The benefits of using a first generation SEM scanner versus an equipment selection pathway in preventing HAPUs

ABSTRACT

Several studies have demonstrated improved clinical outcomes in pressure ulcer prevention using the SEM scanner, but none have compared it with other methods. In one of Scotland's health boards, 'hot spot' wards had been unable to reduce the number of hospital-acquired pressure ulcers (HAPUs) after several years of focused improvement work. In addition, other wards showed high use of dynamic therapy systems with associated costs. This review compares the use of a first generation SEM scanner versus a mattress and equipment selection pathway over a 6-week period. The findings show that the SEM scanner wards had zero HAPU while the equipment pathway wards developed a total of 4 HAPU. The two SEM scanner wards showed a 11% and 33% reduction in dynamic therapy use, while the pathway wards showed an average 40% increase. Consideration should be given to using SEM scanners to support staff decision-making to reduce HAPU development and dynamic therapy usage.

Key words: Pressure ulcer/injury prevention ■ Hospital-acquired pressure ulcer (HAPU) ■ Equipment pathway ■ SEM ■ Scanner ■ Tissue

Supporting the reduction of healthcare-acquired pressure ulcers (PU), also known as pressure injuries (PI), is an ongoing process due to the increasing number of patients seen by healthcare services and deemed to be 'at risk' of developing a PU/PI. Hospital-acquired pressure ulcers (HAPUs) are a subset of all PU/PI seen in practice: this article uses the term pressure ulcers (PU) throughout to cover both descriptors.

National guidelines and standards for the prevention and management of PUs recommend assessing a patient's skin and risk level on admission to a care setting, to reduce the risk of harm from PUs (National Institute of Health and Care Excellence (NICE), 2014; Healthcare Improvement Scotland (HIS), 2020a). The SSKIN care bundle (HIS, 2020b) is a tool designed to help identify risk factors linked to the development or the deterioration of PUs (*Table 1*). It can support care planning following assessment of at-risk patients and has been adapted in different parts of the world to include prompts for assessment, giving information to patients and supporting self-management, all of which are important aspects of prevention.

The challenge with visual skin assessment is that it depends on an individual health professional's knowledge and experience and only triggers interventions based on visual skin changes after damage has occurred.

Before quality improvement (QI) processes became widely used, new ideas and innovations were often developed and put into use without testing their effect on patient care. This created a challenge to identify which changes had made an improvement and were effective in reducing HAPUs and which had not. Improvement processes have now become commonplace to test and measure new ideas and innovations, helping to identify which will have a positive impact on patient care and reduce potential harm.

NHS Lothian is the UK's second largest health authority that covers an area of 700 square miles, with Edinburgh at its centre. It includes four major teaching hospitals and multiple community healthcare services, serving a population of about 890 000. The health board has a history of being actively involved in PU improvement work for many years. The evaluation reported in this article followed several years of improvement work undertaken in collaboration with tissue viability (TV) service, the QI support team and frontline clinical staff. A variety of tools, processes and innovations have been tested and developed to support the improvement work across both inpatient and primary care settings, such as repositioning charts, SSKIN bundles and aide-memoire, training days, the use of a significant adverse event review template, focus boards and safety briefs (*Box 1*).

Ruth Ropper, Senior Nurse Advisor, TBM Contract, NHS Lothian. Previously Lead Nurse Tissue Viability, NHS Lothian (retired September 2020), Ruth.Ropper@nhslothian.scot.nhs.uk

Accepted for publication: July 2021

Presenting challenge

At the start of the PU improvement work in 2012–2013 there was a rise in reporting of all PU in acute sites, as was expected. Once improvement work started to identify effective strategies, a reduction in the number and rate of HAPUs was noted across acute sites. However, there were hot spots where HAPUs were still developing despite interventions and changes in practice. These hot spots included medicine of the elderly, trauma orthopaedics and rehabilitation, as well as critical care units. The ward with the highest number of HAPUs had 19 PUs develop in heels and sacrum over a 12-month period. This area had a higher number of vulnerable, elderly and less mobile patients. Critical care units were identified as having an issue with device-related HAPUs and so were excluded from this work that focused specifically on heel and sacral HAPUs.

It was disheartening for staff in hot spots where they had made changes to practice, but had not seen a reduction in the numbers of HAPUs in patients. It was decided to identify whether there were other, more effective ways than current

© 2021 MA Healthcare Ltd

Table 1. SSKIN care bundle

The SSKIN care bundle enables health professionals to effectively assess key factors associated with the prevention and management of pressure ulcers (PUs), including:

Surface	Assessment of the appropriateness of mattresses and/or cushions, and review of the functionality and integrity of equipment intended to reduce risk of PUs
Skin inspection	Assessing pressure areas and monitoring skin reddening
Keep moving	Assessment of regularity of movement intended to prevent pressure ulcers or deterioration of existing PUs
Incontinence/ Increased moisture	Assessing bowel and bladder function and control, and other body fluids on the skin
Nutrition	Ensuring the right diet, fluids and supplements

Source: Healthcare Improvement Scotland, 2020a; 2020b

Box 1. Tools and processes to support pressure ulcer improvement work (year)

- Datix reporting for all HAPU (2011/12)
- Repositioning charts (2011)
- SSKIN bundles (2011)
- Run charts/Pareto charts (2012/13)
- Care rounding tool including SSKIN (2013)
- Training days (2013)
- Education resources (2014)
- Safety briefs/huddles (2015/16)
- Adapted red day PU review tool (Grades 2–3) (2016)
- Significant adverse event (SAE) review template (2016)
- Local tools developed
- Think Pink Sticker (2017)
- Focus boards (2017)
- SSKIN aide-memoire (2018)

strategies to reduce HAPUs. A subepidermal moisture (SEM) scanner was identified as one option because it supports early identification of potential skin changes and triggers staff to intervene before damage becomes visible. Another suggestion was a pathway to guide staff decision-making in relation to equipment choice and repositioning, based on Waterlow risk assessment and visual skin checks.

