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Increased wound pH as an indicator of local wound infection in second degree burns

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ABSTRACT

Wound pH affects a number of important factors in wound healing. It is known that the pH of the skin surface of healthy adults and children is 4.2–5.6 and that it decreases with the lapse of epithelialization. We measured the pH of the exudates from second degree burns in 26 cases. Among these, local burn wound infection developed in 6 cases. The causative organisms were *Staphylococcus aureus* in 2 cases and *Staphylococcus epidermidis* in 4 cases. The maximum pH value measured was 10.0 and the minimum was 5.0 for all samples. There were no differences in the initial measurements of pH between the non-infected cases and the local-infected cases. In cases of local infection, the pH rose prior to the onset of clinical signs of local burn infection. By consecutive measurement of pH, early detection of local wound infection can be achieved and this is very beneficial in clinical practice. Moreover, measurement is very easy and results are available immediately. In conclusion, consecutive pH measurement of exudates is considered to be a useful indicator in the treatment of second degree burns.

1. Introduction

The pH of the skin surface of adults and healthy children is 4.2–5.6, kept slightly acidic by acidic keratin sebum and eccrine secretions to form a film on the surface of the stratum corneum. If the pH is increased from normal baseline, the number of bacteria on the skin surface is increased, the types of bacteria change, and transepidermal water loss increases [1]. Therefore, abnormal pH of the skin surface causes the destruction of the skin barrier function.

However, apparently no study has yet been published to describe the pH values of wound after trauma or burns. This report follows the changes in pH of wound exudates over time for a series of 26 cases of second degree burn.

2. Materials and methods

This study took place from September 2013 to February 2014 at the outpatient clinic of the Department of Plastic and Reconstructive Surgery, Tokyo Medical University Hospital. Inclusion criteria included having a second degree burn and a preserved blister film at the start of the study. Pediatric cases under the age of 12, and infected cases at the initial visit were excluded. There were two outcomes, namely, wound

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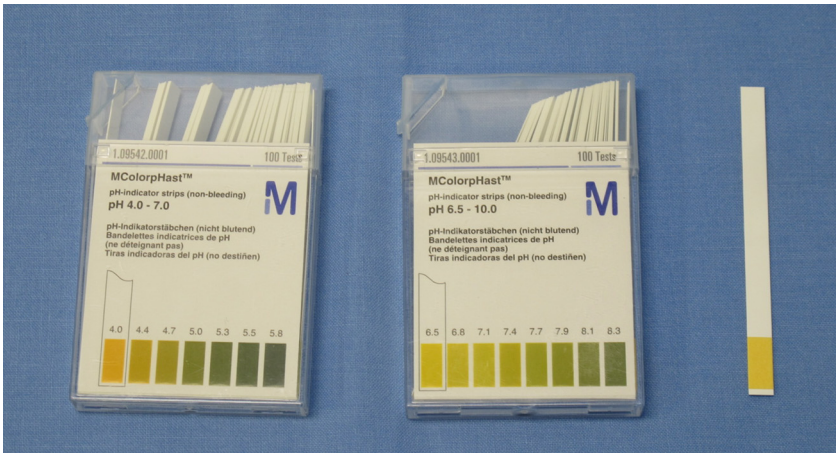

Fig. 1 – pH indicator strips. The pH indicator strips used in this study were MColorpHast™ (Merck KGaA, Darmstadt, Germany; pH 4.0–7.0 and 6.5–10.0).

epithelialization without infection or development of local wound infection. Local wound infection was defined as a burn wound with clinical signs of pain, erythema, edema, heat, and purulence.

2.1. *Measurement of pH*

The pH of the exudate was recorded using pH indicator strips (MColorpHast™; Merck KGaA, Darmstadt, Germany) and could be measured to one decimal point accuracy (Fig. 1). First, the pH of the blister fluid during the initial visit was measured. After initial measurement, the blister film was removed and the wound was rinsed with saline solution, and transparent hydrogel dressing (Viewgel®; Taiho Pharmaceutical Co., Ltd., Japan) was applied in all cases to standardize the treatment regimen. Viewgel® is composed of polyethylene liner and hydrogel absorbent. Depending on the clinical need, the dressing was changed 2 or 3 times a week. At the time of the dressing change, the pH of the exudate that had accumulated under the Viewgel® was measured. After the pH measurement, the wound was rinsed with saline solution and the dressing was reapplied. Wound swab sampling was performed at least once every week. The pH of the Viewgel® was 4.0–7.0 and the pH of the saline solution was 4.5–8.5.

Statistical analysis was performed using the Student *t*-test and a *p*-value <0.05 was considered to indicate a statistically significant difference.

This study was conducted with the approval of the institutional review board.

3. Results

Table 1 shows the demographics of the 26 patients who were recruited between September 2013 and February 2014. The mean age was 46.0 years and 62% were male. All burned wound size was less than 2% TBSA.

The pH was measured a total of 103 times in these patients (mean, 4.0 times per patient; range 2–6 times). The pH at the initial visit was a mean of 8.55 and ranged from 6.5 to 9.0. During the study period, 9.0 was the maximum value of pH and 5.0 was the minimum value. Local wound infection occurred in 6 cases (23%). There were no differences in the initial pH between the non-infected cases and local-infected cases (Table 2).

Fig. 2 shows the time course of changes in pH values in the non-infected cases. The pH decreased along with epithelialization and there was a statistically significant decrease in pH value between the initial visit and the pH value at the final measurement just before epithelialization.

Fig. 3 shows the time course of changes in pH values in the local-infected cases. All 6 cases showed statistically significant increases in pH at the end of the study compared to the pH at the previous measurement ($p < 0.01$).

Clinical symptoms of local wound infection were not evident until the end of the study. It should be noted here that pH value was elevated before the clinical symptoms of infection occurred.

Table 1 – Patient demographics and pH values.

Mean age, years (range)	46.0 (20–72)
Male/female	16/10
Number of pH measurements: mean (range)	4.0 (2–6)
pH at initial visit: mean (range)	8.4 (6.5–9.0)
Maximum pH value during the study	9.0
Minimum pH value during the study	5.0

Table 2 – pH values with and without occurrence of infection.

Non-infected cases	20 (77%)
Number of measurements (range)	3.7 (2–5)
Initial visit pH (range)	8.6 (7.7–9.0)
Maximum pH value	9.0
Minimum pH value	5.0
Local-infected cases	6 (23%)
Number of measurements (range)	5.0 (3–6)
pH at initial visit: mean (range)	8.0 (6.5–9.0)
Maximum pH value	10.0
Minimum pH value	6.5