American Journal of Infection Control 47 (2019) 811–815

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

Effects of disposable bath and towel bath on the transition of resident skin bacteria, water content of the stratum corneum, and relaxation

Chiharu Matsumoto RN, PhD [a,*], Kimiyo Nanke RN, MSN [a], Saori Furumura RN [b], Misao Arimatsu RN, PhD [c], Miki Fukuyama RN, PhD [a], Hitomi Maeda RN, PhD [a]

[a] Department of Nursing, Faculty of Life Sciences, Kumamoto University, Kumamoto, Japan
[b] Graduate School of Health Sciences, School of Health Sciences, Kumamoto University, Kumamoto, Japan
[c] Department of Nursing, Faculty of Nursing and Nutrition, Kagoshima Immaculate Heart University, Kagoshima, Japan

Key Words:
Disposable towel
Skin hydration
Comfort
Profile of Mood States Second Edition (POMS 2) short form

Background: Bed bath in daily nursing care is crucial for cleaning and moisturizing patients' skin. The purpose of this study was to compare the effectiveness of cleaning and level of comfort of towel and disposable baths. The 2 methods were evaluated based on measurements of the transition of resident skin bacteria, stratum corneum water content, transepidermal water loss, and perceived relaxation levels.

Methods: Twenty-six healthy women aged 65-90 years participated in this study and received disposable and towel baths. We measured 4 indicators before and after bathing. The participants' relaxation levels were measured by the Japanese adult version of the Profile of Mood States Second Edition short form.

Results: Both disposable and towel baths significantly decreased resident skin bacteria. Disposable bath also significantly reduced *Staphylococcus aureus* and effectively maintained the water content of the stratum corneum. Furthermore, disposable bath was as effective as towel bath at contributing to participants' relaxation levels.

Conclusions: This study suggested that using a disposable bath for daily cleaning of patients' skin is more comfortable and effective than using a towel bath.

Traditionally, bed baths in Japanese hospitals are administered either with linen towels that are heated with electric steam warmers or linen towels dampened in basins of hot water. These methods do not necessarily use soap or moisturizing agents. For intensive care unit (ICU) patients, skin cleanser is most often used to prevent infection and enhance skin hydration, but its use depends on the hospital. ICU patients were significantly less likely to acquire a bloodstream infection (BSI)[1,2] when 2% chlorhexidine gluconate (CHG)–impregnated linen towels were used for their daily baths. The Centers for Disease Control and Prevention's report titled "Guidelines for the prevention of intravascular catheter-related infections" includes a category II recommendation that strongly encourages the use of 2% CHG-impregnated towels for daily skin bathing to reduce the development of catheter-related BSI.[3] The Centers for Disease Control and Prevention also stated that the causes of BSI include coagulase-negative staphylococci and *Staphylococcus aureus*.[4-6]

As a result of rapid aging in Japan, there are more elderly patients who require advanced medical treatment for serious diseases.[7] Xerosis is present in 56% of the population aged >65 years and is more prevalent in women and significantly associated with older age, itchiness during sweating, history of dry skin, and history of atopic dermatitis.[6] Elderly patients tend to have weakened immune systems and skin and are more likely to experience xerosis. Therefore, bed bath requires moisturizing care of the skin. It is crucial to examine the benefits of disposable bath—which is known to have strong antibacterial and moisture-retention abilities—in ensuring effective cleaning and moisturizing of the skin. Most patients are equally satisfied with both towel and disposable baths, but nurses prefer the latter.[8,9] There is no significant increase in bacteria after either towel bath or disposable bath. However, disposable bath is preferable for patients in critical care and long-term care settings because of the lower laundry costs and greater time effectiveness.[9] The purpose of

* Address correspondence to Chiharu Matsumoto, RN, PhD, Department of Nursing, Faculty of Life Sciences, Kumamoto University, 4-24-1 Kuhonji, Chuo-ku, Kumamoto 862-0976, Japan.
E-mail address: matsu-c@kumamoto-u.ac.jp (C. Matsumoto).
Funding/support: We acknowledge funding from Niti-On Co, Ltd.
Conflicts of interest: None to report.
Ethics approval and consent to participate: This study was approved by the institutional review board of Kumamoto University (approval no. 2188). The research outline, purpose, methods, and withdrawal were explained to each participant orally and in written documents. Informed consent was obtained in writing from each participant.

https://doi.org/10.1016/j.ajic.2018.12.008
0196-6553/

this study was to compare the effectiveness of cleaning and level of comfort of towel and disposable baths in terms of the removal of resident skin bacteria, retention of stratum corneum water content, minimization of transepidermal water loss, and relaxation of the patient.

