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Relationship between the cleaning frequency and healing time of pressure ulcers in elderly receiving home care: An observational pilot study

**Aims**: We investigated the relationship between the healing time of pressure ulcers and wound cleaning frequency among elderly individuals in home care settings.

**Methods**: This study was a prospective cohort study conducted from April 2018 to March 2019. The subjects were 12 patients who utilized home-visit nursing services, had NPUAP classification stage 2 pressure ulcers, and had their wounds cleaned at least twice a week. Wound cleaning was performed using tap water and a weakly acidic cleanser. Participants were divided into two groups by the frequency of wound cleaning (twice weekly vs. three or more times weekly), and the duration of pressure ulcer healing and the increase in care insurance premiums were compared in both groups.

**Results**: The mean healing period of pressure ulcers cleaned three or more times per week ( $65.3 \pm 24.8$  days) was significantly shorter than that of ulcers cleaned twice a week ( $102.6 \pm 19.2$  days). Furthermore, the increase in care insurance premiums due to care for pressure ulcers cleaned three or more times per week ( $\$122,497 \pm 105,660$  per half-year) was significantly lower than that due to care for ulcers cleaned twice a week ( $\$238,116 \pm 60,428$  per half-year).

**Conclusions**: Our results suggest that frequent cleaning of pressure ulcers by personnel of specialized occupations in home care settings not only shorten the healing period of pressure ulcers but also reduces care insurance premiums for pressure ulcer care.

Keywords: pressure ulcer, home-visit nursing services, wound irrigation, elderly, nursing care

#### **Key Points**

This prospective observational study aimed to determine whether wound cleaning frequency affects healing time among elderly individuals in home care settings. The mean healing period of pressure ulcers cleaned three or more times per week by both nurses and physical therapists was significantly shorter than that of ulcers cleaned twice a week only by nurses. More frequent wound cleaning was also cost-effective, with significantly lower increases in long-term care insurance premiums for pressure ulcers cleaned three or more times per week by both nurses and physical therapists compare to the care for ulcers cleaned twice a week only by nurses. Frequent cleaning of pressure ulcers by specialized personnel in home care settings shortens the healing period and reduces long-term care insurance premiums.

## **Reflective Questions**

Why is wound cleaning important for pressure ulcer healing in home care settings?

Does the frequency of wound cleaning by medical professionals affect pressure ulcer healing in a home care setting?

What is the economic effect of frequent wound cleaning by medical professionals in home care settings?

## Introduction

Pressure ulcer is a localized injury to the skin and/or underlying tissue, usually over a bony prominence, resulting from sustained pressure and shear,<sup>1</sup> which increases the medical burden of the aging population worldwide. There are reportedly 3 million people with pressure ulcers in the United States; moreover, 5–15% of hospitalized patients have pressure ulcers.<sup>2</sup> Systematic reviews have further reported a high incidence of pressure ulcer management in Europe, Asia, and the United States. <sup>3</sup> Similarly, the prevalence of pressure ulcers in Japan is high; a cross-sectional study in a rural Japanese community found that pressure ulcers occur in 2.03% of individuals aged >65 years and in 4.46% of those aged >80 years.<sup>4</sup> Moreover, pressure ulcers are observed in various care environments in Japan, where their prevalence (according to the 4<sup>th</sup> report of The Japanese Society for Pressure Ulcers Homecare Committee conducted in the fiscal year 2016) is 2.13% in hospitals, 1.07% in long-term care health facilities, and 1.68% in home dwellers who use home-visit nursing services.<sup>5</sup> In fast-aging societies such as that in Japan, the treatment of pressure ulcers is becoming more urgent than ever before. The prolong of pressure ulcer healing by incorrect care imposes a tremendous burden on patients, the families, and care workers not only physicaly but also psychologically and economically.<sup>6</sup> Therefore, in addition to epidemiological studies of pressure ulcers, effective and efficient prevention and treatment of such lesions are needed; however, little information to that effect is currently available.

