# Advancing pressure ulcer prevention with the SEM™ Scanner

PROFESSOR ZENA MOORE
*Professor of Nursing, Head of the School of Nursing & Midwifery, Royal College of Surgeons in Ireland (RCSI)*

GILLIAN O'BRIEN
*MSc Advanced Practice, School of Nursing & Midwifery, RCSI*

SUSAN MALLOY
*MSc Research, School of Postgraduate Studies, RCSI*

ROSALIND O'CONNOR
*MSc Research, School of Postgraduate Studies, RCSI*

This article is based on a symposium held at the Wounds UK conference in Harrogate on 11th November 2015. Given the great diversity in wound care, there is a need for targeted diagnostics that objectively influence choice of treatment. Zena Moore called for a critical approach to pressure ulcer prevention and presented data in support of the SEM Scanner™ (Bruin Biometrics), an innovative diagnostic tool that is able to detect damage under the skin that is not yet visually apparent.

The symposium opened with the challenge that development and innovation are needed in wound diagnostics. Tests are routinely used to determine wound aetiology, comorbidities, and wound status, to inform appropriate management, and to re-evaluate the patient and their wound, but current diagnostic tests are variable in the degree to which they inform and guide treatment. Moreover, tests are not always able to determine why a wound is not healing where it is being managed optimally.

Diagnostics must provide the clinician with objective support to make treatment decisions; it should be obvious that the tool actually leads to a better treatment choice. In 2008, the World Union of Wound Healing Societies (WUWHS) produced best practice guidelines on the emerging use of diagnostics in wound management. A list of biomedical markers that may guide diagnosis and treatment of wounds were identified, and this list continues to grow to the present day (MEP, 2008).

Diagnostics are clearly an important platform through which to optimise wound care, but until assessment and diagnosis are linked to treatment, we will not get an integrated approach. As such, the symposium focused on the importance of using advancing diagnostic technology in the pressure ulcer arena; it proposed that we can and will not meet our pressure ulcer prevention and treatment goals unless we recognise there is currently a problem, and embrace innovative diagnostic tools aimed at detecting early-stage pressure ulcers and informing treatment accordingly.

## THINKING CRITICALLY ABOUT PRESSURE ULCER PREVENTION

Zena reminded the auditorium that pressure ulcers are not a new problem; they were identified in Egyptian mummies over 5000 years ago, described by Hippocrates, mentioned in the autobiography of Ambrose Paré during the French renaissance, and studied by Jean-Martin Charcot in the 19th century. Even so, in the present day, 5000 years later, the global mortality rate shows a 32.5% increase in deaths directly associated with pressure ulcers (1990–2010; 187 countries) (Lozano, 2010).

Pressure ulcers need to be prevented on a patient-by-patient basis before the visual signs become apparent, by which time it is too late. With the reminder that technological advances have been made in many areas over recent years, Zena asked why the same developments should not also be applied to pressure ulcer prevention and diagnosis to help realise this aim.

## MEASURING SUB-EPIDERMAL MOISTURE

Measurement of sub-epidermal moisture (SEM) is related to the quantity of skin and tissue water, and can be measured by surface electrical capacitance, which is determined by the impedance of the skin to electrical forces. Thus, SEM can reflect oedema