METHODS

In this study, bed bath cleaning was evaluated by analyzing the transition of resident skin bacteria. Additionally, we investigated *S aureus*, which causes BSI. In terms of comfort, the bed bath was evaluated by measuring the stratum corneum water content, transepidermal water loss, relaxation levels of participants, and feel of the towel.

Twenty-six healthy women without allergy, skin, cardiac, or respiratory diseases (age range, 65-90 years) participated in this study. To ensure consistent measurement of resident skin bacteria and stratum corneum moisture content, we asked all participants to take a bath as usual the day before the experiment and to stop applying moisturizing agents on the neck and limbs.

Disposable towels, which are available in packets of 10 sheets and are designed for single use, were used for the experimental condition. The disposable baths were 33 × 22 cm and made of 50% polyester and 50% rayon, with components such as water, propylene glycol, benzyl alcohol, dehydroacetic acid, benzoic acid, sodium citrate, capryl/capramidopropyl betaine, polysorbate 20, PEG-12 dimethicone, dehydroacetate, and tetrasodium glutamate diacetate. The disposable baths were warmed in a microwave before use. Towels measuring 34 × 70 cm and made of 100% cotton were used for the control condition. The towel baths were new, presterilized with distilled water (they were not sterilized with cleaning agents, such as soap), and warmed in a microwave. The moisture content of the disposable baths and towel baths was approximately the same.

Interventions

The experiment was conducted between October 2, 2017, and December 5, 2017. The temperature of the laboratory was kept between 24°C and 25°C, with a humidity level between 40% and 60%. The participants were provided with both disposable and towel baths, and each bath interval was >3 days. The order of disposable and towel baths was randomly set by the permuted block method. The participants wore disposable gowns and short pants and underwent bed bath while sitting on a chair. Experimenters wearing sterilized gloves first applied a warm towel to the back of each participant's neck for 10 seconds and then bathed the participant in the following order: upper right limb, upper left limb, lower right limb, and lower left limb. One towel was used for wiping each part of the participant's body, and a total of 5 towels were used. The bathing procedures were standardized among the experimenters. For instance, in case of bed bath of the upper limbs, experimenters used 1 towel and moved the towel back and forth from the wrists to the upper arms 3 times at a rate of 1 movement per second, without lifting the towel away from the skin. In this manner, the number of wipes was determined by the part of the participant's body to be wiped off.

Data collection

Demographic survey included participants' ages and body mass index measurements. The resident skin bacteria of the upper and lower limbs were collected using a swab from a 2 × 2-cm area. The collection locations were 5 cm from the antecubital fossa of the inner forearm and 10 cm from the inguinal area of the medial thigh. The collection of data from right or left limb was determined randomly by the permuted block method. The resident skin bacteria were cultured on soybean casein digest agar plates (Atect Corp., Shiga, Japan), and *S aureus* were cultured on mannitol egg yolk polymyxin agar plates (Atect Corp. Shiga, Japan). The bacterial colonies were cultured for 48 hours at 35°C.

The water content of the stratum corneum and transepidermal water loss were determined right before bathing, right after bathing, and 10, 20, 30, and 60 minutes after bathing. The water content of the stratum corneum and transepidermal water loss were calculated using the mean of the measured values of 5 areas of the skin (2 × 10 cm) of the contralateral limbs that collected bacteria. The inner forearm and medial thigh were the locations measured in the upper and lower limbs, respectively, and were measured with the Corneometer CM 825 (Courage-Khazaka, Cologne, Germany).

The participants' relaxation levels were measured by the Japanese adult version of the Profile of Mood States Second Edition (POMS 2) short form. This questionnaire comprises 35 items and is designed to assess respondents' current affect and mood. It has been found to be particularly useful in measuring changes in affect and mood over time. Participants' relaxation levels were indicated by the total mood disturbance (TMD) score and 7 subscales: anger-hostility (AH), confusion-bewilderment (CB), depression-dejection (DD), fatigue-inertia (FI), tension-anxiety (TA), vigor-activity (VA), and friendliness (F). Data in this study were analyzed using T-scores. Participants answered the POMS 2 short form before and after bathing, which thereby assessed the mood transition from prebath to postbath as an indicator of relaxation level of participants. Furthermore, participants assessed the bath materials using a Likert-type scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The 7 survey items, taken from a study by Hancock et al,[10] included patient comfort, privacy, skin cleanliness, skin dryness, skin softness, relaxation level, and warmth.