Wound cleaning is recommended and conducted in clinical condition as a standard care as well as nutrition management, interface pressure relief, repositioning, and topical therapy.<sup>1</sup> The "Prevention and Treatment of Pressure Ulcers/Injuries: Quick Reference Guide 2019" assigned a "weak positive: Probably do it" recommendation (strength of evidence category B1) for cleaning pressure ulcers.<sup>1</sup> suggesting the growing recognition for the clinical importance of wound cleaning. As for the protocol in wound cleaning, wound cleaning by medical profession is recommended to remove components that prevent healing such as exudate, pus, necrotic tissue, residual drug, and bacteria.<sup>7</sup> Especially, bacterial count on pressure ulcers was reported to be statistically reduced by wound cleaning.<sup>8</sup> Hence, frequent wound cleaning by medical profession could be favorable intervention to diminish the wound contamination as well as the pressure ulcer healing. However, the frequency of wound cleaning is determined by the expert opinion or just depending on the times of wound dressing change not expecting the therapeutic effect by wound cleaning using particular solutions or techniques were performed;<sup>10-12</sup> however, no published study evaluated the effect of cleaning frequency on the healing period in pressure ulcers.

A home-visit nursing station is a facility that provides nursing and care services to those with diseases or disabilities living at home to promote their independence and help with their recuperation. It is staffed by several medical professionals, including nurses and PTs, as well as caregivers. Individuals who receive care services from home-visit nursing stations in Japan should have their pressure ulcers cleaned by visiting nurses or their family members. Japanese medical and care insurance allows nurses to make frequent visits to treat "pressure ulcers beyond the dermis" according to current instructions. However, for treating pressure ulcers that remain in the dermis (National Pressure Injury Advisory Panel [NPUAP] classification stage 2 or lower), frequent treatment by home-visit nurses can be difficult owing to caps set in Japanese medical and care insurance. According to the 4th report of The Japanese Society for Pressure Ulcers Homecare Committee conducted in the fiscal year 2016,<sup>5</sup> 50.6% of these ulcers were of NPUAP classification stage 2 or lower. Therefore, there appear to be many home dwellers with pressure ulcers that are not frequently cleaned by homevisit nurses, which in turn may delay the healing of these lesions. Meanwhile, physical therapists (PTs) can also conduct wound cleaning as a medical staff, and Japanese medical and care insurance allows the home visit. Therefore, the frequency of wound cleaning can be increased via the participation of physical therapist, and this system can be an experimental model to compare the effects of wound cleaning frequencies. In the present study, we conducted a single-center prospective observational study at a home-visit nursing station where PTs can join the home care to increase the frequency of wound cleaning as a pilot study to obtain preliminary evidence needed to develop a large-scale multicenter trial. The goal was to investigate the relationship between the frequency of cleaning and the pressure ulcer healing period and propose the importance of frequent wound cleaning by medical staffs in home care setting.

### **Materials and Methods**

#### Study design and setting

A single-center, prospective cohort pilot study was conducted to investigate the effects of cleaning frequency on the early healing of pressure ulcers. This study was performed in a home-visit nursing station in Hyogo, Japan, between April 2018 and March 2019.

#### Population and sample

We enrolled 26 individuals with pressure ulcers receiving services from the home-visit nursing station. Individuals who had NPUAP classification stage 2 pressure ulcers, and had their wounds cleaned at least twice a week by nurses or PTs dispatched from the station were included. The participants were assigned to two groups, depending on the number of pressure ulcer cleaning sessions they received each week (2 times vs. ≥3 times per week). The 2 times group included individuals whose pressure ulcers had been cleaned twice a week by homevisit nurses, while the  $\geq$ 3 times group included the individuals who had received additional wound cleaning at least once a week by home-visit PTs in addition to the cleanings performed by the nurses. This allocation was dependent on the care plans, plans for the content, dates and times of services available under the long-term care insurance coordinated for each individual, made by the care manager. That is, participants with pressure ulcers whose care plan needed for physical therapy were allocated to the  $\geq 3$  times group, as this allowed for additional cleaning by the PTs, while those whose care plan did not need for physical therapy were allocated to the 2 times group. Participants who experienced changes in general condition or whose methods used for management of pressure ulcers were modified during the observational period were excluded. Of the 26 individuals enrolled, 12 completed the follow-up for this study. Of the 14 excluded individuals, 9 had NPUAP classification stage 1 pressure ulcers, 2 had stage 3 ulcers, and the remaining 3 met the inclusion criteria but did not complete the follow-up owing to changes in general condition, nutritional management, or wound care management. Twelve individuals enrolled were divided into the two groups according to the number of cleanings; 5 individuals were assigned to the 2 times group and the remaining 7 to the  $\geq$ 3 times group.

