, 2010).

Compared to manually adjusted systems, automated products also offer more sophisticated alarm and monitoring features that provide early warning of product malfunctions.

Alpha Response Auto Profile™ technology

An important safety feature of the *Alpha Response* mattress is that the only intervention the carer is required to perform when setting up the mattress is to select one of three patient weight range options. Once set up, a specially designed sensor (positioned at the head of the mattress) recognises the angle of inclination and feeds the information directly to the pump: the status is indicated on the LED display (*Figure 3*).

When the bed-frame/backrest is raised beyond approximately 30° from the horizontal, air is pumped into the mattress to support the patient beneath the seat area. Conversely, when the backrest is lowered, the pump releases air, returning the mattress pressures back to their original settings and thus providing optimum pressure redistribution in the recumbent position. This important safety feature has, until now, only generally been available in the more costly, fully automated support surfaces.

Figure 2. Lifting (boosting) a patient incorrectly can present a manual handling risk.

Twenty-four hour risk management: the seated patient

Clinical guidelines (EPUAP-NPUAP, 2009) recognise that pressure ulcer prevention and management is required both when patients are in bed and when they are seated. Although individual patient risk factors make outcomes difficult to quantify, Gefen (2008) has suggested that deep tissue injury may develop in a high-risk patient in less than two hours without repositioning or a specialist cushion. This elevated risk occurs because the body's weight is supported by a smaller surface area than when lying — principally the ischial tuberosities, buttocks, sacrum and upper thighs.

Although a link between sitting and pressure ulcer development has been identified (Gebhardt and Bliss, 1994; Stockton and Parker, 2002), the risk is still poorly managed. Audit data revealed that three out of four patients who had been allocated a therapeutic bed surface had no

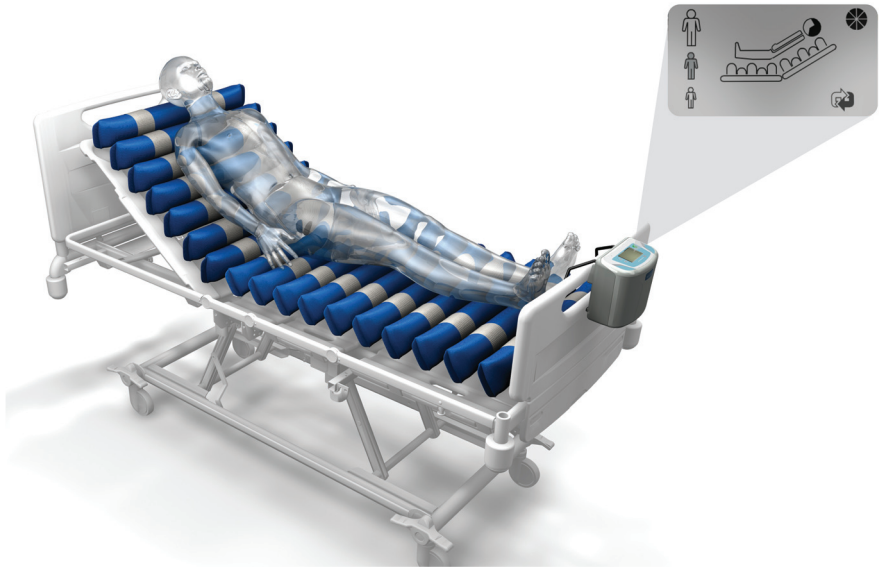

Figure 3. Auto Profile Technology.

form of pressure-redistributing surface in their chairs, with some sitting out for much longer than the recommended maximum of two hours (Buttery and Phillips, 2009).

Alpha Response cushions (*Figure 4*), unlike the ubiquitous air-filled or gel cushions, deliver active (alternating) pressure off-loading, a mode shown to facilitate tissue perfusion at levels comparable to those seen with periodic physical repositioning (Stockton and Rithalia, 2008).

Additional therapy and safety features

Additional safety features of the *Alpha Response* range include:

- Cable management: the power cord is contained within an integrated flap at the edge of the mattress reducing trip hazards and cable damage
- Bio-filter: the inclusion of a 0.3µ bio-filter in the pump unit means that only clean air is blown from the pump to the mattress, reducing the spread of airborne contaminants
- Cover options: as the *Alpha Response* mattress is designed for use within a wide variety of clinical settings, two different cover options are available. The standard cover features two-way stretch, water resistant and vapour permeable fabric that complements the pressure-redistribution properties of the mattress. The second option features greater breathability for patients who would benefit from management of the tissue microclimate (temperature and moisture) and a lower friction surface (particularly useful for those who require assisted repositioning)
- Transport mode: a non-powered transport facility enables the support surface to be isolated from the pump and remain inflated for up to eight hours. During this time, all of the cells maintain an equal pressure. This is useful for when the patient requires transportation to and from medical procedures in an acute care setting, or in the event of a power cut in the community
- Simple design: once set up, the *Alpha Response* mattress has been designed to require minimal intervention from staff. The simple LED display indicates normal operating status and the patient's lie-sit position. A suite of alarms ensure that staff are advised as soon as a potential safety issue arises. This simple automation can reduce the risk of user error and is particularly helpful in busy clinical areas, units with high staff turnover, or where patients are supervised by carers.

