Development and preliminary evaluation of a static air mattress with a heel flotation zone

KEY WORDS
- Heel protection
- Prudent healthcare
- Static mattresses

The concept of prudent healthcare emphasises the importance of co-production in health care and has been suggested as a way forward for an overstretched NHS. This article describes the collaboration between clinical staff and Direct Healthcare Services to modify a mattress in order to provide protection to patients' heels when using profiling bed systems. It describes a preliminary evaluation of the mattress and its heel flotation zone on a mixed medical ward.

The NHS faces many challenges brought about by changes to the population such as the rise in numbers of people with obesity and diabetes and people living longer with chronic diseases and it is required to meet these challenges in an environment where economic pressures are unprecedented. This has led to a ceaseless drive to improve quality and productivity. This drive is embodied in the 'prudent healthcare' system described by the Bevan Commission (Aylward et al, 2013), which urges healthcare providers to consider these key messages:

- Do no harm
- Carry out the minimum appropriate intervention
- Only do what you can do
- Promote equity
- Remodel the relationship between the user and provider on the basis of co-production.

Prudent healthcare is not rationing in disguise, it is a recognition that we can and should do things better and that we should not continue to do things the way we have always done them 'just because.' The prudent healthcare discussion paper said: "We have a duty to establish not only that we are doing good, but that we are doing better than anything else that could be done with the same resources" (Aylward et al, 2013).

A key focus of all these changes in healthcare delivery is innovation, looking at "an idea, service or product new to the NHS or applied in a way that is new, which significantly improves the quality of health and care wherever it is applied" (NHS England, 2011). It suggests that health care has focussed on what clinicians want rather than valuing the input of others such as the patient. Instead, it is recommended that everyone should have a contribution and health services should embrace co-production (Public Health Wales, 2014). This thought is echoed in the Association of British Healthcare Industries document regarding joint working between the NHS and pharmaceutical industry which suggests that working with commercial partners can supplement the skills and resources of the NHS providing benefits that are not otherwise achievable (Medicines, Pharmacy and Industry Group, 2008).

The Welsh Wound Innovation Initiative has collaborative working at its core with a range of partners, such as higher education institutes, the NHS, patients, charitable organisations and the commercial sector (*Figure 1*).

One of these collaborative initiatives is with Direct Healthcare Services (DHS) — a mattress manufacturer based in Wales that wishes to work collaboratively with clinicians in order to develop new products that meet the needs of patients and the healthcare environment.

This paper describes the process of developing a new product based on the identification of two clinical challenges and the pilot evaluation of that product in one ward.

A COLLABORATIVE APPROACH TO CLINICAL PROBLEMS

Clancy (2013) described how the pressure area care mattress has remained relatively static for many years relying on alternating