Improvement planning

Along with the challenge of increased HAPUs in specific wards on the acute sites, other areas had zero HAPUs, but an extremely high usage of dynamic therapy systems with associated costs. Dynamic therapy systems include alternating pressure mattresses, low-air loss mattresses and alternating pressure cushions. This led the tissue viability nurses (TVNs) to query whether the zero HAPU rate was linked to the high use of therapy systems or whether it was unrelated. The question was posed: 'If HAPU and equipment use were unrelated, could a reduction in therapy systems be achieved without increasing the potential for harm?' This then raised issues about the financial implications in other high-use areas, whether equipment was being used appropriately and whether both HAPUs and therapy use could be reduced by introducing an innovative device.

Because the wards involved were all part of the total managed equipment (TME) contract, reducing patient harm, high dynamic therapy usage and related costs would benefit both the health board and Arjo, the TME supplier. Arjo offered the opportunity to work in partnership with Bruin Biometrics LLC, which manufactures the SEM scanner, to evaluate it in clinical practice.

Two improvement ideas were identified to test in different wards to see whether one option was better at supporting staff decision-making to reduce HAPUs compared with the other:

- The use of an SEM measurement scanner to identify potential PUs in wards with either high or zero HAPU rates plus high dynamic therapy use
- The use of a 'mattress and equipment selection pathway' to address high dynamic therapy use by directing staff to choices based on a patient's risk level and mobility (an option that will be referred to as the 'equipment pathway' in the article).

Both improvement ideas had the potential to reduce HAPUs and improve equipment use, so rather than run them as individual projects the TVNs made the decision to test and measure outcomes from both proposals over a 6-week period in October and November 2019. All parties involved were interested in the potential findings because the SEM scanner had not been compared with the use of an equipment pathway before. It was proposed to record outcomes for HAPU rates and equipment use for all areas to compare the outcomes.

Subepidermal moisture measurement scanner

It has been identified in the literature that in the early phase of cell damage, when a forming PU is still microscopic, there is a local increase in extracellular fluid content within affected tissues, known as subepidermal moisture (SEM) (Peko et al, 2019). Recommendations on skin and tissue assessment made in the 2019 international guideline on pressure ulcers/injures (European Pressure Ulcer Advisory Panel et al, 2019) state that clinicians should 'consider using a subepidermal moisture/oedema measurement device as an adjunct to routine clinical skin assessment'. This was confirmed in a systematic review by Scafide et al (2020), who noted that 'subepidermal moisture measurement provided the most consistent findings in the early detection of pressure injury'.

Figure 1 demonstrates the main factors that affect the development of SEM in the body in response to pressure on tissues, and at which stage this can be detected by a non-invasive, handheld scanner.

Inflammatory changes and tissue oedema due to prolonged periods of mechanical loading on tissues have been shown to occur 3–10 days before skin breakdown occurs (Okonkwo et al, 2017; Moore et al, 2018a, Moore et al, 2018b; O'Brien et al, 2018). These epidermal and subepidermal changes result in changes in the electrical properties (biocapacitance) of the tissue, thereby presenting an objective, non-invasive method for assessing any damage (Moore et al, 2017; Okonkwo et al, 2020).

The SEM scanner (Bruin Biometrics) has been on the market for several years and is a simple, handheld, non-invasive device for use on intact tissue over a patient's heels and sacrum. It uses biocapacitance technology to

© 2021 MA Healthcare Ltd

assess the changes associated with localised oedema in the inflammatory phase within the tissues. By taking a minimum of three readings over a pressure area, the device calculates the difference between the highest and lowest readings and displays the findings on the screen as a delta (Δ) value (*Figure 2*).

The process in clinical practice involves assessing a patient's skin daily at three anatomical sites, the sacrum and both heels, using the SEM scanner and comparing results. For example, if six readings were taken over the sacrum (*Figure 3*), ranging from 3.2–2.9, the difference between the maximum and minimum would be 0.3. This would be considered healthy tissue. If the range is between 2.7 and 1.6, the difference is 1.1. If the delta value is equal to or greater than (≥) 0.6, this is an indication that there is an increase in moisture in the subepidermal tissues, which can be indicative of tissue oedema and early stages of damage (Moore et al, 2018a).

In most cases, such subepidermal changes occur before any redness can be seen with the naked eye. It is recognised that visual skin assessment by a health professional is a subjective measure that detects damage only after it has occurred and can be particularly challenging in patients with darker skin tones. The aim therefore is to identify early signs of tissue damage by using non-invasive technology, such as the SEM scanner, to 'react before red' to prevent PU. In patients with darker skin tones, the warning sign of redness is difficult to detect visually, so using a device that measures subepidermal changes would support earlier detection and intervention in this group. The early warning provided by using the scanner will enable the health professional to make informed decisions based on an objective measure and change care plans, in line with local guidelines, to prevent a PU developing. Several papers note the benefits of the SEM scanner in different areas of clinical practice. (Moore et al, 2017; Raizman et al, 2018; Smith, 2019).