### Wound cleaning

In this study, participants' pressure ulcers were cleaned by nurses or PTs dispatched from the station in addition to the participants' family. PTs who conducted wound wash in the present study were educated in the postgraduate training by Japanese Physical Therapy Association as well as by the Certified Nurses in Wound, Ostomy and Continence Nursing in Japan. Wound cleaning was performed using tap water and a commercially available and weakly acidic cleanser (Biore U, Kao, Tokyo, Japan) was used in this study.

Several studies have reported that the use of tap water for wound cleaning is comparable in safety and cleaning efficacy to sterile saline solution.<sup>13-15</sup> Therefore, in this study, tap water was used for cleaning because of its easy availability at home and cost effective. In addition, since using a cleanser shortened the healing time of NPUAP stage 2 pressure ulcers compared to saline solution,<sup>16</sup> a cleanser was used for wound cleaning in this

study. Previous studies have reported that the pH of cleanser should avoid alkalinity<sup>17</sup> and that wound cleaning with weak acidic cleanser contributes to keeping the wound clean.<sup>18</sup> Therefore, a weakly acidic cleanser (BioreU, Kao, Tokyo, Japan) was used in this study.

## Data collection

We collected information on the age, sex, height, body weight, body mass index, and the number of home visits by nurses and PTs from the medical records of patients with pressure ulcers during the observation period. Care level at the beginning of observation was evaluated for each subject, as determined by the Certification Committee of Needed Long-Term Care in Japan.<sup>19</sup> The degree of independence (degree of "bedriddenness") of the disabled elderly in performing activities of daily living was also evaluated for each subject at the beginning of observation. The degree of bedriddenness comprises criteria developed by the Ministry of Health and Welfare, now Ministry of Health, Labour and Welfare, in Japan.<sup>20</sup> DESIGN-R, a clinical wound evaluation scale for the chronological monitoring of individual pressure ulcers developed by the Scientific Education Committee of the Japanese Society of Pressure Ulcers (JSPU),<sup>21, 22</sup> was used to score the severity of the ulcers at the start of the follow-up period. The DESIGN-R reflects the following seven conditions of pressure ulcers: Depth, Exudate, Size, Inflammation/infection, Granulation tissue, Necrotic tissue, and Pockets.<sup>23</sup> Serum albumin levels were used as an indicator of the nutritional status and were obtained from biochemical data collected at the start of follow-up. The healing periods were calculated from the start of follow-up until the ulcer healed, with the number of days it took to heal compared between factors. Moreover, we investigated the increase in care insurance premiums associated with a greater number of home-visit services due to pressure ulcer care in order to compare financial burdens before and after the development of pressure ulcers. The effects of the number of wound cleaning sessions on the pressure ulcer healing periods and the increase in care insurance premiums associated with pressure ulcers care were examined.

