



## Using SEM (Sub Epidermal Moisture) Measurement for Early Pressure Ulcer Detection

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Are we really assessing PUs properly?

If you went to your general practitioner about your hypertension, but your GP didn't really know anything about hypertension, and then he or she was going to TREAT your hypertension - you wouldn't stand for that!

We would want to expect in our clinical practice that the assessments we use are fundamentally effective - and the question is: are current assessment methods for PUs really effective?

### Challenges with current PU assessment

The main problem is in the traditional concept of pressure ulcer development and classification.

Classification has its origins in BURN injuries, which start from the outside and go deeper the more serious they are, in a linear progression (first an injury will go through stage 1, then 2, then 3, etc.).

The problem is that pressure ulcers don't work that way. Stage 4 IS deeper and more serious than stage 1, but a PU doesn't always go through stages 1 and 2 before it gets to 4.

Additional problem: We often don't agree on what we're looking at!

If we have a skin disorder, and we cannot recognize or understand what it is, how on earth can we plan for treatment? We MUST agree what we're looking at.

The majority of PUs in Ireland are being reported as "unknown" – the staff says "there is a PU but I cannot grade it," and that's why we need more education.



We've been arguing for years about what to call it – pressure sore, bed sore, pressure ulcer, pressure injury – has any of that arguing been able to help us prevent or diagnose or treat? NO! Are we talking about words because it's easier than treatment? Can we RECOGNIZE this before it's too late?

Can we actually recognize what we're supposed to be preventing before it occurs in full force?

## The mechanics of a pressure ulcer

Many pressure ulcers occur from the INSIDE OUT!

4 mechanisms that results in PUs:

- Local ischemia (slow development)
- Reperfusion injury
- Impaired interstitial fluid flow
- Sustained cell deformity (rapid development)

Cell deformation can be extreme!

When the muscle cells are stretched around the bony tuberosities (shear strain), changes in the cell membrane and nucleus membrane occur, leading to permanent destruction of the muscle cell, resulting in deep tissue injury.

We need to be able to recognize the potential for this VERY VERY early.

It's like a volcano – it's emerging from the inside out. Once we see the damage, it's too late! So we must have mechanisms that allow us to recognize it before we can see it visually.

## Sub Epidermal Moisture background

**SEM (sub-epidermal moisture)** is related to the quantity of skin and tissue water.

Tissues have capacitive and conductive properties that are dependent on water content. Measures of bioimpedance can be correlated to physiological events related to changes in the volume, orientation and distribution of dermal fluids and tissues.



## What is SEM?

- SEM can be measured through the use of surface electrical capacitance
- Surface electrical capacitance is related to the capacity of tissue to hold/store energy, e.g. an electrical charge
- Determined by the impedance (resistance/opposition) of the skin to electrical forces
- Reflects oedema and water content of the epidermal and sub-epidermal tissues

## SEM and Pressure Ulcers

- In PU development, apoptosis, necrosis and the inflammatory process lead to leakage from vascular vessels and other changes that modify the underlying structure of the damaged tissue
  - This results in an increase in interstitial fluid: subepidermal moisture (SEM)
  - Changes in SEM as a physiological marker of early PU development is an exciting opportunity!

**For the first time, we may actually have something that allows us to “see in the dark”.** These subepidermal changes occur 3-10 days before anything is seen on the skin surface.

4 studies in the systematic review looking at ultrasound thermography and subepidermal moisture:

- PU incidence rates varied between 24–46%
- 80 stage 2+ PUs developed across the studies
- All studies showed that skin damage and higher PU stages were associated with high SEM measures
  - Once the SEM was elevated, this predicted the presence of a PU development, that showed one week later

If we were able to do this, we wouldn't have to wait for the volcano to erupt at the skin's surface! We could, instead, recognize the impending damage that was occurring underneath and alter our strategies to PREVENT.



## 2017 paper published by Barbara Bates Jenssen:

- 417 NH residents; 19 facilities; mean age: 77 years; 58% female; at risk of pressure ulcer development, mean Braden score 15.6
- Mean SEM readings rose in tandem with increasing tissue damage
- Sacrum:
  - Normal: n = 4534; Mean: 37.1 (SD: 7.7)
  - Erythema: n= 222; Mean: 38.4 (SD: 7.5)
  - Stage 1 PU: n= 74; Mean: 39.3 (SD: 7.6)
  - Stage 2+ PU: n=305; Mean: 40.1 (SD: 9.5)
  - SEM was significant for predicting stage 2 or greater PUs

As we go from normal to stage 2, we can see that the SEM measures are rising.

SEM was significant in predicting stage 2 or greater PIs.

