Reducing the use of Dynamic Mattress Systems in clinical practice using the TREZZO HS Advanced System

Abstract

Background: This study aimed to determine whether the TREZZO HS Advanced foam mattress system could reduce the use of dynamic mattress systems (Alternating and Constant Low Pressure) in patients on vascular and stroke wards. **Methods:** TREZZO HS mattresses were evaluated in a vascular and stroke wards over a 6-week period with respect to the outcome of reduction in need for dynamic mattress use and any affect on skin integrity. Data was compared with corresponding retrospective data from the previous year in which high specification pressure reducing foam mattresses were available. Mean length of patient stay on both types of mattresses, and the dynamic mattress, was evaluated. Cox semiparametric time-to-event methods were used to assess the hazard of patient transfer to a dynamic mattress in patients positioned on TREZZO HS, rather than the previously used foam mattress. **Results:** Use of the TREZZO system reduced mean length of stay on a dynamic mattress by 70% over both wards; from 41.0 days to 12.6 days. The proportion of patient-days spent on dynamic mattress systems decreased from 47.8% to 7.1%. Mattress type was significantly associated with the event (*p*=0.036); hazard ratio 0.328 (95% confidence interval 0.116 to 0.929). Ward type was not significantly associated with the event (*p*=0.333). **Conclusion:** The TREZZO HS system has been shown to substantially reduce the use of dynamic mattress usage and may be a cost-effective way of reducing the likelihood of pressure ulceration in vascular and stroke patients.

Key words: Pressure ulcers, alternating systems, constant low pressure mattress systems, high specification pressure reducing foam mattress, advanced foam system, pressure-relieving equipment, evaluation

Conflict of Interest: This work was supported by an unrestricted educational grant from Essential Healthcare

Introduction

Increased pressure is placed on tissue viability nurses, and other healthcare professionals, to minimise the number of pressure ulcers occurring in clinical practice. This must be achieved whilst ensuring expenditure on recommended pressure-redistributing equipment is confined within the constraints of the limited budgets available (Gleeson, 2015; Oliveira, Nascimento, Nicolussi, Chavaglia, Araújo, & Barbosa, 2017). The Health and Social Care Information Centre (2013) report that the average inpatient length of stay is 5.6 days, which greatly increases by a further 5-8 days upon development of a hospital-acquired pressure ulcer (Dealey, Posnett & Walker, 2012).

One reason to explain the delay in discharge could be lack of availability of necessary pressure-relieving equipment within the community (Hampton, 2000). Development of pressure ulcers can have serious repercussions for both patient and hospital resources. For patients, additional unnecessary distress could be caused due to the over-extended stays, pain and discomfort experienced, alongside the potential for bed-blocking; preventing the admission of others in need of hospital treatment (McInnes, Jammali-Blasi, Bell-Syer, Dumville, Middleton & Cullum, 2015). The daily management of pressure ulcers is estimated to incur a cost of between £43 to £374, dependent on the associated complications, in addition to the costs of standard care (Dealey, Posnett & Walker, 2012; NICE, 2014). Indeed Clancy (2013) estimated the 2012 NHS spend on rental and purchase of pressure redistributing mattresses and beds to be in excess of £100m.

Oliveira et al (2017) emphasises the great number of pressure-redistributing systems available for use in practice and affirms that healthcare providers' choice should involve a multitude of factors, including: recommendations through evidence-based research, financial issues and availability. A systematic review conducted by McInnes et al (2015) identified that patients placed on standard hospital foam mattresses had an increased likelihood of developing a pressure ulcer in comparison to those on an high specification foam or dynamic mattress (constant low pressure and alternating pressure). Dynamic mattresses, however, remain to be judged as the pinnacle of pressure ulcer prevention (Gleeson, 2015; McInnes et al, 2015). There is a considerable difference in cost between the two systems: high-specification foam mattresses cost around £120-£200; and dynamic mattresses cost around £3,500-£3,600 (NICE, 2014).

Given the current climate surrounding effective use of healthcare resources and funding, it is essential to investigate ways in which cost can be reduced whilst maintaining high quality care for patients. Savings can be made by continuing to prevent pressure ulcers. The NHS Safety Thermometer reported that in June 2016, 4.4% of reported patients had developed pressure ulcers in hospital. Ensuring appropriate use of dynamic systems in practice could also substantially save NHS funding. The aim of this study was to evaluate whether the TREZZO HS Advanced static system, shown in figure 1, could reduce the use of dynamic mattress systems. Secondary outcome measures included monitoring of the incidence in pressure damage in patients positioned on different systems.