#### Statistical analysis

Data are expressed as means  $\pm$  standard deviations. Statistical analysis was performed using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan).<sup>24</sup> Significant differences in the healing period as a function of sex, underlying diseases, care level, degree of bedriddenness, body location of pressure ulcers, and the number of wound cleaning sessions were analyzed using unpaired Student's *t*-tests. Pearson r correlation

coefficients were calculated between healing period and age, height, body weight, body mass index, albumin level, and total DESIGN-R score. Significant differences in cleaning frequencies (2 times vs.  $\geq$ 3 times) categorized by age, height, body weight, body mass index, albumin level, and total DESIGN-R score were analyzed using unpaired Student's *t*-tests. Differences categorized by sex, underlying diseases, care level, degree of bedriddenness, and body location of pressure ulcers were analyzed using chi-square tests. The healing rates of pressure ulcers categorized by degree of bedriddenness or cleaning frequency were analyzed using Kaplan-Meier curves and compared with log-rank tests. Differences in the amounts of LTCI premium increases due to home-visit pressure ulcer care were analyzed using unpaired Student's *t*-tests. Normality of distributions was confirmed via the Shapiro-Wilk test for all data. *P*-values <0.05 were considered reflective of statistical significance.

### Ethical considerations

The present study complied with the principles of the Declaration of Helsinki regarding investigations in human subjects and was approved by the XXX University (approval number XXX). Written informed consent was obtained from each patient before HVNS intervention.

### Results

The characteristics of the study participants are listed in Table 1. The participants included 4 men and 8 women aged  $78.2 \pm 5.8$  years. The underlying conditions of the participants were cerebral infarction sequelae (n = 5), Parkinson's disease (n = 3), lumbar spine compression fractures (n = 2), and rheumatoid arthritis (n = 2). With respect to care, one individual required care level 3, three required care level 4, and the remaining eight required care level 5. All individuals were grade "C" in terms of their degree of bedriddenness (spending all day in bed and requiring assistance with toileting, eating, and changing clothes); five individuals were C1 (able to turn over on their own) and the remaining individuals were C2 (unable to turn over on own). The pressure ulcers were located on the sacral (n = 9), sciatic (n = 2), and thoracic (n = 1) regions. The total DESIGN-R score for each individual ranged from 5 to 12.

Comparison of the number of days to heal relative to each assessed parameter is shown in Table 2. The healing period of pressure ulcers in the  $\geq$ 3 times group was significantly shorter than that in the 2 times group (65.3 ± 24.8 vs. 102.6 ± 19.2 days, *P* < 0.01). No significant effect on the healing period was observed with other factors (Table 2).

Differences in the assessed parameters between different cleaning frequency groups are shown in Table 3. There were no significant differences between the two groups in age, sex, height, body weight, body mass index, serum albumin level, underlying disease, care level, body location of pressure ulcers, or total DESIGN-R score at the start of follow-up (Table 3). Although the degree of bedriddenness in the  $\geq$ 3 times group was significantly lower than that in the 2 times group (Table 3), this difference did not influence the healing period of pressure ulcers (log-rank *P* = 0.584; Fig. 1). The benefit of a shorter healing period in the  $\geq$ 3 times group was also confirmed via Kaplan-Meier and log-rank analyses, indicating a significant acceleration of wound healing following additional cleaning by PTs (log-rank *P* = 0.00832; Fig. 2).

Finally, the increase in the LTCI premiums due to care for pressure ulcers in the  $\geq 3$  times group was significantly lower than in the 2 times group ( $\$122,497 \pm 105,660$  vs.  $\$238,116 \pm 60,428, P < 0.05$ ).

### Discussion

This study found that individuals in the  $\geq 3$  times group experienced significantly faster healing than did those in the 2 times group. In contrast, there were no differences between the two groups in the total DESIGN-R score or individual characteristics. These results indicate that a higher frequency of cleaning by medical staff leads to a shorter healing period.

In the present study, the participants' pressure ulcers had a score of 1 on the DESING I: inflammation/infection item (a situation where the wound surface had signs of inflammation). Although we failed to quantify the number of bacteria in this study, it is possible that the bacterial activity affected the wound healing because of the inflammatory condition. Pressure ulcers with inflammation are recommended to be cleaned frequently with a large amount of water.<sup>25</sup> As for the effect of cleaning on bacteria involved in wound inflammation, wound cleansing, whether using saline<sup>8</sup> or cleanser,<sup>18</sup> reduces the number of bacteria on the pressure ulcers, but the effect returns to the pre-cleaning state in 24 hours. Therefore, even when a cleanser is used, shortening the cleaning interval is likely to reduce the bacterial load on the wound. Therefore, the  $\geq$ 3 times group, in which the wounds were cleaned frequently by medical staffs in addition to the family members, is presumed to have reduced bacterial growth in the wound and accelerated the wound healing. In order to clarify the mechanism by which frequent cleaning promotes wound healing, the effect of cleaning frequency on the bacterial count of pressure ulcers should be examined in the future.