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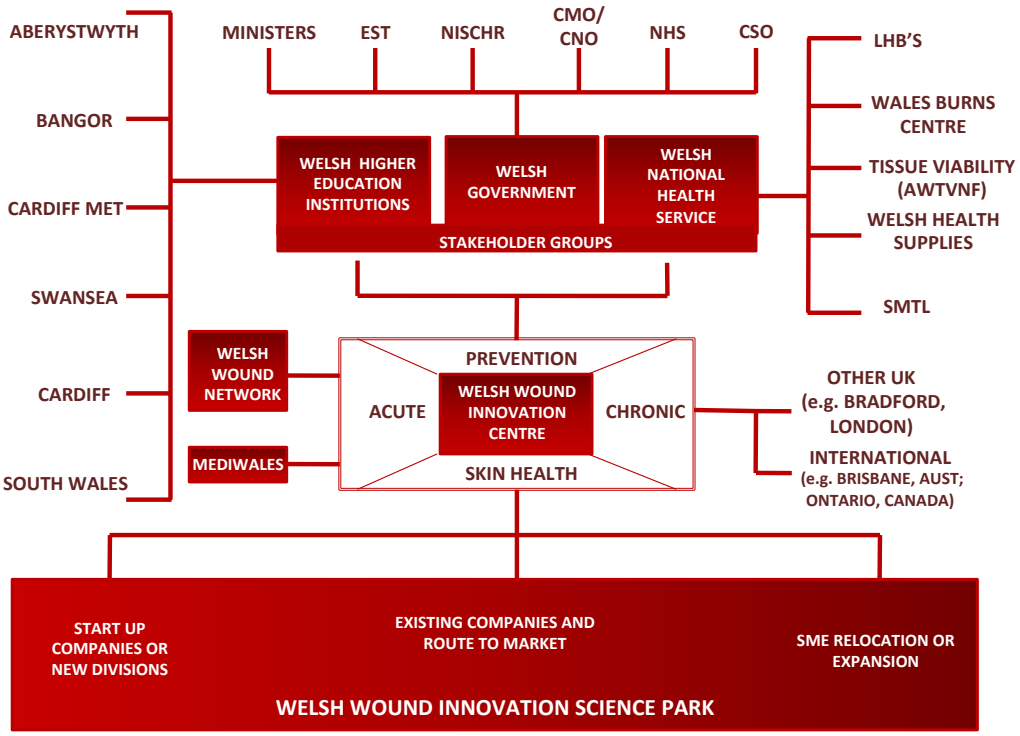

Figure 1. The Welsh Wound Innovation Initiative Model of Collaboration.

systems or low air loss systems for patients who are identified as at a higher level of risk of developing pressure ulcers. There have been some changes to the standard foams but no significant new developments until the past few years when a small number of innovations, such as combination/convertible mattresses (such as foam mattresses that can easily be converted to a powered mattresses) and immersion technology have come to the market. Perhaps the most significant changes over the past 20 years have been the conversion of standard hospital beds and mattresses from being mere 'furniture' — a functional item on which to sleep — into specialist equipment.

The majority of hospital beds now have an electronic profiling frame topped with, at minimum, a good quality replacement foam mattress. These changes have seen significant improvements, such as a reduction in back injuries to staff as the bed frames take the strain of manoeuvring the patient and a gradual decline in the amount of sacral pressure ulcers (National Pressure Ulcer Advisory Panel et al, 2014).

However, these changes seem to have generated two problems of their own as the profiling bed frames alter the length of the mattresses making them shorter by up to 15 cm (Fletcher, 2014) which results in the patient frequently resting with their feet/heels firmly pressed on the end of the bed (*Figure 2*). The second issue is an increase in the percentage of patients developing pressure ulcers on their heels, (Fletcher, 2014), which could relate to the first issue (although there is no evidence to support this).

Many bed and mattress companies suggest that to alleviate the bed end issue staff should remove the bed end, extend the bed frame and insert an additional section of mattress. This seems reasonable and does indeed resolve the issue. A whole range of solutions have been developed to alleviate pressure risk to the heel including specific heel pads, heel boots, wedges and by floating the heels using pillows (National Institute for Clinical Excellence [NICE], 2014; NPUAP, 2014) all of which could reduce the number of heel ulcers that occur.

In reality, these solutions are rarely implemented in a consistent or satisfactory way. All of these solutions are 'add-ons' — additional things that busy clinical staff have to think about and remember to do. There are products to order, store and pay for — as well as keeping staff up to date in how to use them. The patient must find them comfortable and convenient to use, but all too frequently heel protection is found somewhere loose in the bed, on a window ledge, tucked under a foot stool — in fact anywhere apart from correctly placed on the patient's foot.