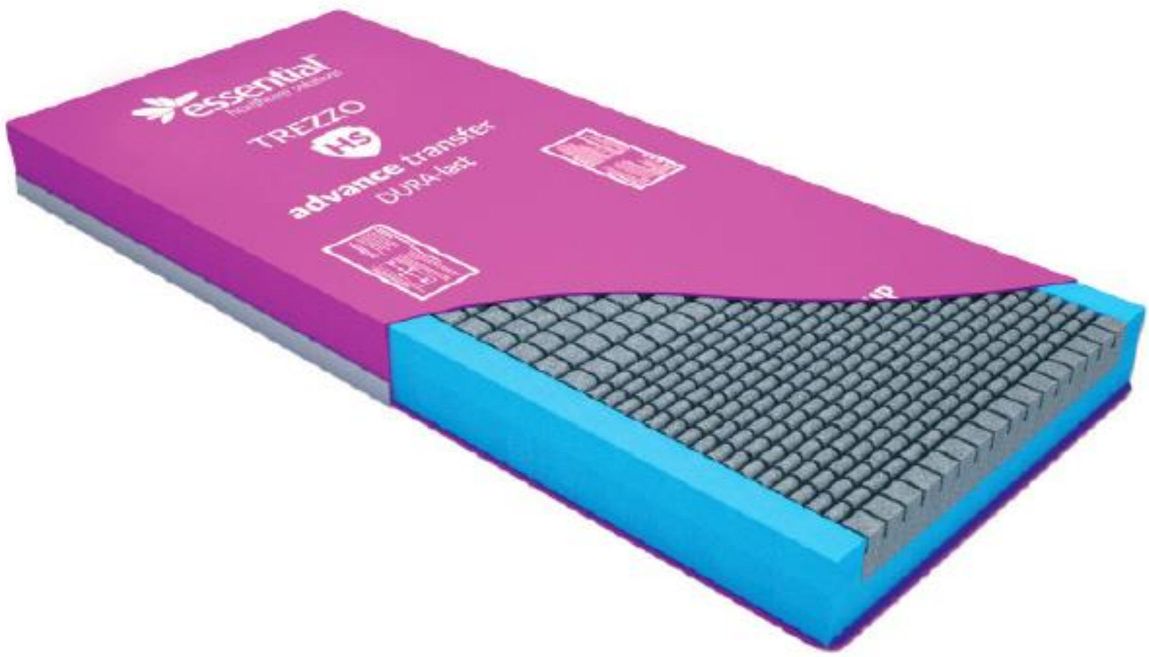


Figure 1: The TREZZO HS Advanced Foam Mattress System, consisting of a 40 Kg foam density split into three zones. The open cell structure allows airflow, which combined with the infused micro gel beads help to regulate temperature (Ousey, Stephenson & Fleming, 2016).

Methods

The TREZZO HS advanced foam mattress system, as supplied by Essential Healthcare, was clinically evaluated at two sites (one stroke and one vascular unit) in the North West of England. Prior to conducting the evaluations, ethical approval was sought and granted by The University of Huddersfield School of Human and Health Sciences Research Ethics Panel, in addition to Research Governance permission from both Trusts.

Essential Healthcare provided training to the staff at each site prior to installation of the TREZZO HS advanced system; highlighting correct use of the system. A total of 57 systems were distributed to the wards, where all high specification pressure reducing foam mattresses systems were replaced with the TREZZO HS. Site 1 received 26 mattresses and Site 2 received 31 mattresses. All patients nursed in the clinical areas were included in the evaluation; however, any patient who required a powered pressure-redistributing system, as assessed by the nursing staff, was transferred according to hospital policy.

The evaluation consisted of a comparison between retrospective and prospective data collected at patient level over a period of 6 weeks. Prospective data was collected using questionnaires completed by the clinical ward staff. The retrospective data was gathered from the patient notes during the same period in the previous 12 months: for instance, retrospective data was collected in April 2016 for 6 weeks and prospective collected in April 2017 for 6 weeks.

Patient data from both wards was recorded, including: date of admission, demographics (age, gender, co-morbidities), the type of mattress, details of any mattress transfer, results of skin damage assessment, Waterlow scores and date of discharge (if before the 6 weeks). Following inspection of admission and discharge timings of patients with identical admission and discharge dates, any patient who spent less than 2 hours on the ward was removed from the data set.