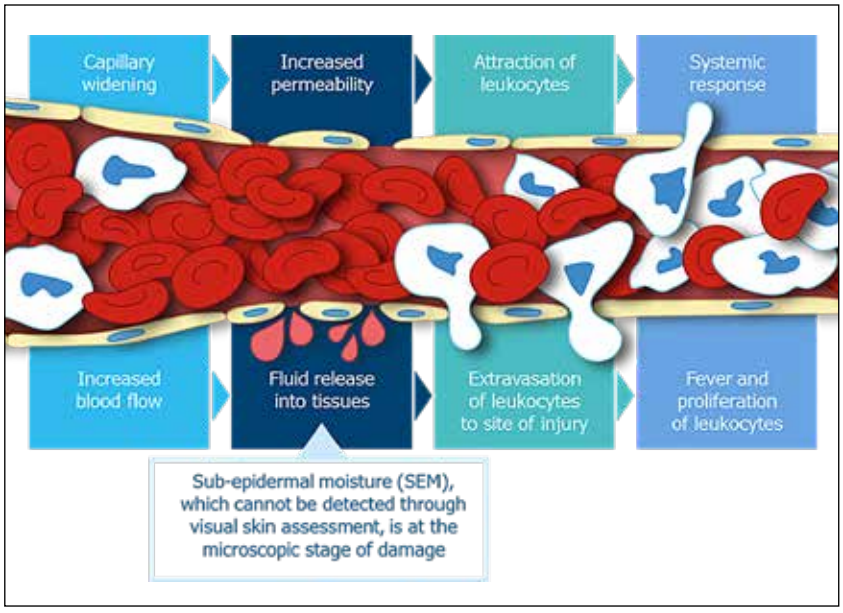
Equipment pathway

Decision pathways have been used in many areas of health care and have proven to be effective when introduced with education to support correct use (Ropper, 2018). It was proposed by the TVNs that a pathway designed to support decisions around choosing specific equipment and encouraging patients to keep moving to prevent HAPUs could also be used effectively. To test whether this assumption was correct an equipment pathway was developed (*Figure 4*): this was based on a patient's Waterlow risk assessment score plus visual skin assessment, which then guided staff towards using repositioning, off-loading and pressure-redistributing equipment to reduce the risk of PU development. Heel PUs were of particular concern, so the equipment pathway was linked to the 'CPR for feet' tool (O'Regan et al, 2018), which is widely used across Scotland, and this was created as an A4 laminated colour poster for use in clinical areas throughout the review period.

Aims

It was decided that the evaluation would have a number of aims, in view of the fact that there were two different, but related issues of HAPUs, and also high dynamic therapy usage. There was also the question of whether a zero HAPU rate recorded over a period longer than 1 year was related to the high equipment use in one area. The final aims for the evaluation were to identify over a 6-week period whether:

- Using the SEM scanner would reduce HAPUs, with or without a reduction in dynamic mattress usage
- A ward with zero HAPUs but high dynamic mattress usage could reduce equipment use without increasing HAPUs
- An equipment pathway could reduce hired mattress use in high use wards without increasing the number of HAPUs.



Reproduced with permission of Bruin Biometrics

Figure 1. Effects of pressure on capillaries and tissues (Source: Amit Gefen, Professor in Biomedical Engineering, Tel Aviv University)

Figure 2. SEM scanner display showing the delta (Δ) value

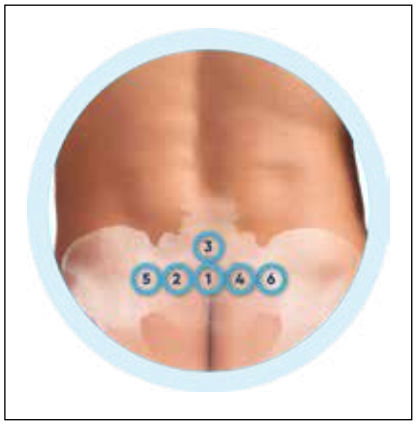


Figure 3. Points to scan on a patient's sacrum

Clinical areas identified for test of change

In consultation with the associate nurse directors and senior nurses at the Western General Hospital (WGH) and Royal Infirmary Edinburgh (RIE), both of which are acute hospitals, two wards (A, B) were identified for testing the SEM scanner over the 6 weeks, one that had been reporting a high rate of HAPUs and one that had not reported any HAPUs, but had high dynamic therapy usage.

For the other part of the evaluation, two wards at WGH (C, D) and three at RIE (E, F, G) were identified to test the