Figure 4. *Alpha Response*™ Active Therapy Seat Cushion.

Alpha Response clinical efficacy

Ward (2010) conducted a formal prospective clinical outcome study that monitored the progress of 60 acute-care, high-risk patients within a range of different clinical specialties. Of the patients included in the study, just one developed non-blanching erythema to the sacrum, while more than two-thirds of the 39 patients with existing pressure damage (including some with category 3 and 4 pressure ulcers) improved or healed.

Since the global launch of the *Alpha Response* mattress replacement, mattress overlay and cushion, post-market evaluation has shown this range to be a valuable tool in the prevention and treatment of pressure ulcers (unpublished observations).

Conclusion

There is little doubt that effective pressure ulcer prevention requires a multifaceted approach aimed at minimising the risk of prolonged pressure and moderating the factors that affect tissue tolerance, such as nutritional status, incontinence and underlying disease.

However, given that immobility is a key predictive risk factor for pressure damage, perhaps the most important protective intervention is an individualised repositioning programme combined with a pressure-redistributing support surface. An equally important factor is to ensure that functional mobility is not impeded by therapy choices and, where possible, patients should be advised to maximise their independence through access to assisted repositioning equipment such as a powered profiling bed frame. WUK

The *Alpha Response* range has been designed to reduce the risk of user error and the frequency of manual repositioning, and to encourage a level of patient independence, providing a safer environment for patients and staff alike.

Conflict of interest

This manuscript was originally prepared by the author while an employee of ArjoHuntleigh.

References

Bennett G, Dealey C, Posnett J (2004) The cost of pressure ulcers in the UK. *Age Ageing* **33(30)**: 230–5

Bermark S (2010) Six prevalence studies for pressure ulcers: snapshot from Danish hospitals. *EMWA J* **10(2)**: 36–44

Buttery J, Phillips L (2009) Pressure ulcer audit highlights important gaps in the delivery of preventative care in England and Wales 2005-2008. *EWMA J* **9(3)**: 27–31

Defloor T, Vanderwee K, Wilborn D, Dassen T (2006) Pressure ulcer prevention and repositioning. In: Romanelli M (Ed). *Science and Practice of Pressure Ulcer Management*. Springer, London: 67–73

DH (2010) *Pressure Ulcer Productivity Calculator*. DH, London

European Pressure Ulcer Advisory Panel/ National Pressure Ulcer Advisory Panel (2009) *Pressure Ulcer Prevention and Treatment: clinical practice guideline*. NPUAP, Washington DC

Finnegan MJ, Gazzero L, Finnegan JO, Lo P (2008) Comparing the effectiveness of a specialised alternating air pressure mattress replacement system and an air-fluidized integrated bed in the management of post-operative flap patients: A randomised controlled pilot study. *J Tissue Viability* **17(1)**: 2–9

Gallagher P, Barry P, Hartigan I, McCluskey P, O'Connor K, O'Connor M (2008) Prevalence

of pressure ulcers in three university teaching hospitals in Ireland. *J Tissue Viability* **17(4)**: 103–9

Gebhardt KS, Bliss MR (1994) Preventing pressure sores in orthopaedic patients. Is prolonged chair nursing detrimental? *J Tissue Viability* **4**: 51–4

Gefen A (2008) How much time does it take to get a pressure ulcer? Integrated evidence from human, animal and in-vitro studies. *Ostomy Wound Manage* **54(10)**: 26–35

Goldhill DR, Badacsonyi A, Goldhill AA, Waldman C (2008) A prospective observational study of ICU patient position and frequency of turning. *Anaesthesia* **63(5)**: 509–15

Goossens RH, Rithalia SVS (2008) Physiological response of the heel tissue on pressure relief between three alternating pressure air mattresses. *J Tissue Viability* **17(1)**: 10–14

Gunther RA, Clark M (2000)The effect of a dynamic pressure-redistributing bed support surface upon systemic lymph flow and composition. *J Tissue Viability* **10(3 Suppl)**: 10–15

Iglesias C, Nixon J, Cranny G et al (2006) Pressure relieving support surfaces (PRESSURE) trial: cost effectiveness analysis. *Br Med J* **332(7555)**: 1413–15

IHI (2006) *Protecting Five Million Lives from Harm*. Available at: www.ihi.org/ihi/programs/campaign (accessed 20 September, 2010)

James A (2008) Moving and handling in the health and social care sector: Health and Safety Exectutive's perspective. Oral Presentation. Disabled Living Foundation Conference, London

Krapfl LA, Gray M (2008) Does regular repositioning prevent pressure ulcers? *J Wound Ostomy Cont Nurs* **35(6)**: 571–7

Krishnagopalan S, Johnson W, Low LL, Kaufman LJ (2002) Body positioning of intensive care patients: clinical practice versus standards. *Crit Care Med* **30**: 2588–92