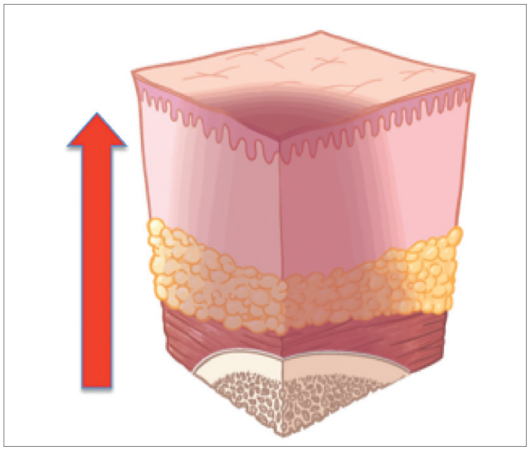

**Figure 1. Pressure ulcers develop from the inside out**

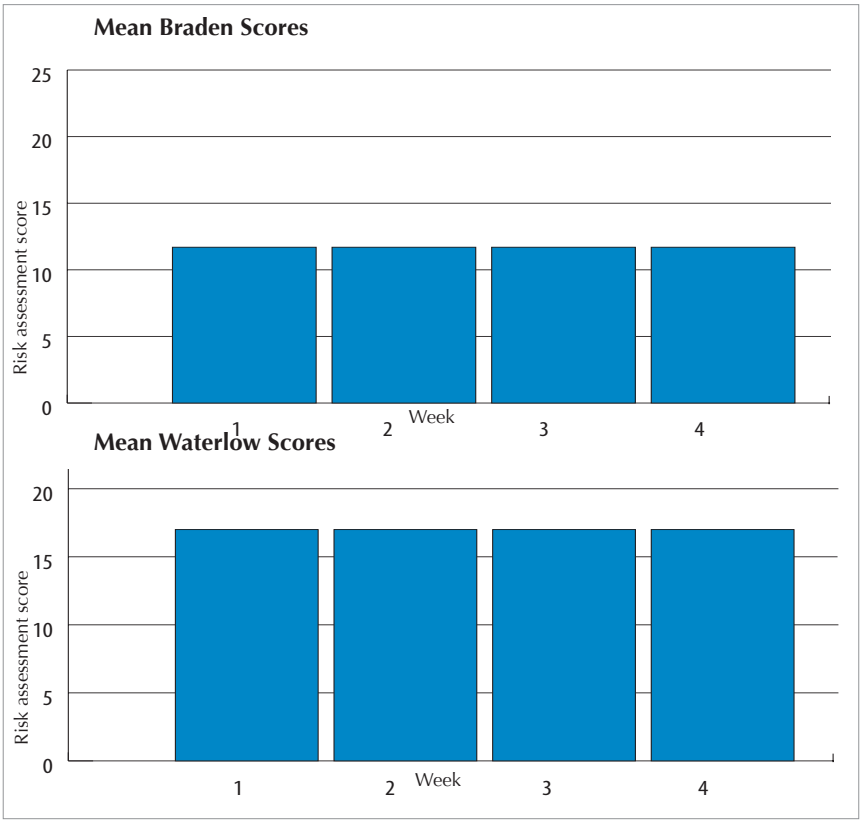


**Figure 2. Mean Braden and Waterlow assessment scores for 4-week follow-up period**

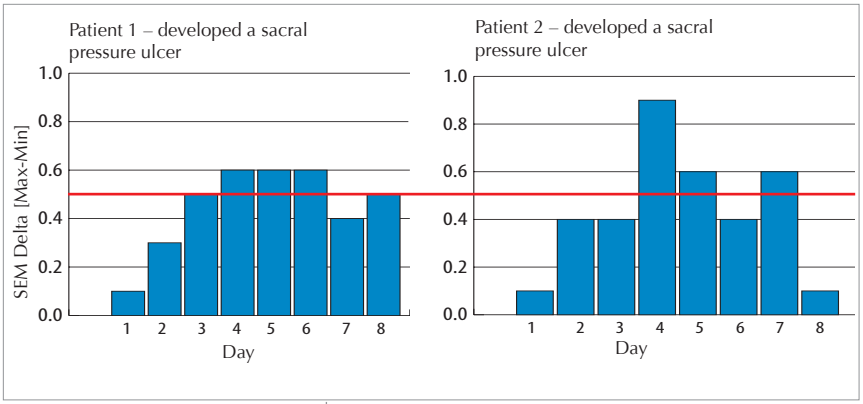


**Figure 3. SEM readings for two patients showing change in tissue health status**

**Declaration of interest**
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and water content of the epidermal and sub-epidermal tissues (Bates-Jenson, 2009).

The SEM Scanner™ is a diagnostic technology for the identification of early-stage pressure ulcers. It measures SEM through a signal from an electrode placed in direct contact with the patient's skin for at least one second. At least three readings are taken at each anatomical location: four at the heel and six at the sacrum. A difference between the lowest and highest recorded values of >0.5 suggests elevated SEM, which is an early sign of pressure ulcer development and is deemed abnormal.

In an evaluation of four studies exploring the scanner, SEM measurements were able to detect skin damage that was not yet visually apparent but would become so approximately 1 week later, with higher SEM measurements corresponding to increased levels of skin damage (Martins and Moore, 2015).

## CHALLENGES IN THE PREDICTION AND DETECTION OF PRESSURE ULCERS

Traditionally, classification of pressure ulcers has been similar to classification of burn injuries (grade 1 to 4). However, the challenge with pressure ulcers is that they develop from the inside out, as shown in *Figure 1*. As such, if we only look at what is happening on the outside, the mechanisms under the surface of the skin (i.e. at the bone interface) are ignored.

Moreover, current pressure ulcer grading systems are unreliable. In a review of 2480 healthcare professionals, mean reliability across six studies was 60%, demonstrating only moderate agreement with pressure ulcer classifications across a large number of participants (Moore, 2011).

Four mechanisms result in pressure ulcers: local ischaemia, reperfusion injury, impaired interstitial flow, and sustained cell deformity. Cell deformity with pressure ulcers can be extreme, potentially leading to permanent destruction. Thus, it is important that we ask what is going on underneath the surface when looking to diagnose a pressure ulcer, rather than just assessing the external indicators of damage.

## CLINICAL EVIDENCE SUPPORTING USE OF THE SEM SCANNER

Using the SEM Scanner allows clinicians to get ahead of the visual indicators of pressure damage, detecting pressure ulceration before it becomes clear at the surface level. A number of studies conducted at the Royal College of Surgeons in Ireland (RCSI) have examined the SEM Scanner's effectiveness as a diagnostic tool, comparing SEM measurement with existing assessment techniques in terms of pressure ulcer prevalence rates and length of time to diagnosis.