© 2021 MA Healthcare Ltd

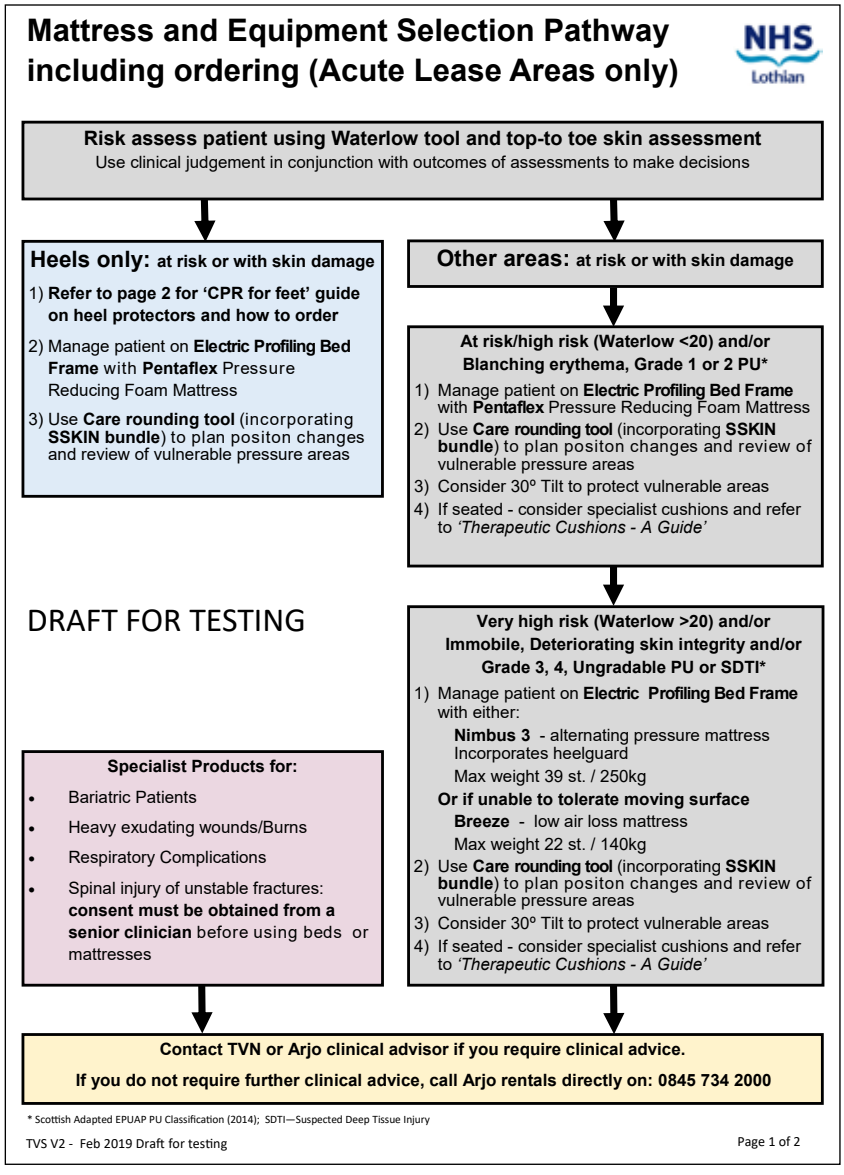


Figure 4. Mattress and equipment selection pathway used during the evaluation

Table 2. Ward specialties

Ward	Site	Clinical specialty	Evaluation process	No. of beds
A	WGH	Medicine for the elderly	SEM scanner	26
B	RIE	Medicine for the elderly	SEM scanner	36
C	WGH	Stroke ward	Equipment pathway	24
D	WGH	Medicine for the elderly	Equipment pathway	26
E	RIE	Medicine for the elderly	Equipment pathway	36
F	RIE	Trauma orthopaedics	Equipment pathway	36
G	RIE	Orthopaedic rehab	Equipment pathway	14

RIE= Royal Infirmary Edinburgh, WGH= Western General Hospital

equipment pathway based on high-risk patient groups with high dynamic therapy usage. Wards C and D had reported zero HAPUs in the previous 12 months. Wards E, F and G had all reported HAPUs in the 12 months prior to the evaluation. The selected wards had a range of specialties caring for high-risk patient groups (*Table 2*).

Methods

The improvement work was approved by the nurse director who managed the TV service, to whom the results were to be reported initially, along with the TVNs involved. It would then be presented to the executive nurse director and nurse directors' group once full analysis had taken place.

SEM scanner wards

The start of the evaluation was phased by 1 week, to ensure the same level of training on the device and support was provided to both wards using the SEM scanner. Both wards had an information and training session for senior charge nurses 2 weeks before the evaluation started, training for all ward staff on how to use the device during week 1, and ongoing support was available, if required, from the Bruin Biometrics nurse advisers.

There were no exclusion criteria because all patients were potentially at risk of PUs in the evaluation wards. As part of the admission process, along with the standard Waterlow risk assessment and visual skin checks, every patient admitted during the 6-week period to these two wards was to be scanned. This was an additional process for staff and would be repeated daily throughout each patient's stay in that ward.

The process for each patient involved scanning the sacrum and both heels daily as described previously. *Figure 5* shows the device in use on a heel. Each reading takes 1 second, with the scanner automatically calculating the difference (delta value) between readings. If a delta value of 0.6 or higher was noted, this prompted staff to make a decision on how to intervene using current practice guidelines to prevent a HAPU developing. Current guidelines for staff on PU prevention are available on the wards either via the TV resource folder or via the TV intranet pages accessible from each ward computer.

At the end of the 6-week evaluation period the results were analysed and presented to the ward staff, who were able to provide verbal feedback and ask questions. At the request of the charge nurse, a face-to-face meeting was arranged with one of the deputy charge nurses to gather specific comments from nurses involved in the evaluation.

Equipment pathway wards

The wards using the equipment pathway were to continue to assess patients on admission using the Waterlow risk assessment and visual skin checks. There were no exclusion criteria because all patients were potentially at risk of PUs in the pathway wards. If staff identified high-risk patients or skin changes, then they would consult the newly developed equipment pathway to identify appropriate equipment and repositioning advice. This method was more prescriptive, with certain triggers for choosing equipment.