Furthermore, this study examined the increase in care insurance premiums over 6 months following home-visit services conducted for pressure ulcer care. The treatment of pressure ulcers accounts for 4% of

public health care costs in the United Kingdom, with 41% of these costs associated with nurse care.<sup>26</sup> Additionally, it has been reported that the cost of nursing care increases with the severity of the pressure ulcers,<sup>27</sup> and that, in Japan, having a pressure ulcer may result in an increase in medical economic loss.<sup>28</sup> Based on such previous findings, we predicted that the occurrence of pressure ulcers in home-care settings would increase the frequency of home-visit services for wound management. Surprisingly, however, our results showed that the total care insurance premium for the  $\geq$ 3 times group was approximately half of that for the 2 times group. This may be because pressure ulcers healed faster owing to additional cleaning by PTs, which in turn led to a shorter period of pressure ulcer treatment-specific home-visit services. Our data indicate that the participation of PTs in home-visit rehabilitation and wound-cleaning efforts for those with pressure ulcers can lead to a reduction in care insurance premiums.

In the present study, the degree of bedriddenness was associated with the frequency of pressure ulcer cleaning. Since additional cleaning was performed during the PT's home visit, it was posited that the degree of bedriddenness may influence the number of visits required by the PT, creating a confounding factor in terms of the number of wound cleanings performed. However, because the degree of bedriddenness did not affect the healing period of wounds, only the increased number of cleanings was associated with faster healing. As such, these data show that increasing the number of cleanings by multiple medical personnel promotes pressure ulcer wound healing among home dwellers regardless of their degree of bedriddenness.

This study was conducted as a pilot study for a future multicenter large-scale study and therefore has some limitations. Only univariate statistical analyses were performed owing to the small sample size of 12 individuals with pressure ulcers. Additionally, since this study examined the effect of frequency of wound cleaning on the healing period in stage 2 pressure ulcers and could not examine the effect on slough and biofilm, the results cannot be generalized to other stages of pressure ulcers. In addition, since additional cleanings were performed only by home-visit PTs, we did not determine the effects of additional wound cleaning by home-visit nurses.

### Conclusions

Our study findings suggest that the pressure ulcer healing period may be shortened by frequent cleaning performed by medical staff among elderly individuals in home-care settings. As such, medical staff who provide home-visit services need to actively participate in wound cleaning. Based on the results of this pilot study, further larger multicenter studies are expected to be conducted for the evaluation of the effect of cleaning frequency on the healing period of pressure ulcers in home-care settings.

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# **Figure Legends**

Fig. 1 Comparison of the number of days required for healing between participants with degree of bedriddenness of C1 versus C2. C1, able to turn over on their own; C2, unable to turn over on ownFig. 2 Comparison of the number of days required for healing according to cleaning frequency