### Relationship between risk assessment tools and sub-epidermal moisture measurement

Study 1 examined the relationship between current risk assessment techniques and SEM measurement, looking at the ability of each grading system to detect pressure ulcer activity. The population

comprised 29 older patients (Molley, 2015).

In this study, Waterlow and Braden measurements remained constant across the follow-up period (*Figure 2*) implying that the patient's condition did not alter throughout the 4-week period. As clinicians, we know the patient's condition does not remain static. In contrast, SEM readings varied over this time period (*Figure 3*), reflecting the change in the patient's tissue health status and the impact of pressure-relieving interventions put in place to ensure the patient did not reach the manifestation threshold (Malloy, 2015).

Over the course of the follow-up period, nine patients exhibited deviated SEM values (values that suggest pressure-induced tissue damage) at the sacrum (3 days or more); 10 patients exhibited deviated SEM values at the left heel (3 days or more); and nine exhibited deviated SEM values at the right heel (3 days or more).

Of the two patients who developed sacral pressure ulcers (*Figure 3*), both exhibited SEM deviation of >0.5 for 3 or more consecutive days (Malloy, 2015). These results indicate no relationship between Braden and SEM, and force us to question the reliability of existing grading systems.

### Measuring pressure ulcer prevalence using SEM versus visual skin assessment

Study 2 assessed SEM measurement versus visual skin assessment, looking at pressure ulcer prevalence. Of 31 patients in an acute surgical setting, SEM measurement showed a pressure ulcer prevalence rate of 42% compared with only 6% for visual skin assessment (O'Connor 2015).

### Relationship between nurses' visual assessment of the skin and sub-epidermal moisture measurement

In Study 3, nurses' visual assessment of pressure ulcers was compared with assessment using the SEM Scanner. Data were collected over 20 days from 47 at-risk adults; 34% (16 patients) went on to develop 18 early signs of pressure damage. SEM measurements for all of these patients remained elevated until they showed visual signs of pressure damage (*Figure 4*). Mean SEM deviations exceeded the 0.5 threshold for all patients, and ranged from 0.7 to 2.1. Importantly, the mean number of days for a nurse to detect damage was 5 days (SD: 5.15), whereas for the SEM Scanner it was 1.1 days (SD: 0.75) (O'Brien, 2015). Therefore, SEM measurement identified early damage 3.9 days earlier than nurse assessment.

## CONCLUSION

To achieve our pressure ulcer goals, both clinicians and patients must understand what exposes an individual to pressure, and we must think about how can we provide patient-centred care. We must utilise innovative diagnostic tools such as the SEM Scanner to recognise the early signs of damage, in order to apply interventions as soon as possible. Patients must be able to self-assess, early, in order to make the invisible signs of damage visible.

These study results show that the SEM Scanner effectively detects changes in SEM levels and corresponding pressure-induced tissue damage, pre-empts the development of pressure ulcers, and does so earlier than visual nurse assessment. In practice, it is important to focus efforts below the skin surface. SSKIN (Surface, Skin, Keep patients moving, Incontinence/moisture, Nutrition/hydration) assessment does not allow us to see below-skin damage. With the SPUR strategy ('SPUR the patient into action'), SEM is recorded, the patient is advised of the appropriate intervention, action is taken by the patient and finally, reassessment takes place. This approach not only focuses directly on the cause of pressure ulcers, revealing prolonged exposure to pressure and stress, but also detects early signs of damage at the deeper skin layers. WUK

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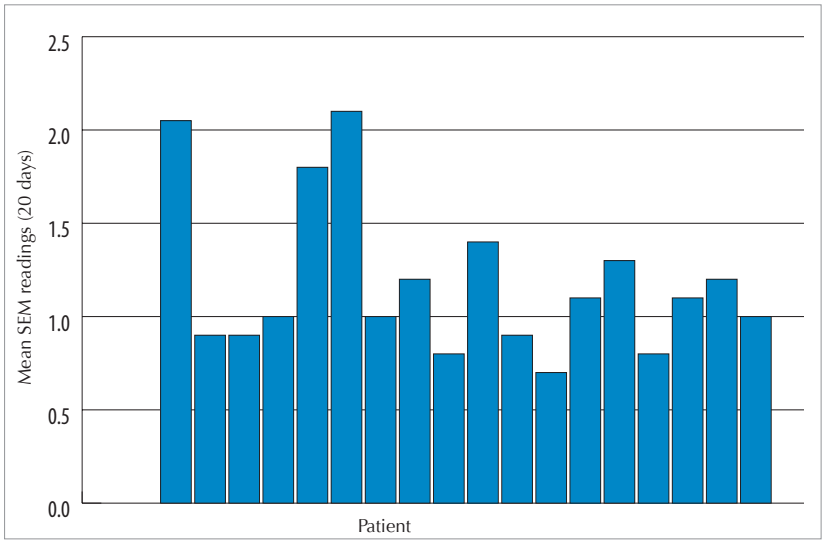


**Figure 4: Mean SEM readings (20 days) for 16 patients with pressure ulcer characteristics**