There was concern that providing extra TVN support to the wards using the equipment pathway could affect staff decision-making. To ensure that staff received enough support without this potential influence, an information pack containing copies of the A4 poster and feedback forms was hand delivered by the lead TVN. An explanation was given to either the senior charge nurse or a designated link nurse on how to use this resource. These key individuals then

© 2021 MA Healthcare Ltd

disseminated information on how to use the resource to their staff, who used the pathway over the agreed 6-week evaluation period. Staff were able to provide written comments using the feedback form and there was a phone call and email reminder to ensure return of forms at the end of the 6-week period.

Data collection

The equipment pathway directed staff to use current practice of recording skin checks on the standard care rounding tool, which incorporates the SSKIN bundle, and record changes to care plans in the electronic patient record. It would have been labour intensive to identify all patients in the wards over the 6-week period and check individual electronic and paper patient records for changes linked to the pathway. The TV service did not have staff resources to commit to that level of data collection, so it was decided to standardise data collected from all areas.

To ensure that there was consistency across all wards and minimal intervention to reduce impact on outcomes, data were gathered from easily accessible systems used by all areas via:

- The Datix incident reporting system: this has been used as the standard for PU reporting since 2012, and was used to identify data on HAPUs for all the wards involved in the evaluation
- Equipment rental records: the total managed equipment nurse adviser for NHS Lothian collated the data relating to the number and types of dynamic therapy systems rented by each ward during that period, but did not visit the wards
- Standard paper form: this was used to collect anonymised SEM scanner and patient data. This was collected on a weekly basis and input into a standard study database by nurse advisers from Bruin Biometrics.

To reduce the risk of bias, the TVNs were not involved in the day-to-day evaluation on the wards, but would visit any patients referred as per usual protocols. Full details of the data collection parameters can be seen in *Box 2*.

Findings

SEM scanner wards

A total of 126 patients were scanned with 3211 readings taken over the 6-week evaluation period. Patients were scanned for an average of 9 days with the range being from 1 to 30 days.

- Ward A staff scanned 48 patients with 1212 readings
- Ward B staff scanned 78 patients with 1999 readings.

Full details of all data collected for the SEM wards can be found in *Table 3:* the data show the numbers of patients involved, how many scans were undertaken and what interventions were implemented by the clinical staff over the 6-week period.

In wards A and B, it was noted that for 75% and 79% of patients respectively, use of the SEM scanner changed the clinical decision making of staff that day and they introduced additional interventions into patient's care plans. The intervention options available to record on the forms were:

- Increased turning/mobilisation today
- Introduced specialist surface/mattress today
- Heel supports or elevation introduced today

Figure 5. The use of the first-generation SEM scanner to check a patient's heel

Figure 6. The design of the second generation Provizio SEM scanner makes it easier to take readings from small heels

- Started prophylactic dressing or barrier cream today.

Ward A reported zero HAPUs during the 6-week evaluation period, with a 33% reduction in the use of dynamic therapy systems compared with the same period in the previous year. This was sustained for the 6 weeks post-evaluation.

Ward B reported zero HAPUs during 6-week evaluation period, which was a relative reduction in HAPUs of 100% compared with the previous year's data. The ward also unexpectedly showed an 11% dynamic therapy system reduction compared with the same period in the previous year, which was sustained for the 6 weeks post-evaluation.

SEM scanner wards: staff feedback

Staff reported back at the review meetings that the scanners were 'user-friendly' and it had been 'easy to learn the scanning process'. Several commented that 'all patients should be

© 2021 MA Healthcare Ltd

Box 2. Data collection parameters for each ward

Datix reports of HAPUs in the sacrum and heels for:

- 12 months before evaluation started (October 2018–September 2019)
- 6-week evaluation period
- 6 weeks after the evaluation period finished

Rented therapeutic equipment, number, and types for:

- 6-week evaluation period
- 6 weeks after evaluation period finished
- Equivalent 6-week period of previous year

SEM scanner: weekly collection of data (SEM wards only)

- Numbers of patients scanned
- Delta value readings
- Skin inspection findings
- Interventions based on results

Table 3. Evaluation findings for the SEM scanner wards

SEM scanner results and related actions	WGH, Ward A		RIE, Ward B	
	%	*n*	%	*n*
Scans undertaken	**100**	**1212**	**100**	**1999**
– SEM delta ≥0.6	67	812	71	1420
– Visual skin change	14	164	45	907
– SEM delta ≥0.6 no skin change	55	673	36	709
Number of patients	**100**	**48**	**100**	**78**
– Did SEM delta affect clinical decision?	75	36	79	62
– Any additional interventions?	75	36	79	62
– Increased turning/mobilisation today?	92	33	92	57
– Introduced specialist surface/ mattress today?	28	10	26	16
– Heel supports or elevation introduced today?	72	26	29	18
– Started prophylactic dressing or barrier cream today?	39	14	10	6
Number of HAPUs	0 (zero)		0 (zero)	
Relative reduction in HAPUs	n/a (zero before)		100%	
Reduction in dynamic therapy systems	33%		11%	

RIE=Royal Infirmary Edinburgh, WGH=Western General Hospital

Table 4. Equipment pathway ward data: collated results

	WGH, Wards C & D	RIE, Wards E,F & G
Number of HAPUs	0 (zero)	4
Relative reduction in HAPUs	N/A (zero before)	86%
Dynamic therapy systems use	64% reduction	40% increase

RIE=Royal Infirmary Edinburgh, WGH=Western General Hospital

scanned on admission to hospital to stop pressure ulcers', with a local trigger for daily checks for low-risk patients. They also described a few challenges that included:

- 'It is difficult to scan small heels as the scanner has to be in contact with the skin to get a reading and with frail elderly they often have small heels' (This feature has been addressed in second generation SEM scanner (Provizio) (*Figure 6*)
- 'We could have done with more scanners as we have 3 bases within the ward and we only had 4 scanners' (the project team had planned the number of scanners based on patient numbers not on the layout of the ward)
- 'Challenge if bank staff and no students as this reduced the number of staff trained to scan.'