Statistical analysis

Statistical data were analyzed using SPSS Statistics software version 20 (International Business Machines Corporation, Armonk, NY) for Windows (Microsoft Corporation, Redmond, WA). The effects of disposable and towel baths on the water content of the stratum corneum and transepidermal water loss were analyzed using t tests. Resident skin bacteria and POMS 2 scores were analyzed with the Wilcoxon rank-sum test.

RESULTS

The results of the demographic survey indicated that the average age of the participants was 73.1 years (SD, 4.8 years), and the average body mass index was 22.9 (SD, 3.4).

Transition of resident skin bacteria

Based on the data gathered from participants' upper and lower limbs, number of resident skin bacteria significantly decreased ($P < .05$) from prebath to postbath for both disposable and towel baths (Table 1). *S aureus* collected from the upper and lower limbs decreased from prebath to postbath in both disposable and towel baths (Table 1), but only disposable bath achieved statistical significance ($P < .05$). Number of resident skin bacteria and *S aureus* collected from upper and lower limbs was not significant between disposable bath prebath and towel bath prebath.

Water content of stratum corneum and transepidermal water loss

The results showed no significant difference between disposable and towel baths in terms of water content of the stratum corneum at pretreatment. However, overall, the water content of the stratum corneum was significantly higher after disposable bath in comparison

Table 1
Resident skin bacteria and *Staphylococcus aureus* for the upper and lower limbs

		Body parts	Prebath	Postbath	*P* value
Resident skin bacteria	Disposable	Upper limbs	19.0 (5.0-74.0)	3.0 (0.0-10.5)	.001
		Lower limbs	13.0 (5.5-49.0)	4.0 (1.0-14.5)	.016
	Towel	Upper limbs	12.0 (3.0-60.8)	6.5 (1.8-15.0)	.003
		Lower limbs	16.5 (6.3-46.3)	8.0 (1.0-28.5)	.010
S aureus	Disposable	Upper limbs	4.0 (1.0-18.0)	1.0 (0.0-4.5)	.024
		Lower limbs	8.0 (2.0-20.0)	1.0 (0.0-6.0)	.003
	Towel	Upper limbs	4.0 (0.0-13.0)	1.0 (1.0-5.5)	.115
		Lower limbs	2.0 (0.8-8.5)	1.0 (0.0-15.3)	.779

NOTE. Values are presented as median (interquartile range).
S, *Staphylococcus*.

with towel bath. In particular, there was a significant difference between disposable bath and towel bath in the upper limbs right after and 30 minutes after, whereas there was a significant difference between disposable bath and towel bath in the lower limbs right after, 10 minutes after, and 20 minutes after ($P < .05$) (Fig. 1 and 2). Regarding transepidermal water loss in the upper limbs, disposable bath showed a higher level of water loss 10, 30, and 60 minutes after (Fig 1). Regarding transepidermal water loss in the lower limbs, disposable bath showed a higher level of water loss at all other times (Fig 2). However, such differences were not statistically significant.

Participants' relaxation levels

The effect of disposable and towel baths on participants' affect and mood was investigated using the Japanese adult version of the POMS 2 short form. AH, CB, DD, FI, TA, and TMD all decreased from prebath to postbath when disposable bath was used, whereas VA and F increased from prebath to postbath. However, TMD was the only factor that achieved statistical significance ($P < .01$) (Fig 3).

Regarding towel bath, AH, CB, FI, TA, VA, and TMD all decreased postbath in comparison with prebath, whereas F was the only subscale that increased postbath in comparison with prebath. However, the only subscales that reached statistical significance were FI, TA, and F ($P < .05$) (Fig 4).

Evaluation of towel materials

The towel materials of disposable and towel baths were evaluated by the participants. In comparison with towel bath, disposable bath was rated higher in terms of skin softness, privacy, comfort, relaxation level, and skin cleanliness. Among these, all except skin cleanliness were statistically significant ($P < .01$) (Table 2).