Dates (and times where available) of admission, discharge and transfer were used to calculate the times spent by each patient on each type of mattress from which the total number of patient-days spent on each type of unit, mean length of hospital stay amongst patients positioned on that unit, and the proportion of patient-days spent by patients on dynamic mattress systems were determined. Any incidences of pressure ulceration of any category were also recorded; however, due to expected low incidences, no distinction was made between different categories.

Retrospective data was provided by the Tissue Viability Lead or Ward Manager at the site to the research team at the University of Huddersfield. All the data provided was anonymised and no identifying patient data was collected.

The primary analysis was based on time-to-event methods, with the event of interest being transfer to a dynamic mattress from a non-dynamic mattress. Cox semi-parametric methods were utilised for this procedure, with the key grouping predictor variable considered to be mattress type (high specification pressure reducing foam mattresses in the case of retrospective (2016) data; and the TREZZO mattress in the case of prospective (2017) data). Noting that different institutions may have different policies regarding placing patients on dynamic mattress systems, ward type was also considered to be a key grouping variable. Patient age, gender and Waterlow score were considered to be controlling variables.

A sequential Cox model was derived, with controlling variables entered as a block in the initial step; and the key variables of type of mattress and type of ward forced entered at a second step alongside any controlling variables qualifying from the first step by exhibiting an association of substantive importance with the event of interest (transfer of patient from mattress to dynamic mattress). The proportionality of hazards assumption in the Cox model was tested by the testing of interactions between all included variables and the logarithm of the time variable. Non-significance interactions (i.e. those revealing no evidence for non-proportionality of hazards) were removed once proportionality had been established before construction of the final model. This analysis included only those patients who were initially placed on a non-dynamic mattress; and hence were "at risk" of the event under investigation.

The significance of individual parameters in the model was assessed, with hazard ratios and associated 95% confidence intervals, also reported. The proportionality of hazards assumption in the Cox model was tested by the testing of interactions between all included variables and the logarithm of the time variable. These interactions were removed from the final model once proportionality had been established.

Results

Valid retrospective data was obtained from 175 patients on the vascular ward and 52 patients on the stroke ward; i.e. 227 patients in total. Valid prospective data was obtained from 27 patients on the vascular ward and 45 patients on the stroke ward; i.e. 72 patients in total. Thus a grand total of 298 patients were included in the analysis.

Patient demographics are summarised descriptively in Table 1 below

Table 1: summary of patient demographics

	Retrospective data			Prospective data			Grand total
	Vascular	Stroke	Total	Vascular	Stroke	Total	
Gender (frequency (%)							
Male	109 (62.3%)	15 (28.8%)	124 (54.6%)	20 (76.9%)	21 (46.7%)	41 (57.7%)	165 (55.4%)
Female	66 (37.7%)	37 (71.2%)	103 (45.4%)	6 (23.1%)	24 (53.3%)	30 (42.3%)	133 (44.6%)
Age (years) (mean (SD))	58.3 (19.6)	76.4 (14.7)	62.4 (12.6)	63.6 (14.1)	75.7 (12.5)	71.2 (14.3)	64.5 (19.2)
Waterlow score (mean (SD))	11.1 (7.62)	17.0 (5.67)	12.6 (7.61)	16.2 (7.09)	14.0 (5.12)	14.9 (5.98)	13.3 (7.24)

Hence some difference in age and gender between retrospective and prospective cohorts are apparent. However, the magnitude of these differences does not appear to be sufficient to expect a substantive effect on outcome measures. Due to differences in the definitions of risk bands using the Waterlow score, mean risk statuses are different in different wards. For retrospective data, the mean risk score in vascular patients (11.1) corresponds to the status of "At risk"; whereas the mean risk score in stroke patients (17.0) corresponds to the status of “High risk”. For prospective data, the mean risk score in vascular patients (16.2) corresponds to the status of “High risk”; whereas the mean risk score in stroke patients (14.0) corresponds to the status of “At risk”.