| Patient | Sex    | Age<br>(years) | BMI<br>(kg/m <sup>2</sup> ) | Albumin<br>(g/dL) | Underlying<br>disease | Care<br>level | Degree of<br>bedriddenness | Location<br>of pressure<br>ulcers | Total DESIGN-R<br>score | Number<br>of<br>nurse's<br>visits | Number<br>of PT's<br>visits |
|---------|--------|----------------|-----------------------------|-------------------|-----------------------|---------------|----------------------------|-----------------------------------|-------------------------|-----------------------------------|-----------------------------|
| 1       | Female | 72             | 16.9                        | 3.3               | Rheumatoid            | 3             | C1                         | Ischium                           | 5                       | 2                                 | 0                           |
|         |        |                |                             |                   | arthritis             |               |                            |                                   | (d2/e1s3i1g0n0)         |                                   |                             |
| 2       | Male   | 84             | 16.7                        | 3.1               | Parkinson's           | 5             | C2                         | Sacrum                            | 5                       | 2                                 | 1                           |
|         |        |                |                             |                   | disease               |               |                            |                                   | (d2/e1s3i1g0n0)         |                                   |                             |
| 3       | Male   | 71             | 17.4                        | 3.1               | Sequelae of           | 5             | C1                         | Sacrum                            | 5                       | 2                                 | 0                           |
|         |        |                |                             |                   | cerebral              |               |                            |                                   | (d2/e1s3i1g0n0)         |                                   |                             |
|         |        |                |                             |                   | infarction            |               |                            |                                   |                         |                                   |                             |
| 4       | Female | 72             | 17.1                        | 3.4               | Lumbar                | 5             | C2                         | Sacrum                            | 8                       | 2                                 | 2                           |
|         |        |                |                             |                   | compression           |               |                            |                                   | (d2/e1s6i1g0n0)         |                                   |                             |
|         |        |                |                             |                   | fracture              |               |                            |                                   |                         |                                   |                             |
| 5       | Female | 81             | 14.6                        | 2.8               | Parkinson's           | 5             | C2                         | Sacrum                            | 12                      | 2                                 | 2                           |
|         |        |                |                             |                   | disease               |               |                            |                                   | (d2/e3s8i1g0n0)         |                                   |                             |

## Table 1 Characteristics of the 12 study participants

| 6  | Male   | 80 | 17.4 | 3.0 | Parkinson's | 4 | C1 | Sacrum    | 5               | 2 | 1 |
|----|--------|----|------|-----|-------------|---|----|-----------|-----------------|---|---|
|    |        |    |      |     | disease     |   |    |           | (d2/e1s3i1g0n0) |   |   |
| 7  | Female | 73 | 16.4 | 2.9 | Rheumatoid  | 5 | C2 | Sacrum    | 8               | 2 | 0 |
|    |        |    |      |     | arthritis   |   |    |           | (d2/e1s6i1g0n0) |   |   |
| 8  | Female | 86 | 17.5 | 3.4 | Sequelae of | 4 | C1 | Sacrum    | 7               | 2 | 0 |
|    |        |    |      |     | cerebral    |   |    |           | (d2/e3s3i1g0n0) |   |   |
|    |        |    |      |     | infarction  |   |    |           |                 |   |   |
| 9  | Female | 82 | 15.8 | 3.0 | Sequelae of | 5 | C2 | Sacrum    | 8               | 2 | 1 |
|    |        |    |      |     | cerebral    |   |    |           | (d2/e1s6i1g0n0) |   |   |
|    |        |    |      |     | infarction  |   |    |           |                 |   |   |
| 10 | Female | 87 | 15.1 | 2.9 | Lumbar      | 5 | C2 | Sacrum    | 10              | 2 | 1 |
|    |        |    |      |     | compression |   |    |           | (d2/e3s6i1g0n0) |   |   |
|    |        |    |      |     | fracture    |   |    |           |                 |   |   |
| 11 | Male   | 76 | 18.0 | 3.1 | Sequelae of | 5 | C2 | Thoracic  | 10              | 2 | 2 |
|    |        |    |      |     | cerebral    |   |    | vertebrae | (d2/e3s6i1g0n0) |   |   |
|    |        |    |      |     | infarction  |   |    |           |                 |   |   |

| 12 | Female | 74 | 17.1 | 3.0 | Sequelae of | 4 | C1 | Ischium | 5               | 2 | 0 |
|----|--------|----|------|-----|-------------|---|----|---------|-----------------|---|---|
|    |        |    |      |     | cerebral    |   |    |         | (d2/e1s3i1g0n0) |   |   |
|    |        |    |      |     | infarction  |   |    |         |                 |   |   |
|    |        |    |      |     |             |   |    |         |                 |   |   |