These challenges were noted and will be taken into consideration for any future work.

Equipment pathway wards

Wards were grouped together by site for collation of the results (*Table 4*). Wards C and D noted zero HAPUs developed during the 6-week evaluation period, which was the same number as during the 12 months prior to the evaluation. They also showed a 64% reduction in dynamic therapy use but this was not sustained post evaluation.

Wards E, F, and G noted 4 HAPUs that developed during 6-week evaluation period: 2 x category 2 (sacrum), 1 x category 2 (left heel) and 1 x suspected deep tissue injury (right heel). Although four HAPUs developed this still showed an 86% relative reduction in HAPUs from the previous 12 months data. However, they showed a 40% increase in dynamic therapy system usage, and they sustained this increase following the evaluation.

Equipment pathway wards: staff feedback

The majority of staff who provided written comments on the feedback forms noted that they found the pathway clear to follow and easy to use.

- 'Flow chart easy to read and follow'
- 'No issues with understanding this'
- 'Very helpful and concise.'

One registered nurse commented: 'Pathway is good, but will staff use it often or keep referring to old guideline for mattress ordering?' This raises the issue of the need for ongoing staff education to support implementation of new guidance.

Two staff requested that the pathway include a range of other factors to consider when deciding on equipment. On investigation, these factors were already covered by the current risk assessment tool and SSKIN bundle and are triggers on the PU prevention and management pathway that should be used for all patients. This indicates a need for further education around current processes aimed at reducing HAPUs at ward level to ensure that all staff are familiar with available resources.

Discussion

Two of the three aims set out at the start of the evaluation were achieved:

- Using the SEM scanner would reduce HAPUs, with or

© 2021 MA Healthcare Ltd

without a reduction in dynamic mattress use
- A ward with zero HAPUs but high dynamic mattress use could reduce equipment use without increasing HAPUs
- The third aim was only partially achieved, with two of the five pathway wards showing a reduction in equipment use without increasing the number of HAPUs, but this reduction was not sustained post-evaluation. The other three wards increased equipment use and, although four PUs were recorded during the 6-week evaluation period, this represented a relative reduction in HAPUs compared with the same 6 weeks in the previous year.

The findings from the evaluation show that using the SEM scanner maintained zero HAPUs in ward A and achieved a relative reduction of HAPUs in ward B, with a consistent reduction in the use of dynamic therapy systems across both sites. It was interesting to note that the ward that had a record of zero HAPUs was able to reduce equipment use, while still maintaining this year-long achievement. Staff noted their main concerns were the challenge of using the device on small heels and the number of devices required, depending on ward layout.

One of the challenges with introducing new technology into a patient care pathway is how it impacts on the staff decision-making process. When staff saw a delta value of ≥0.6 they were encouraged to use their clinical judgement to decide whether to intervene. It is important that staff consider the holistic assessment they have undertaken for each patient and use the delta value to support their decision-making process daily. It should not be considered a trigger to always intervene in a particular way, but must be used as part of person-centred care planning that includes encouraging patient involvement in their care as they are able.

The SEM scanner results show that 55% and 36% of patients scans, for wards A and B respectively, fell into a category where there was no visual skin change and no HAPUs developed. This may have been due to false positive readings, as reported by Okonkwo et al (2020), or due to the interventions of the staff which changed care for those individuals and so prevented the underlying tissue changes developing into visually identified skin damage. False positives could potentially mean staff intervene with preventative care when it is not required. However, there is not yet enough evidence to predict which patients will or will not develop PU either using a hand held device or standard practice. Current guidelines and standards therefore advises intervening to prevent PU development based on the daily assessments staff undertake.

When staff chose to intervene after a high delta value, increased mobilisation or position change was the preferred option for 92% of patients. As the patients in these wards did not develop HAPUs this could indicate that one of the important interventions to reduce the risk of HAPUs developing is increasing mobility. Patients anecdotally report finding it harder to reposition on dynamic therapy systems, if the SEM scanner supports staff in making more informed decisions about patient care and not automatically ordering these systems, this could lead to increased position changes and easier transfers on the high specification foam mattress.

The Equipment Pathway wards achieved a reduction in HAPUs but not to zero as was expected, however there was a relative reduction in HAPUs in 3 wards compared to the previous year. They saw a consistent increase in equipment use on one site and the initial reduction in equipment use on the other site was not sustained. Although the project team thought a simple equipment pathway would help staff choose equipment more effectively and still reduce HAPUs, it was interesting to note it had a negative effect with staff choosing more dynamic therapy systems in some wards than previously.

Combining the findings from both parts of the evaluation demonstrated that the use of the SEM scanner not only helped staff maintain or reduce HAPUs to zero, but it also supported staff decision making and increased mobilisation and repositioning of patients. It provided a more structured approach to assessing patients skin with an objective measure, the delta value, to review the care plan and make decisions daily. The equipment pathway had a negative outcome of guiding staff towards choosing more dynamic therapy systems without the predicted reduction in HAPUs to zero.