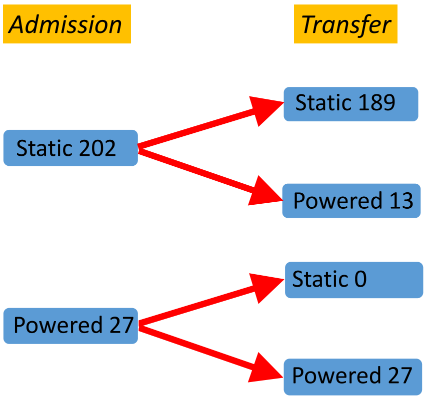
Mattress allocation– retrospective data

On the vascular ward, of those patients whose status could be determined, 175 were initially positioned on a high specification pressure reducing foam mattress. Seven of these patients (4.0%) were subsequently transferred to a dynamic mattress before discharge, transfer or death; with the remaining 168 patients remaining on a high specification pressure reducing foam mattress until discharge, transfer or death. Four patients were initially positioned on a dynamic mattress; all of whom remained on the dynamic mattress until discharge, transfer or death.

On the stroke ward, of those patients whose status could be determined, 27 were initially positioned on a high specification pressure reducing foam mattress; Six of these patients (22.2%) were subsequently transferred to a dynamic mattress before discharge, transfer or death; with the remaining 21 patients remaining on a high specification pressure reducing foam mattress until discharge, transfer or death. 23 patients were initially positioned on a dynamic mattress; all of whom remained on the dynamic mattress until discharge, transfer or death. Data was unavailable for 2 patients.

Hence over both wards, 202 patients were initially positioned on a high specification pressure reducing foam mattress, with 13 (6.4%) being subsequently transferred to a dynamic mattress. 27 patients were initially positioned on a dynamic mattress with no subsequent transfers. Patient positioning movements over both wards are summarised in Figure 2.

Figure 2: patient positioning (retrospective data)



In both vascular and stroke wards, mean lengths of stay for patients positioned on dynamic mattress systems were substantially greater than for patients positioned on high specification pressure reducing foam mattresses. Hence, although the majority of patients were positioned on high specification pressure reducing foam mattresses, the total patient-days spent on each mattress type was similar (Table 2).

Table 2: summary of patient-days spent on high specification pressure reducing foam mattresses and dynamic mattress systems (retrospective data)

Ward	Mattress	Total patient days	Mean length of stay (days)	Proportion of patient-days on dynamic mattress systems
Vascular	High specification pressure reducing foam mattress	1238.7	7.1	22.5%
	Dynamic mattress	358.6	32.6	
Stroke	High specification pressure reducing foam mattress	282.0	10.4	78.6%
	Dynamic mattress	1034.0	45.0	
Total	High specification pressure reducing foam mattress	1520.7	7.5	47.8%
	Dynamic mattress	1392.6	41.0	

Mattress allocation– prospective data

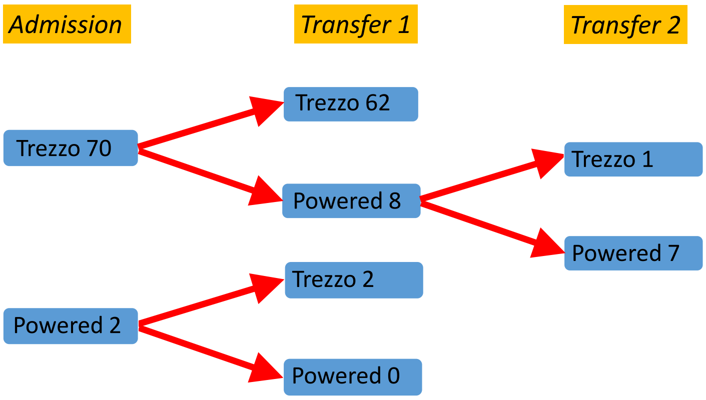
On the vascular ward, 26 patients initially positioned on a TREZZO mattress. Five of these patients (19.2%) were subsequently transferred to a dynamic mattress before discharge, transfer or death; with the remaining 21 patients remaining on a TREZZO mattress until discharge, transfer or death.

One patient was initially positioned on a dynamic mattress; and subsequently transferred to a TREZZO mattress before discharge, transfer or death.

On the stroke ward, 29 patients (64.4%) were initially positioned on a TREZZO mattress. In addition, 15 patients were positioned on a high specification pressure reducing foam mattresses at the start of the study period but subsequently transferred to a TREZZO mattress during the course of the study. These patients were also considered to be available for analysis, with their date of entry to the study considered to be the date of their transfer to the TREZZO mattress. Of these 44 patients, three patients (6.8%) were subsequently transferred to a dynamic mattress before discharge, transfer or death; with the remaining 41 patients remaining on a TREZZO mattress until discharge, transfer or death. One patient was initially positioned on a dynamic mattress and was subsequently transferred to a TREZZO mattress.