BMI, body mass index; PT, physical therapist; C1: able to turn over on their own; C2: unable to turn over on own

| Factor  | Days to heal (days)             | <i>P</i> -value |
|---|---------------------------------|-----------------|
| Age (years)   | r = -0.30                       | N.S.            |
| Sex (male vs. female)                                     | $73.0\pm 37.0/82.5\pm 27.9$     | N.S.            |
| Height (cm)   | r = -0.30                       | N.S.            |
| Body weight (kg)  | r = -0.36                       | N.S.            |
| Body mass index (kg/m <sup>2</sup> )                      | r = -0,17                       | N.S.            |
| Albumin level (g/dL)                                      | r = -0.29                       | N.S.            |
| Underlying disease (cerebral infarction vs. other)        | $87.8 \pm 21.0 / 73.3 \pm 35.2$ | N.S.            |
| Care level (5 vs. 3 and 4)                                | $81.0\pm 35.3/76.0\pm 18.5$     | N.S.            |
| Degree of bedriddenness (C1 vs. C2)                       | $85.6\pm26.8/74.9\pm33.2$       | N.S.            |
| Body location of pressure ulcers (sacrum vs. other)       | $82.0\pm 32.1/74.0\pm 28.5$     | N.S.            |
| Total DEISGN-R score                                      | r = -0.01                       | N.S.            |
| Number of cleanings per week (2 times vs. $\geq$ 3 times) | $102.6 \pm 19.2/65.3 \pm 24.8$  | < 0.01          |

Table 2 Comparison of the number of days to heal for each factor

Values are presented as means  $\pm$  standard deviations or Pearson r correlation coefficients. Differences in the number of days to heal by the sex, underlying disease, care level, degree of bedriddenness, body location of pressure ulcers, and the number of cleanings per week were analyzed using unpaired Student's *t*-tests. Relationships between healing period and age, height, body weight, body mass index, albumin level, and total DESIGN-R score were analyzed using Pearson r correlations.

N.S., not significant.

C1: able to turn over on their own; C2: unable to turn over on own

|                                      | Number of wound cleanings pe |                |                 |
|--------------------------------------|------------------------------|----------------|-----------------|
| Factor                               | 2 times                      | >3 times       | <i>P</i> -value |
|                                      | 2 times                      |                |                 |
| Age (years)                          | $75.2 \pm 6.4$               | $80.3 \pm 5.0$ | N.S.            |
| Sex (male/female)                    | 1/4                          | 3/4            | N.S.            |
| Height (cm)                          | $152.2 \pm 4.3$              | $157.0\pm6.0$  | N.S.            |
| Body weight (kg)                     | $39.6 \pm 3.0$               | $40.6\pm5.5$   | N.S.            |
| Body mass index (kg/m <sup>2</sup> ) | $17.1 \pm 0.4$               | $16.4 \pm 1.3$ | N.S.            |
| Albumin level (g/dL)                 | 3.1 ± 0.2                    | $3.0\pm0.2$    | N.S.            |
| Underlying disease (cerebral         | 3/2                          | 2/5            | N.S.            |
| infarction/other)                    |                              |                |                 |
| Care level (5/3 and 4)               | 4/1                          | 4/3            | N.S.            |
| Degree of bedriddenness (C1/C2)      | 4/1                          | 1/6            | < 0.01          |
| Body location of pressure ulcers     | 3/2                          | 5/2            | N.S.            |
| (sacrum/other)                       |                              |                |                 |
| Total DESIGN-R score                 | $6.0 \pm 1.4$                | 8.3 ± 2.6      | N.S.            |

Table 3 Differences in assessed parameters between different cleaning frequencies

Values are presented as means ± standard deviations or the number. Age, height, body weight, body mass index, albumin level, and total DESIGN-R score were analyzed using unpaired Student's *t*-tests. Sex, underlying disease, care level, degree of bedriddenness, and body location of pressure ulcers were analyzed using chi-square tests. N.S., not significant.

C1: able to turn over on their own; C2: unable to turn over on own