Table 5. Indicative costs to heal sacral and heel pressure ulcers developed prior to the evaluation (October 2018 to September 2019) using Dealey (2012) as a cost guide

PU category	Number	Estimated cost per PU	Total cost
Category 1	23	£1214	£27 922
Category 2	62	£5241	£324 942
Category 3	24	£9041	£216 984
Category 4*	45	£14 108	£634 860
Totals	**154**		**£1 204 708**

*Costs for unstageable and deep tissue injury have been included with category 4

Potential cost savings

As well as the cost implications of the high use of dynamic therapy systems, the costs of healing HAPUs can be calculated (Dealey et al, 2012). In 2012, suspected deep tissue injuries and unstageable PUs were not descriptions that were in common use, so Dealey's work only refers to category 1-4. For the purposes of this evaluation these have been included with category 4. Although Guest et al (2017) undertook a more recent review of the burden of wound care in the UK and associated costs, PU were not reviewed by category and so figures from that work cannot be used in the same way.

To try to identify the potential cost benefits of preventing heel and sacral HAPUs using the SEM scanner, data was collected for the year prior to the evaluation. This data showed that between October 2018 and September 2019, 154 PUs developed on the sacrum and heels in acute care settings. Using Dealey et al (2012) figures (*Table 5*), the cost to NHS Lothian for managing the 154 HAPUs between October 2018 and September 2019 would have been £1 204 708.

If at-risk patients had been assessed using the SEM scanner over the previous 12 months and if these 154 PUs had been prevented, there would have been a great reduction in patient harm. The potential saving of £1 204 708 of this preventive action needs to be offset against the costs of the

© 2021 MA Healthcare Ltd

KEY POINTS

- New ideas and innovations need to be tested to confirm that they make the expected improvement in patient outcomes
- Working in partnership with industry can help all parties to achieve their outcomes
- When undertaking improvement work you may see unexpected results and positive outcomes you had not anticipated
- Staff using the SEM scanner were able to sustain zero HAPUs or achieve a relative reduction in HAPUs along with a consistent reduction in the use of dynamic therapy systems
- Keeping up to date with new technologies and research can lead to improved outcomes for patients and more cost-effective health care

SEM scanners. At the time of the evaluation, the cost of each scanner is about £6000 plus VAT, and were not available for rental.

Any financial saving relates to a reduction in spend for renting dynamic therapy systems, a reduction in staff time, costs of dressings and medication to manage HAPUs, as well as a reduction in occupied bed days when HAPUs are prevented. Financial modelling was undertaken by an external independent auditor to demonstrate potential savings if scanners were used across the health board to reduce HAPUs and related costs. Presentation of the results to the nurse directors was delayed due to the COVID-19 pandemic and are outside the remit of this article. A recent article by Gefen et al (2020) goes into greater detail on this subject and discusses how to model cost benefits when using SEM scanners in practice.

Additional information following the evaluation

Since this evaluation was undertaken, several papers have been published confirming efficacy of SEM scanners both in modelling and in clinical practice. Peko et al (2019) demonstrated that the scanner was sensitive enough to detect as small as 1mL variations in water contents within simulated tissues in physical models representing human anatomy and clinical scenarios. They demonstrated for the first time that the SEM scanner is sensitive and robust under controlled laboratory conditions in simulating clinical use and that the laboratory research complements and supports the body of published clinical evidence. Peko et al (2019) concluded: 'The SEM scanner is a technological breakthrough in PUP [pressure ulcer prevention], which is able to detect physiologically and clinically relevant information concerning tissue health status in at-risk individuals. As an adjunct to standard care, the SEM scanner has a pivotal and pioneering role in PUP'.

NICE guidance (2020) noted that 'SEM scanner 200, with visual skin assessment, shows promise for preventing pressure ulcers', however NICE did not identify enough evidence at the level required at the time to recommend its use across healthcare settings and recommended further research to look into specific aspects of its potential use. Further papers have now been published that may help fill this gap in evidence and guide clinicians. Okonkwo et al (2020) confirmed in a blinded clinical study that the use of an SEM scanner is more effective at assessing the potential for PU development than visual assessment of skin and tissue alone in clinical practice.

In early 2020, Bruin Biometrics introduced a second-generation model, the Provizio SEM scanner to Scotland (*Figure 6*). The new version has been designed to include an improved user interface and better wireless connectivity (Gefen, 2020) and to deal with the issue that the original scanner head was too large for smaller heels. It has also incorporated a disposable sensor head that reduces risk of cross-infection between patients.

Conclusion

Combining the findings from both parts of the evaluation demonstrates that the use of the SEM scanner not only helped staff maintain at or reduce HAPU levels to zero, but also supported staff decision-making. Use of the scanner provided a more structured approach to assessing patient skin by using an objective measure, the delta value, to support daily review of the care plan and interventions. An unexpected outcome from the evaluation was that the equipment pathway increased rather than reduced the use of high-end dynamic therapy systems and did not, as predicted, produce a reduction in HAPUs to zero.

In the ever-changing financial situation facing publicly funded health care organisations it is clearly not sufficient for technology to be solely clinically effective, it must also be financially justified. Gefen et al (2020) suggested that increasing diagnostic accuracy using such technology to aid clinical decision-making results in measurable, financial savings for healthcare providers.