Hence over both wards, 70 patients were initially positioned on a high specification pressure reducing foam mattress, with 8 (11.4%) being subsequently transferred to a dynamic mattress (with one patient subsequently returned to a TREZZO mattress). 2 patients were initially positioned on a dynamic mattress; both of whom were subsequently transferred to a TREZZO mattress. Patient positioning movements over both wards are summarised in Figure 3. Column headings refer to the status of all patients after transfer processes were completed.

Figure 3: patient positioning (prospective data)



In both vascular and stroke wards, lengths of stay for patients positioned on TREZZO mattresses were greater than for patients positioned on dynamic mattress systems; with over 90% of patient-days being spent on TREZZO mattresses. (Table 2).

Table 2: summary of patient-days spent on TREZZO mattresses and dynamic mattress systems (prospective data)

Ward	Mattress	Total patient days	Mean length of stay (days)	Proportion of patient-days on dynamic mattress systems
Vascular	TREZZO mattress	423	15.7	9.4%
	Dynamic mattress	44	7.3	
Stroke	TREZZO mattress	1218	27.1	6.3%
	Dynamic mattress	82	20.5	
Total	TREZZO mattress	1641	22.8	7.1%
	Dynamic mattress	126	12.6	

Hence the use of the TREZZO mattresses resulted in a reduction of the mean length of stay on a dynamic mattress from 41.0 days to 12.6 days; representing a decrease in usage of 28.4 days; about 70%. This benefit occurred in approximately equal measure in both types of wards. The proportion of patient-days spent on dynamic mattress systems decreased from 47.8% to 7.1%; approximately a 7-fold decrease.

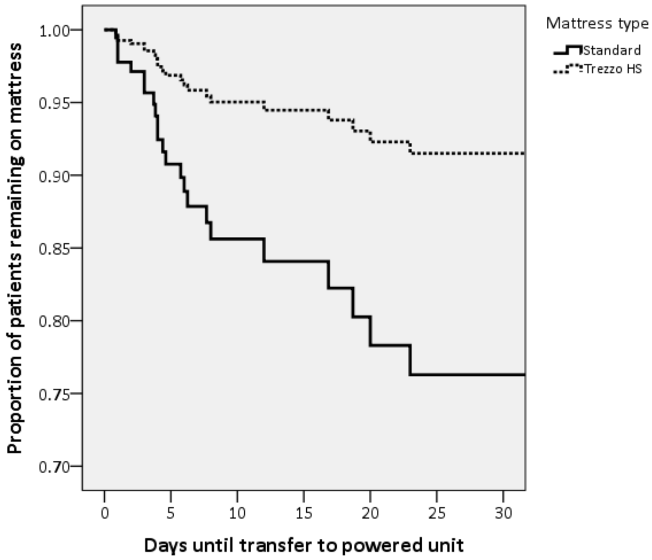
Cox analysis

The first step of the sequential Cox model, including all controlling variables, revealed that Waterlow score exhibited an association of substantive importance with the event of interest (transfer of patient from foam mattress to dynamic mattress). This is to be expected as most policies use the Waterlow score as an indicator for stepping up to a powered mattress. This variable was carried forward for inclusion in the second step of the model with the key variables type of mattress and type of ward. Inclusion of the interaction terms between included factors and the *ln* (time) variable revealed no evidence for non-proportionality of hazards, with all such interactions being non-significant.

After removal of the interaction terms, the final multiple Cox regression revealed that controlling for type of ward and Waterlow score, type of mattress was significantly associated with the time to transfer to a dynamic mattress (p=0.036). The hazard ratio for type of mattress of 0.328 (95% confidence interval 0.116 to 0.929) indicated that at best estimate, the hazard of transfer to a dynamic mattress for patients positioned on a TREZZO mattress was approximately one third of the hazard of transfer to dynamic mattress systems amongst patients placed on standard foam mattresses. Controlling for type of mattress and type of ward, Waterlow score was also revealed to be significantly associated with the time to transfer to a dynamic mattress (p=0.019). The hazard ratio for Waterlow score of 1.078 (95% confidence interval 1.013 to 1.148) indicated that at best estimate, the hazard of transfer to a dynamic mattress was raised by about 8% for each additional point on the Waterlow scale. Ward type, was not significantly associated with the hazard of patient transfer (p=0.333).

Figure 4 below indicates survival to transfer for patients on the two mattress types.