It helps us understand that even in patients who have generalized oedema, you can still detect changes in the SEM readings. We are interested in the delta – the difference between the lowest and the highest reading of the individual. The delta can tell me what I need to know. This method of measurement and detection is reassuring, because the readings all belong individually to the person. My SEM readings are going to be different than yours. It's the delta between readings that will tell me if there's an impending PU.

## Conclusions from the existing literature:

- SEM measurement corroborated the fact that PU damage can start in deeper levels of the skin and tissue developing upwards, and not always at the skin surface and developing downwards
- SEM measurement might be a reliable method for early prediction of tissue damage and of PU presence

YES, there are PUs occurring that you cannot see, but there is something happening under the skin that can be detected with the right method of assessment!



### **Study 1: The Relationship between Risk Assessment Tools and Sub-Epidermal Moisture Measurement (2015)**

- Older persons
- Four weeks
- Measured with Waterlow scale, Braden scale

Over time, the Waterlow and Braden measurements remain constant

They are predictors of RISK. Unfortunately, people use them to determine progress “how is my patient doing over time?” But they’ll remain constant over time even with minor changes of condition, so they can’t tell us anything about those changes.

BUT when we’re measuring SEM over time, we can see that YES! As you would expect, in the patients who are seated, you see differences in their SEM deltas over time. If some patients are not doing any lifting, you would expect differences in their deltas. This may show us individual responses to pressure and shear.

### **Study 2: Pressure Ulcer Prevalence using SEM vs Visual Skin Assessment (2015)**

- Younger people as subjects
- Surgical patients

As the patient’s immobility increases, the SEM rises accordingly

Once the people started to move again, down goes the SEM

The SEM deltas are responding to the individual’s mobility status

### **Study 3: Relationship between Nurses’ Visual Assessment of the Skin and Sub-Epidermal Moisture Measurement (2015)**

- Nurses are observing what’s happening while delivering normal PU prevention
- Despite that, 34% of patients developed visual signs of PUs and 18 PUs!
- The mean number of days it took nurses to detect the PUs was 5 days
- The mean number of days for SEM to detect it was 1.1 days
- Therefore, SEM was able to detect it 3.9 days earlier than a nurse assessment

Nurses were implementing prevention strategies, but in many cases, it didn’t work! They wouldn’t have realized the issue until they SAW changes in the skin. BUT if they had been using SEM and looking at the deltas, they would have seen the problem earlier.



#### **Study 4: Relationship between subepidermal moisture and pressure ulcer damage in a paediatric population**

- Mean age was 12.5
- 24 patients
- Data collected daily for 3 days
- 75% of them were wheelchair dependent
- 71% had surgery – surgery times were 1-4 hours
- 50% of them developed erythema and 8% of them developed a PU that was greater than stage 2

(Medical facility in question did not have a PU prevention policy there.)

In all anatomical locations, SEM recorded was higher than normal. Had staff recorded SEM deltas prior to surgery and post surgery, they would have seen the changes in the deltas.

#### **Study 5: Pressure ulcer risk assessment: risk factors and risk screening in older persons - a validation study - pilot data (2012)**

- 48 patients
- Older persons, mean age was 85.6
- Data collected daily for 20 days: looking at movement and monitoring SEM deltas
- 10.41% of the patients developed a stage 1 PU
- Mean number of days for a stage 1 PU to be recognized visually was 12
- Mean number of days for a stage 1 PU to be detected by SEM was 5.9

### **Conclusions:**

As mobility decreases, SEM deltas increase.

SEM detected PU on average of 7.5 days earlier than visual assessment

### **Need to improve assessment and patient care**

#### **Patients' rights:**

- Each individual has the right of access to high quality health services on the basis of the specification and observance of precise standards (*we must have standards of care! Consensus statements. International guidelines*).



- Each individual has the right to be free from harm caused by the poor functioning of health services (*if I am using a method of assessment which is inherently flawed, how can I detect problems effectively?*)
- Each individual has the right to diagnostic or therapeutic programmes tailored as much as possible to his or her personal needs (*How can I do that if I can't recognize what's happening to the patient?*)

### The truth:

- One in 10 patients is harmed while in hospital care!
- 15% of hospital expenditure and activity in OECD countries can be attributed to treating safety failures.
- The most burdensome include healthcare-associated infections (HAI), venous thromboembolism (VTE) and pressure ulcers.
- The annual cost of common adverse events in England is equivalent to 2,000 GPs or 3,500 hospital nurses.

Greatest burden on the disability adjusted life years is PRESSURE ULCERS

Therefore, critical that we do something about this.

We think we're doing a good job, but we must do better. Why? Because:

- Pressure ulcers are common, costly, and a very negative experience
- Current assessment of impending pressure ulcer development is flawed
- Often, assessments assume an outside-in development, but inside-out is more likely
- We need to be able to see under the skin to detect the pressure ulcer in its early development, and SEM offers that potential

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