Shortly after this evaluation was undertaken the first wave of the COVID-19 pandemic hit the healthcare sector in the UK. This, in combination with the retirement of the NHS Lothian TV service lead nurse and the process of recruiting a new lead, resulted in future work being put on hold for the time being. **BJN**

Declaration of interest: none

Funding: Arjo (TME contractor for NHS Lothian) worked in partnership with Bruin Biometrics LLC to provide the SEM scanners and nurse advisers to support the evaluation for the 6-week evaluation

Acknowledgement: The author would like to thank the tissue viability nurses and staff of Western General Hospital and Royal Infirmary of Edinburgh wards for their support and involvement in this evaluation. Thanks to Zoe Wood, Nurse Advisor, Bruin Biometrics LLC for reviewing that the SEM scanner details were correct and for providing permission for use of the images

Dealey C, Posnett J, Walker A. The cost of pressure ulcers in the United Kingdom. J Wounds Care. 2012;21(6):261-266. https://doi.org/10.12968/jowc.2012.21.6.261

European Pressure Ulcer Advisory Panel, National Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and treatment of pressure ulcers: Quick Reference Guide. Haesler E (ed). 3rd edn. 2019. tinyurl.com/53avwx9d (accessed 3 August 2021)

Gefen A. The SEM Scanner for early pressure ulcer detection: a 360-degree review of the technology. Wounds International. 2020; 11(4):22-30. tinyurl.com/2d3uw2z (accessed 2 August 2021)

Gefen A, Kolsi J, King T, Grainger S, Burns M. Modelling the cost-benefits arising

© 2021 MA Healthcare Ltd

from technology-aided early detection of pressure ulcers. Wounds International 2020;11(1):22-29. tinyurl.com/a7dwanf4 (accessed 2 August 2021)
Guest JF, Ayoub N, McIlwraith T et al. Health economic burden that different wound types impose on the UK's National Health Service. Int Wound J. 2017;14(2):322-330. https://doi.org/10.1111/iwj.12603
Healthcare Improvement Scotland. Prevention and management of pressure ulcers standards. 2020a. tinyurl.com/4shmfktb (accessed 2 August 2021)
Healthcare Improvement Scotland. SSKIN care bundle. 2020b. tinyurl.com/7z6cspzc (accessed 3 August 2021)
Moore Z. Patton D. Rhodes SL. O'Connor T. Subepidermal moisture (SEM) and bioimpedance: a literature review of a novel method for early detection of pressure-induced tissue damage (pressure ulcers). Int Wound J. 2017;14(2):331–337. https://doi.org/10.1111/iwj.12604
Moore Z, Fletcher J, Milne J. Enhancing efficiency of pressure ulcer/pressure injury care and patient outcomes with the SEM Scanner. Wounds UK 2018a; 14(1):68-71. tinyurl.com/yawhdd3k (accessed 2 August 2021)
Moore Z, Gershon S, Fletcher J. SEM scanner made easy. Wounds International 2018b. Update. tinyurl.com/aywkanbe (accessed 2 August 2021)
National Institute of Health and Care Excellence NICE. Pressure ulcers: prevention and management. Clinical Guideline [CG179]. 2014. https://www.nice.org.uk/guidance/cg179 (accessed 2 August 2021)
National Institute of Health and Care Excellence NICE. SEM Scanner 200 for preventing pressure ulcers. Medical technologies guidance [MTG51]. 2020. https://www.nice.org.uk/guidance/mtg51 (accessed 2 August 2021)
O'Brien G, Moore Z, Patton D, O'Connor T. The relationship between nurses assessment of early pressure ulcer damage and sub epidermal moisture measurement: a prospective explorative study. J Tissue Viability. 2018; 27(4): 232-237. https://doi.org/10.1016/j.jtv.2018.06.004
Okonkwo H, Milne J, Bryant R. Evaluation of a novel device using capacitance of the detection of early pressure ulcers (PU), a multi-site longitudinal study. Poster presented at Wounds UK Annual Conference, Harrogate, UK; 2017
Okonkwo H, Bryant R, Milne J et al. A blinded clinical study using a subepidermal moisture biocapacitance measurement device for early detection of pressure injuries. Wound Repair Regen. 2020; 28:364–374. https://doi.org/10.1111/wrr.12790
O'Regan R, MacDonald R, Boyle JG et al. 'CPR for Feet' care bundle to improve foot assessment in inpatient diabetes. BMJ Open Qual, 2018;7(3):e000196. https://doi.org/10.1136/bmjoq-2017-000196
Peko Cohen L, Gefen A. Phantom testing of the sensitivity and precision of a sub-epidermal moisture scanner. Int Wound J. 2019; 16(4):979–988. https://doi.org/10.1111/iwj.13132
Raizman R, MacNeil M, Rappl L. Utility of a sensor-based technology to assist in the prevention of pressure ulcers: A clinical comparison. Int Wound J. 2018;15(6)_:1033–1044. https://do i.org/10.1111/iwj.12974
Ropper R. The Scottish Ropper Ladder for infected wounds: a 5-year journey from concept to national tool. Wounds UK 2018;14(4):18-23. tinyurl.com/vd7m9nhs (accessed 2 August 2021)
Scafide KN. Narayan MC. Arundel L. Bedside technologies to enhance the early detection of pressure injuries: s systematic review. J Wound Ostomy Continence Nurse. 2020. 47(2):128-136. https://doi.org/10.1097/WON.0000000000000626
Smith G. Improved clinical outcomes in pressure ulcer prevention using the SEM Scanner. J Wound Care. 2019 28(5):278-282. https://doi.org/10.12968/jowc.2019.28.5.278

CPD reflective questions

- Consider the pressure ulcer (PU) prevention measures in your workplace. Are there areas of practice that could be improved?
- What could improve your confidence to approach senior staff or managers to suggest changes to PU prevention in practice?
- Consider who you could work in partnership with, either within or outside your organisation, to take a piece of improvement work forward?

© 2021 MA Healthcare Ltd

© 2021 MA Healthcare Ltd