DISCUSSION

The results of this study revealed that there was a significant decrease in resident skin bacteria from prebath to postbath when both disposable and towel baths were used. However, only disposable bath achieved a significant decrease in the number of *S aureus*

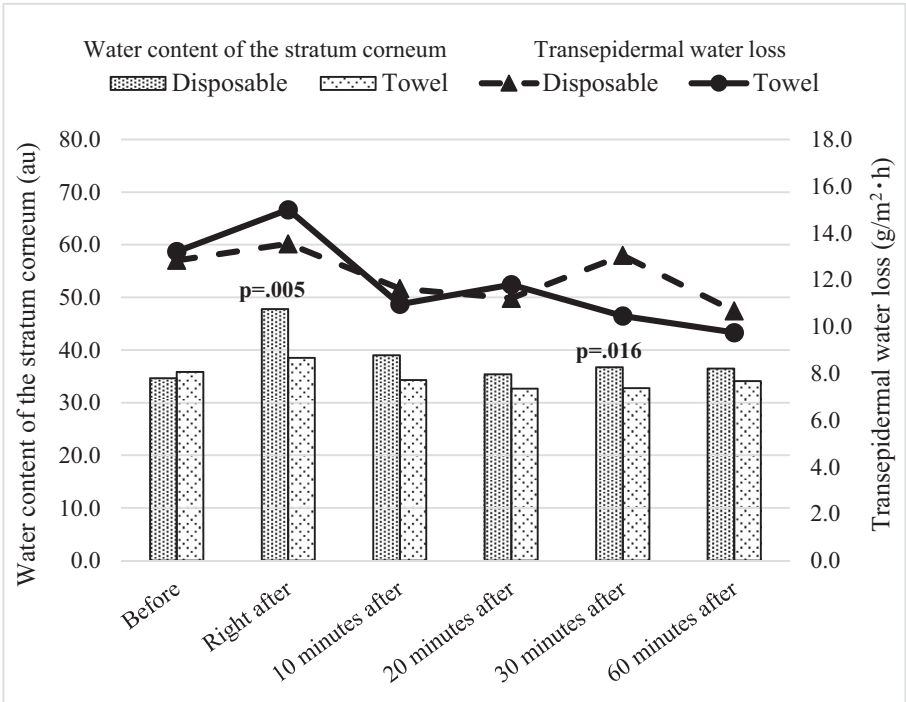

Fig 1. Water content of the stratum corneum and transepidermal water loss of the upper limbs.

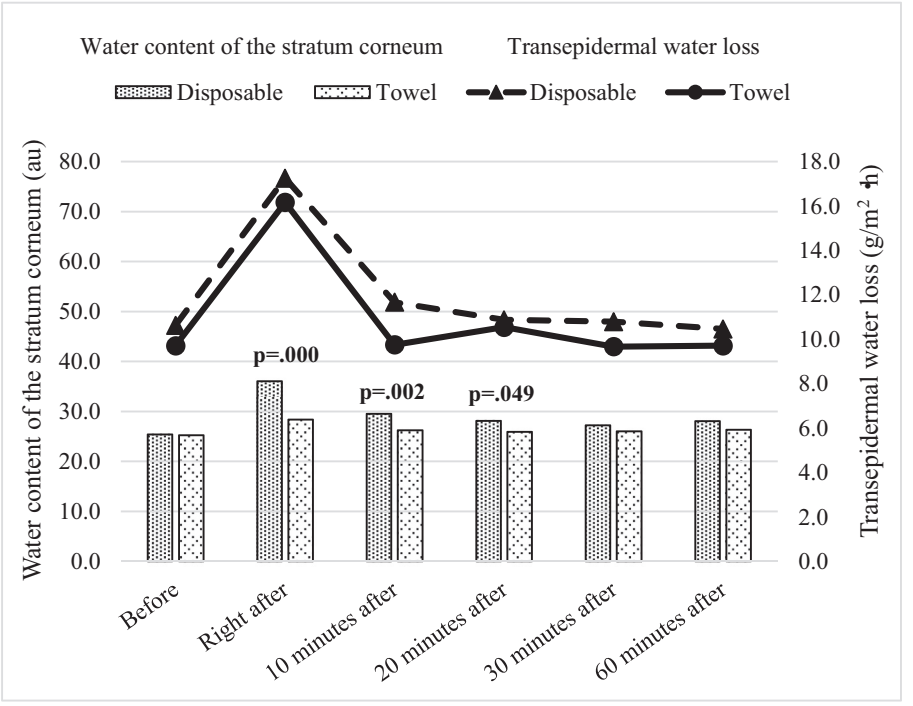

Fig 2. Water content of the stratum corneum and transepidermal water loss of the lower limbs.