In the 4-patient pilot of her observational study of SKIN bundle interventions, Turley (2014) identified clearly that even though staff had undertaken elements of the bundle they were not correctly alleviating pressure. She identified three out of four patients who were recorded as having heels floated with pillows actually still being at significant risk — two because the pillows were incorrectly placed (heels on the pillows rather than over the end) and one where despite having been positioned correctly, the pillow had collapsed within 30 minutes to such an extent that

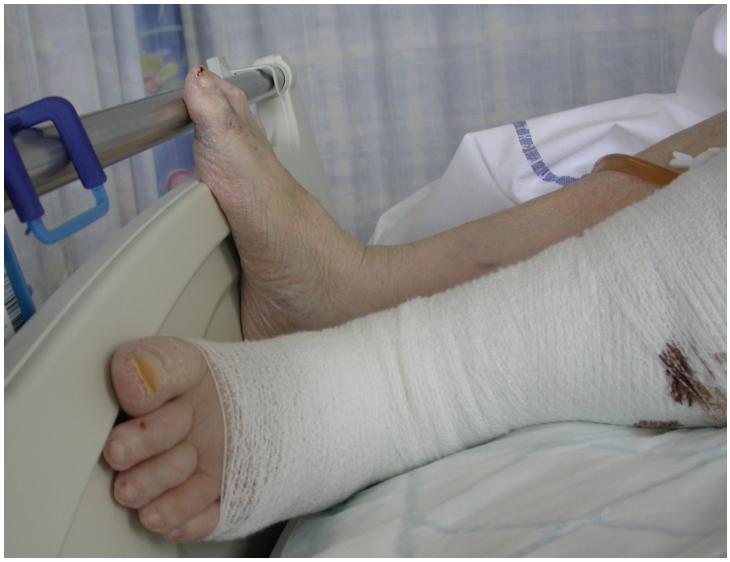

Figure 2. Patient's feet against the end of the bed.

the patient's heel was resting on the mattress. The use of bed frame/mattress extenders is perfectly possible, but rarely used. It is far more common to see pillows or blankets stuffed down the end of the bed frequently resulting in a very high-risk heel resting on a totally inappropriate surface. These practices are incorrect, but understandable. Clinical staff have many demands on their time. They frequently have limited storage space and they simply overlook the correct solution, but do provide a 'quick fix.'

This was the challenge worked on between the Welsh Wound Innovation Centre (WWIC) staff and DHS. There was a need to provide a simple solution to these two issues that did not add to nursing time or require the purchase of add-on equipment. The starting point was the Dynaform Static Air HZ mattress, which incorporates air and foam and air-only cells, and has a patented valve system that allows Reactive Airflow System (RAS™) technology to displace and adjust to the patient's body weight and movement (Direct Healthcare Services, 2014). The benefits of this system can be seen in *Box 1*.

Box 1. Benefits of using the Dynaform Static Air HZ mattress (Direct Healthcare Services, 2014).

- Reactive Airflow System helps maximise body weight displacement and minimise tissue interface pressure by automatically reacting to body movement by adjusting the internal air pressure
- A series of air and foam cells offer additional support under the lower back and seat through non-powered pressure relief
- An air-only low pressure heel zone offers effective off-loading of pressure in this most vulnerable area
- A specially designed U-Core prevents additional upward pressure on the heels and prevents shrinkage on mattress length when the bed is profiled
- Clinically proven foam mattress
- Fixed head section maintains head stability.

Engineers from DHS worked with clinical staff from WWIC to develop solutions that worked simply in daily practice. It was crucial that they investigated how and why the mattress became shorter and by what distance. They also needed to find out what happened to the patient when the bed was profiled. Volunteers ranging in height from 5ft to 6ft 5 sat on the mattress and the bed profiled repeatedly while the mattress was measured. The distance of travel by the heels was also measured as well as how much the foot end of the mattress lifted from the bed frame when the bed was profiled giving an upwards pressure.

Once the engineer could see what the actual clinical issue was it was possible to develop a solution. A number of cuts placed in the foam U-core that frames the mattress allowed the mattress to conform to the bed frame (*Figure 3*) without losing any length and maintaining the full length of the bed base. This alteration required several iterations to achieve the correct placement of the cuts and the correct number of cuts. It was found that changes in bed length varied considerably dependent on the depth and placements of the cuts.

