

Influence of dressing changes on wound temperature

- **Objective:** When wound-tissue temperature falls below 33°C neutrophil, fibroblast and epithelial cell activity decreases. This study examined the influence of dressing changes on wound temperature.
- **Method:** The wound-bed temperatures of patients with a wound resulting from trauma or surgical debridement were measured immediately before and after dressing changes using a DermaTemp infrared body surface scanning device. The temperature on the surface of the dressing product was measured immediately before the dressing change and then every five minutes until the pre-procedural temperature was reached.
- **Results:** A total of 133 dressing episodes were measured, yielding 266 wound-bed temperature measurements and 619 external dressing temperature measurements. Pre-procedural temperatures showed that the wound beds were on average marginally below the 33°C threshold immediately after dressing takedown (mean: 32.7°C). This figure dropped two degrees on average as a result of the dressing-change procedure (mean: 29.9°C). Reapplied wound-dressing products return to the pre-procedural temperature within 30 minutes (mean: 23 minutes).
- **Conclusion:** This study provides baseline data for future research aimed at promoting maintenance of a normothermic wound bed.
- **Declaration of interest:** None.

temperature; wound dressing changes

When the temperature of the wound bed falls below the core body temperature, healing can be delayed as a result of slow epithelial repair, lack of collagen deposition, a reduction in late-phase inflammatory cells and fibroblasts¹ and a higher percentage of wound infections, all of which lead to an increased average length of hospital stay — 2.6 days longer than for normothermic patients.²

In vitro studies have demonstrated that 33°C is the critical level at which neutrophil, fibroblast and epithelial cell activity decreases.^{1,3-9} Conversely, studies have shown improved healing when wounds are warmed.⁹⁻¹¹ Increased blood-flow, oxygen tension, collagen deposition and immune cell function have been cited as possible contributory mechanisms.⁴

Studies have suggested that wounds heal most effectively at normal core body temperature, with a faster reduction in the mean surface area of pressure ulcers when the wound bed is 36–38°C,¹²⁻¹⁴ and that wound healing is delayed when temperatures fall below normal core body temperature or rise above 42°C.^{10,12}

Studies have shown that the overall pattern of mitotic activity is significantly higher under dressing materials that maintain the wound at near to body temperatures, with an increase of 108% in the number of dividing cells in the epidermis.^{9,15}

Although the influence of wound-bed temperature at a histological and product level has been

studied, the influence of cleansing on wound temperature during dressing change has largely been ignored. This exploratory study examined the influence that cleansing has on wound temperature.

Objectives

- To examine the wound-bed temperature reduction resulting from cleansing during dressing changes
- To examine associations between the time taken to cleanse a wound and the degree of temperature loss
- To measure the time taken for the wound temperature to return to the pre-procedural temperature
- To examine if the type of dressing influences the time required for the wound bed to return to pre-cleansing temperatures.

Method

A convenience sample of patients was selected from a trauma step-down unit at a major metropolitan hospital. All patients were over 18 years of age, had given written informed consent and had a wound(s) healing by secondary intention.

The following were recorded at each dressing change:

- Ambient room temperature
- Temperature of the outside of the dressing material (before removal)
- Wound bed temperature immediately after dressing removal
- Wound bed temperature at the completion of cleansing

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- Temperature of the outside of the reapplied dressing; this was repeated at five-minute intervals until the pre-procedural temperature was reached
- Ambient room temperature at completion of the dressing change.

A body surface scanning device, DermaTemp (Exergen Corporation), was used to take all temperature measurements. This hand-held infrared thermographic scanner can measure the temperature of wounds without tissue contact. To examine its reliability on dressing surfaces, a 10x10cm hydrocolloid dressing was heated to a specified temperature in a controlled water bath. Its temperature was then measured with the DermaTemp. There were no significant differences in the two temperatures. The DermaTemp was calibrated each day before taking measurements. To ensure it was kept at a consistent distance from the wound bed, a sterile cotton probe was attached to the instrument and rested against the base of the wound.

All wounds were cleansed with normal saline. To represent the practices of the nurses caring for this client cohort, the cleansing solution was left at an ambient room temperature.

To facilitate comparison between temperature loss and confounding variables, we also recorded the:

- Wound aetiology
- Wound duration
- Wound surface area
- Primary and secondary dressing used
- Time taken for dressing change.

Wound depth was not measured. All data were analysed using SPSS.

Results

Forty-four patients were recruited, providing 133 dressing episodes. A total of 266 wound-bed temperature measurements and 619 external dressing temperature measurements were recorded.

Most of the wounds were either caused by surgical debridement (n=25) or were traumatic (n=19) in origin. Nine wounds were between 0 and four days old, 15 were between five and 10 days old, three were between 11 and 15 days old, five were between 16 and 21 days old, and 12 were over 21 days old. Traumatic leg wounds were the most common (n=20). Wound surface area ranged from 1.05cm² to 170cm², with an average of 23.9cm². The average time taken to change a dressing was 11 minutes (range: 0.5 minutes to 1.25 hours).

Temperature changes

Room temperature

As expected in an air-conditioned facility, there was little variation in ambient room temperature (mean: 21.8°C, range: 18–24°C) and little difference between pre-procedure and post-procedure temperatures (mean: 0.8°C, range: 0.5–1.1°C).

Dressing temperature

Temperature measurements taken on the outside of the dressing product before the dressing was changed yielded a mean product-surface temperature of 29.5°C (range: 23.3–35.8°C). Dressings used are listed in Table 1.