Figure 4: survival to transfer to dynamic mattress systems for patients on high specification pressure reducing foam mattresses and Trezzo mattresses



Pressure ulceration

The incidence of pressure ulceration in both wards, in both analysis periods, was low. In the vascular unit, during the retrospective data collection period, two Grade 2 and one unclassified pressure ulcers were recorded. One of the Grade 2 ulcers was recorded on a patient who was admitted on a high specification pressure reducing foam mattress but was subsequently transferred to a dynamic mattress. Prospectively, two of the participants recruited had existing Grade 2 pressure ulcers and were still placed onto the TREZZO HS mattress.

In the stroke ward, a single Grade 3 pressure ulcer was recorded on a patient positioned on a dynamic mattress during the prospective data collection period. In all cases, the system (i.e. foam mattress or dynamic mattress) being used by the patient when the pressure ulcer was first observed was not recorded. The overall frequency of ulceration was too low for statistical analysis.

Discussion

All patients included in the evaluation were considered high risk due to: the nature and typical presenting complaints on the wards; patients' ages; Waterlow scores; and co-morbidities (Gleeson, 2015). The findings of the evaluations on these high-risk patients clearly demonstrates the benefit of implementing the TREZZO HS advanced system in clinical practice on stroke and vascular wards. Replacing the high specification pressure reducing foam mattresses with TREZZO HS resulted in a reduction in the average length of stay of patients who had transferred on to a dynamic mattress from 41.0 to 12.6 days (i.e. a reduction of about 70%). While as a non-experimental study it is not possible to ascribe all changes in a particular outcome measure to a specific exposure factor, it is possible to be confident that any effect of gender, age or Waterlow score was not acting in the same direction as the “mattress effect”. Ages and gender proportions of patients on the vascular wards were very similar in the 2 cohorts; Waterlow scores actually increased. This increase would be expect to act in the opposite direction, if any, to that observed. No evidence for any systematic changes in the patient characteristics between the two cohorts with respect to any other characteristic was observed.

This was achieved despite higher mean Waterlow scores recorded in the prospective patient cohort (14.9) compared with the retrospective patient cohort, before the introduction of the TREZZO system (12.6); i.e. the TREZZO system was being used by patients who were at higher risk than those using foam mattresses. The selection criteria for the mattresses during the trial in both Trusts was in accordance with their existing respective policies: TREZZO equipment was provided for patients at very high risk (taking into consideration risk assessment score and clinical judgement) with up to Category 2 Pressure Ulcers who were physically and cognitively able to reposition themselves. This suggests that there was little confidence amongst staff in utilising their previous foam mattress for this profile of patient.

Hence the potential exists to instil greater confidence within clinicians, supporting them in achieving greater cash releasing savings within ever-challenging budgets. The costing report by NICE (2014) emphasises that the daily rental costs of a dynamic mattress are approximately £14 per day. Hence the 70% reduction in length of stay on dynamic mattress systems associated with the use of the TREZZO HS systems highlights a potential for considerable cost savings. The reduction in the overall proportion of patient-days spent on dynamic mattress systems following the introduction of the TREZZO equipment (from 47.8% to 7.1%) implies lower requirement for the dynamic mattress systems and thus lower associated expenditure.

The patients who were transferred from the TREZZO HS to a dynamic mattress had a significant decrease in their mobility during their stay as a result of the scheduled surgery rather than a deterioration in skin integrity due to the mattress. Although no comparisons of pressure ulcer incidence could be made between mattress types, as pressure ulcer incidence was minimal, patients who were positioned on a standard foam mattress were three times more likely to transfer to a dynamic mattress compared to those who were placed on a TREZZO HS system. It is evident that the TREZZO HS outperformed the high specification pressure reducing foam mattresses in terms of its ability to reduce the use of dynamic mattress systems in high risk patients.

It could be argued that the multi-factorial variables involved in managing the high risk patients being investigated could have impacted on the primary outcome of the evaluation. However, the large differences found between the retrospective and prospective data of dynamic mattress usage validates the conclusion that the TREZZO HS has had a major role to play in the reduction. Further research is required to investigate the cost-effectiveness of the use of the TREZZO HS system in order to attain details of these savings.

Conclusion

The findings demonstrate that the TREZZO HS advanced system is effective at reducing the use of dynamic mattress systems on stroke and vascular wards. This improved use of dynamic mattress systems could enable lucrative savings for health care providers.

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