The second issue was reducing the pressure under the patients' heels, working to 'float' the heel as much as possible without adding in any additional equipment. A solution was designed that allowed the lower limbs to be supported but for it to be still possible to slide a piece of paper out from under the heels without causing any drag on the paper. This simple test was tried with the mattress flat and with the frame articulated to fully support the patients. A simple solution was developed that involved slightly reducing the depth of the air cells supporting the heels.

A clinical evaluation was planned once the team were happy with the new product. In keeping with the principles of prudent healthcare and minimal intervention, it was necessary to carry out a small scale pilot before investing in a large evaluation to first demonstrate that the changes had not resulted in any negative changes to the previous iteration of the mattress and second to act as a pilot for the

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Figure 3. Cuts in the foam open as the mattress contours preventing loss of length.

full evaluation identifying any key issues that needed to be examined.

A PRELIMINARY EVALUATION

A service evaluation proposal was submitted to the Health Board governance department to evaluate the mattress for equivalence with the current hospital mattress. Permission was granted to take this forward on a 30-bed mixed medical ward.

The mattress was placed on the 30-bed ward for 8 weeks on any bed where a patient did not require an alternating pressure mattress. No changes were made to the pressure ulcer prevention protocol and staff allocated equipment exactly as they would have done before the evaluation. Written consent was obtained from each patient (or their designate) to use the mattress and patient information leaflets were supplied to both patients and family members. Staff from WWIC supported the ward team with the product evaluation form with visits at least twice a week to ensure the forms were being correctly filled in. A high percentage of patients were cared for on alternating systems because of their high risk status, therefore, only 12 mattresses were replaced at the commencement of the trial.

The evaluation form collected data on basic demographics (age, sex, height, weight, primary diagnosis) the patient's level of pressure ulcer risk and the presence of any pressure damage on admission. At the end of the evaluation, data were collected on: the length of time the patient used the mattress, the reason the mattress was discontinued, the status of any existing pressure ulcers, the occurrence of any new pressure ulcers, use of any additional heel protection, the staff and patients' views of the mattress and whether the staff would be happy to use the mattress again.

Results

In total, 26 sets of data were collected although some forms were not fully complete, therefore, some results were for less than 26 patients. Ten men and 15 women completed the evaluation with ages ranging from 55–90 (mean 73.4) (age recorded for 23 patients). All patients were deemed to be at risk based on their Waterlow Score with scores ranging from 7–23. There was a complication with one of the scores as it was determined that the patient who scored 7 had been incorrectly scored. He was an 86-year-old man with a category II pressure ulcer who died within days. It was

Table 1. Pressure damage present on admission.

Patient number	Category of damage	Position	End outcome
4	1	Sacrum	Resolved
6	2	Both heels	No deterioration
13	3	Elbow	Patient died
16	2	Sacrum	No change
20	1	Sacrum	Resolved

not possible to recalculate the actual score but based on the limited information on the form his score must have been at least 15. The mean risk score was 13.8 (risk scores recorded for all 26 patients) but was amended to 14.12 (based on 25 patients without the miscalculated patient).

Five patients were recorded as having pressure damage on admission (*Table 1*). Two of these had resolved during admission, one patient died and two remained static.

Patients were on the mattress for between 3–49 days (mean=16.28) with the most common reason for completing the evaluation being discharge (*n*=14) or completion of the evaluation period (*n*=8), one patient died, one patient was transferred onto an alternating mattress and two patients did not find the mattress comfortable. The two patients who found the mattress uncomfortable had also found previous equipment uncomfortable — one having chronic back pain and the other bilateral hip replacements.

Staff were asked to use a 1–5 scale to answer questions about the mattress. Results can be seen in *Figure 5* based on 24 responses.

In response to the question 'Would you use the mattress again?' 20 people said yes, four said no. Of the four negative responses, one commented they would not use it again for the specific patient as they were mobile and active, two no responses related to the patients who found the mattress uncomfortable and one did not give any further detail (two forms were not completed).