Wound-bed temperature

Wound-bed temperatures immediately after dressing removal were, on average, marginally below the 33°C threshold deemed necessary for cellular activity¹ (mean: 32.6°C, range: 25.3–37.3°C). Such a wide range in temperature was unexpected. Some patients may have been hypothermic, but as core body temperature was not measured we were unable to explore this further. Wound-bed temperature dropped 2°C on average when the wound was cleansed with normal saline, which was at a mean ambient room temperature of 29.9°C (range: 23.3–34.4°C). Again, this variation in ambient room temperature was unexpected as the hospital was air-conditioned, but was perceived as normal by the hospital engineering department. This temperature loss was influenced by the time taken to perform the dressing change, but the correlation was not significant (r0.067).

A similar trend occurred when temperature loss at the wound surface area examined. The average temperature loss of 2.7°C did not correlate significantly with the wound surface area (Pearson's r0.052).

Dressing temperature post-application

The time required for the surface temperature of the newly applied dressing to reach the pre-procedural temperature varied from five minutes to 3:08 hours (mean: 23 minutes). The type of dressing influenced the time taken to reach this temperature, but this was no significant (Table 1). Analysis of variance between the dressing products yielded a difference between the groups of f=0.809 (p=0.52).

Discussion and limitations

The decrease in wound-bed temperature following a dressing application was to be expected, but had not been quantified before this study. However, the fact that most of the wound-bed temperatures were below the 33°C threshold immediately after dressing removal was unexpected. If accurate, it can be assumed that the types of wounds in this study are constantly below the 33°C threshold required for normal cellular activity¹ and may account for some delay in healing. The high percentage of wounds on the limbs of patients recruited into this study may, in part, account for these findings. It could be assumed that limbs on average have a lower temperature than core body areas, such as the trunk.

Alternatively, the reason for admission and the hospital environment may have accounted for the wound-bed temperatures. Most of the wounds were

created by surgical debridement or trauma. This suggests the patients had limited mobility, resulting in a lower metabolic rate and body temperature. The lower ambient room temperatures afforded by the air-conditioning, resulting in a lower core body temperature, could further compound this finding.

As the saline used to clean the wounds was on average 10.7°C colder than the recorded wound-bed temperatures, we had expected that the temperature loss at the wound bed during the cleansing procedure would be greater than the 2.7°C recorded.

Even more confounding was the finding that temperature loss from the wound bed did not correlate to the time taken to perform the dressing change or the wound size. The findings suggest that a wound-bed temperature will only drop to a figure that is consistent with the temperatures of underlying tissue. The patient's body temperature appears to maintain the wound bed at that temperature, regardless of the time exposed. Further studies that record the patient's body temperature are required to support or refute this claim.

The recovery time for the surface temperature of a dressing product to return to the pre-procedural temperature (23 minutes) would seem acceptable. Previous studies have shown that it takes approximately three hours for mitotic cell division and leucocyte activity to resume once a wound returns to core body temperature.¹ Therefore, on average, wound activity should resume approximately three to four hours after a dressing change. As most manufacturers recommend durations of days between dressing changes, a window of three to four hours should be accommodated easily. The cumulative damage achieved by this episodic cooling has yet to be established. Three to four hours multiplied by a number of frequent dressing changes may result in a substantial delay in healing.

That the type of dressing product had no significant influence on the time required for the product's surface temperature to return to pre-procedural temperatures is again confounding. Given the different thermal properties of the products used in the study, this finding may indicate a problem with the reliability of the data collected. Equally, the average loss of wound-bed temperature (2.7°C) may have been too small for the dressings' thermal properties to make a significant difference. Larger losses in wound-bed temperatures may highlight the differences associated with dressing products.

This study, although limited by sample size, has provided preliminary findings that, if accurate, suggest that the time taken to do a dressing procedure, the wound size and the type of dressing used have little influence on the amount of temperature lost at dressing change. It is likely that wound-bed temperature losses are associated with the temperature of the underlying tissues. If, as this study suggests,

Table 1. Time required for each dressing to return to its pre-procedural temperature

Product	Minimum	Maximum	Mean	SD	No.
Alginate	0.00	3.08	0.29	0.45	39
Hydrogel	0.05	2.45	0.36	0.52	22
Hydrocolloid	0.05	2.45	0.34	0.51	2
Saline-soaked pack	0.10	0.15	0.12	0.03	2
Foam	0.10	1.00	0.35	0.35	2
Other	0.00	2.35	0.25	0.34	34

a wound takes between three and four hours to recover, then interventions aimed at reducing wound-bed temperature should focus on the frequency of dressing change in preference to dressing-based interventions. Strategies currently recommended in the literature,^{16,17} such as pre-warming normal saline, might have little lasting effect on the wound.

Conclusion

This study found that on average wound-bed temperatures were lower than the 33°C threshold recommended for normal cellular activities. Wound-bed temperatures dropped on average 2.7°C when cleansed with room temperature normal saline. The degree of temperature loss did not correlate to the time taken to change the dressing or the wound size.

On average, dressing products covering a wound took 23 minutes to return to the pre-procedural temperature. Coupled with what is known about the time required by hypothermic cells to resume mitotic division,¹ it has been suggested that cellular activity within a wound should return within three to four hours of a dressing change. Ensuring that dressing change frequency accommodates this recovery time would appear to be one method of maintaining wound-bed temperature.

A number of further studies are recommended. The influence of core body temperature on the degree of wound-bed temperature loss needs further examination. If, as this study suggests, temperature loss is limited to the temperature of underlying tissues, then interventions aimed at increasing the temperature of underlying tissue may increase healing.

Equally, the effect that a 2.7°C temperature loss has on wound healing needs to be examined. If, as *in vitro* studies suggest, temperatures below 33°C delay wound healing, then quantifying the influence of dressing changes on the histology of wound healing will inform decisions about dressing frequencies and help to maximise healing.

In a climate of increasing costs, methods for preventing episodic cooling of the wound during dressing change procedures require further attention. ■

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