Malbrain M, Hendriks B, Wijnands P et al (2010) A pilot randomised controlled trial comparing 'Reactive' air and 'Active' alternating pressure mattresses in the prevention and treatment of pressure ulcers among medical ICU patients. *J Tissue Viability* **19(1)**: 7–15

Massey B S (1983) Mechanics of fluids. *Van Nostrand Reinhold* **5**: 157–60

Mayrovitz H N, Regan M, Larson P (1993) Effect of rhythmically alternating and static pressure support surfaces on skin microvascular perfusion. *Wounds* **5(1)**: 37–55

NPSA (2010) NHS to adopt zero tolerance approach to pressure ulcers. Available at: http://www.npsa.nhs.uk/corporate/news/nhs-to-adopt-zero-tolerance-approach-to-pressure-ulcers/ (accessed 20 September, 2010)

Nixon J, McGough A (2001) Principles of patient assessment: screening for pressure ulcers and potential risk. In: Morison, M (Ed) *The Prevention and Treatment of Pressure Ulcers*. Mosby, Edinburgh: 55–74

National Pressure Ulcer Advisory Panel (2007) *Terms and Definitions Related to Support Surfaces*. NPUAP, Washington DC

Oertwich PA, Kindschuh AM, Bergstrom N (1995) The effects of small shifts in body weight on blood flow and interface pressure. *Res Nurs Health* **18(6)**: 481–8

Olshansky K (2009) The 10 most important questions concerning pressure ulcers and quality of care. *Adv Skin Wound Care* **21(11)**: 505–6

Phillips L (2000) Cost-effective strategy for managing pressure ulcers in critical care: a prospective, non-randomised, cohort study. *J Tiss Viability* **10(3 Suppl)**: 2–6

Phillips L (2004) Optimise outcomes and reduce clinical risk by setting up pressure-relieving equipment correctly. *Nurse2Nurse* **4(3)**: 1–5

Phillips L (2010) Pressure ulcer audit: a paradigm shift. In: Cherry GW, Hughes MA (Eds). *Second Oxford European Wound Healing Course Book*. Positif Press, Oxford: 159–65

Schoonhoven L, Bousema MT, Buskens E (200) The prevalence and incidence of pressure ulcers in hospitalised patients in the Netherlands: A prospective inception cohort study. *Int J Nurs Stud* **44**: 927–35

Shreve J, Van Den Bos J, Gray T, Halford M, Rustagi K, Ziemkiewicz E (2010) *The Economic Measurement of Medical Errors*. Society of Actuaries. Available online at: www.healthlawyers.org/News/Health%20Lawyers%20Weekly/Documents/08%2013%2010/med_errors.pdf (accessed 20 September, 2010)

Schuurman JP, Schoonhoven L, Defloor T, van Englelshoven I, van Ramshorst B, Buskens E (2009) Economic evaluation of pressure ulcer care. A cost minimization analysis of preventive strategies. *Nurs Econ* **27(6)**: 390–415

Still JM, Wilson J, Rinker C et al (2003) A retrospective study to determine the incidence of pressure ulcers in burn patients using an alternating pressure mattress. *Burns* **29**: 505–7

Stockton L, Parker D (2002) Pressure relief behaviour and the prevention of pressure ulcers in wheelchair users in the community. *J Tissue Viability* **12(3)**: 84– 90

Stockton L, Rithalia SVS. (2008) Is dynamic seating a modality worth considering in the prevention of pressure ulcers? *J Tissue Viability* **17(1)**: 15–21

Key points

- *Alpha Response* mattresses automatically compensate for a change in posture (e.g. sit-lie-sit) and so maintain optimised pressure redistribution while being less prone to user error.
- Patients who use powered back-rests to independently change their posture, even slightly, may reduce the risk of tissue ischaemia.
- 'Active' therapy is the recommended therapy mode for patients who cannot be frequently repositioned or, by choice, prefer longer periods of uninterrupted rest and sleep.
- Patient handling is associated with up to half of all healthcare-associated musculoskeletal disorders: this is rarely addressed in wound care literature, despite assisted repositioning playing a critical role in preventative care.

Takahashi M, Black J, Dealey C, Gefen A (2010) *Pressure in Context. International Review. Pressure Ulcer Prevention: pressure, shear, friction and microclimate in context. A consensus document*. Wounds International, London

VanGilder C, Amlung A, Harrison P, Meyer S (2009) Results of the 2008-2009 international pressure ulcer prevalence survey and a three-year acute care, unit specific analysis. *J Ostomy Wound Manage* **55(11)**: 39–45

Vanderwee K, Clark M, Dealey C, Gunningberg L, Defloor T (2007a) Pressure ulcer prevalence in Europe: a pilot study. *J Eval Clin Pract* **13(2)**: 227–35

Vanderwee K, Grypdonck MH, DeBacquer D, Defloor T (2007b) Effectiveness of turning with unequal time intervals on the incidence of pressure ulcer lesions. *J Adv Nurs* **57(1)**: 59–68

Ward C (2010) The value of systematic evaluation in determining the effectiveness and practical utility of a pressure-redistributing support surface. *J Tissue Viability* **19(1)**: 22–7