Overall, it seemed that the mattress had worked well. Comments from staff included:

- "Liked heel guard. This patient had red heels before"
- "Patient found it very comfortable and stated that it moved with her"
- "User-friendly."

One patient was changed back to the previous foam mattress after the trial and although the rationale for this was not clear, it was the patient with back pain who reported being uncomfortable.

No additional heel protection was used for any of the 26 patients, even for the patient who had heel ulcers.

Table 2. Staff responses to questions about mattress use (n=24).

	Mean score using a 1–5 scale where 1=Poor/no 2=below average 3=average 4=good and 5=excellent/yes
Did the mattress meet your objectives?	3.8
How comfortable was the patient?	3.9
How easy was it to use the mattress?	4.2
In your opinion how effective was the mattress at pressure ulcer prevention?	4.1
How easy was it to reposition the patient?	This response was consistently n/a, suggesting patients did not require repositioning

DISCUSSION

This small evaluation was very positive, however ward staff did raise several issues. They felt that simply asking patients for their consent to implement the new mattresses seemed to raise their awareness and many more patients commented on their mattress (both positively and negatively) than would have done usually.

Patients who had been in the ward for some time before switching to the new product initially found the mattress quite firm. This may have been due to the previous mattresses being old and quite soft (some had been in use since 2002). Staff clearly felt the mattress did offer greater protection to heels as during the 8-week period none of the 26 patients were given heel protection even though many were classified as being at risk and had existing or previous heel damage. This perhaps illustrates confidence in the product. As with any ward-based evaluation, maintaining data collection was a challenge and some data were lost when Welsh Wound Innovation Centre staff were not able to visit the ward every day.

CONCLUSION

It would seem that a simple solution to a clinical problem can be designed working collaboratively. It is doubtful this would have occurred if either party had worked alone.

The mattress now requires further testing in a more at-risk patient group to see if it is possible to deliberately remove additional heel protection from the pressure ulcer protocol in a clinical area with positive outcomes. This initial testing was essential to give staff confidence to move forward in this way. WUK

REFERENCES

Aylward, M, Phillips C, Howsen H (2013) *Simply Prudent Healthcare — achieving better care and value for money in Wales — discussion paper.* Available at: http://bit.ly/1pYu0XR (accessed 23.10.2014)

Clancy M (2013) Pressure redistribution devices: what works, at what cost and what's next? *J Tissue Viabil* 22(3): 57–62

Direct Healthcare Services (2014) Dynaform Static Air HZ System Available at: directhealthcareservices.co.uk (accessed 23.10.2014)

Fletcher J (2014) Are our mattresses too short for our beds? *Wounds UK* 10(3): 66–70

Medicines, Pharmacy and Industry Group (2008) *Best Practice Guidance on Joint Working Between the NHS and Pharmaceutical Industry and Other Commercial Organisations.* Available from www.networks.nhs.uk/nhs-networks/joint-working-nhs-pharmaceutical/ (accessed 23.10.2014)

NHS England (2011) *Innovation Health and Wealth: Accelerating Adoption and Diffusion in the NHS.* Available at http://bit.ly/1wLJeH9 (accessed 23.10.2014)

National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance (2014) *Prevention and Treatment of Pressure Ulcers: Clinical Practice Guideline.* Emily Haesler (ed). Cambridge Media, Osborne Park, Western Australia

National Institute for Clinical Excellence (2014) *Nice Guideline Pressure Ulcers: Prevention and Management of Pressure Ulcers.* CG 179. Department of Health, London

Public Health Wales (2014) *Making Prudent Healthcare Happen.* Available at: www.prudenthealthcare.org.uk (accessed 23.10.2014)

Turley L (2014) An observational study of the SKIN bundles in one NHS organisation. Unpublished MSc Thesis, Cardiff University