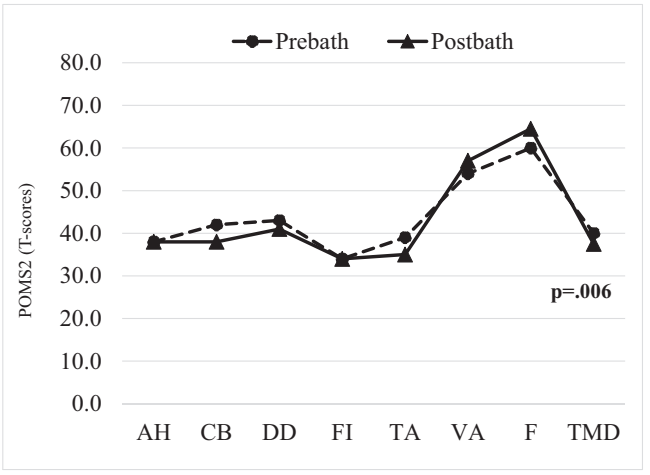

Fig 3. Effect of disposable bath on participants' affect and mood. *AH*, anger-hostility; *CB*, confusion-bewilderment; *DD*, depression-dejection; *F*, friendliness; *FI*, fatigue-inertia; *POMS 2*, Profile of Mood States Second Edition (short form); *TA*, tension-anxiety; *TMD*, total mood disturbance; *VA*, vigor-activity.

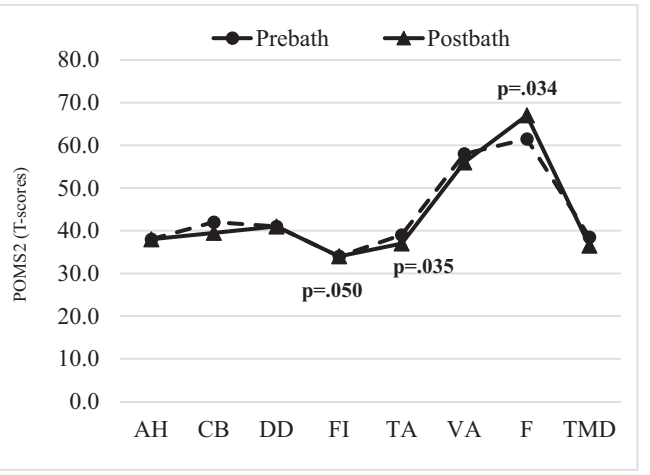

Fig 4. Effect of towel bath on participants' affect and mood. *AH*, anger-hostility; *CB*, confusion-bewilderment; *DD*, depression-dejection; *F*, friendliness; *FI*, fatigue-inertia; *POMS 2*, Profile of Mood States Second Edition (short form); *TA*, tension-anxiety; *TMD*, total mood disturbance; *VA*, vigor-activity.

Table 2
Evaluation of towel materials

	Skin softness	Warmth	Privacy	Comfort	Skin dryness	Relaxation level	Skin cleanliness
Disposable	4.0 (3.0-4.0)	4.0 (3.0-4.0)	4.0 (4.0-4.0)	4.0 (4.0-4.0)	4.0 (3.0-4.0)	4.0 (3.0-4.0)	4.0 (3.0-4.0)
Towel	2.5 (1.0-4.0)	4.0 (3.0-4.0)	3.0 (1.8-4.0)	3.0 (2.0-4.0)	4.0 (3.0-4.0)	3.0 (1.8-3.0)	3.0 (3.0-4.0)
P value	.001	.751	.001	.006	.812	.003	.41

NOTE. Values are presented as median (interquartile range).

from prebath to postbath. Many researchers recommend using 2% CHG-impregnated linen towels for bathing ICU patients.[11-13] Furthermore, cleaning inpatient medical units daily with CHG is effective in reducing hospital-associated methicillin-resistant *S aureus* and vancomycin-resistant *Enterococcus*.[14]

The ingredients in the disposal bath sheets used in the experiment had no bacteria-specific disinfection effect, but there was a certain degree of disinfection effect against resident skin bacteria. In this study, the numbers of *S aureus* in the lower limbs were reduced more by disposable bath than by towel bath. The organisms causing BSIs are usually coagulase-negative staphylococci, followed by *S aureus*.[4,5] This study suggested that the disposable bath is effective in nursing care cleaning of patients.

Moreover, disposable bath maintained the moisture level of the stratum corneum better than towel bath. Although the disposable baths contained alcohol, which includes volatile ingredients, there was no significant difference between disposable and towel baths in the level of transepidermal water loss. The disposable baths used in the present study were effective in maintaining skin hydration because they contained propylene glycol. Previous research has shown that the use of premoistened disposable wash gloves does not increase the risk of dry skin in comparison with traditional washing methods.[15] Given that it is necessary to administer moisturizing cream for hydration after towel bath, it is easier and more time effective to use premoistened disposable bath wipes. Furthermore, a study showed that xerosis was highly prevalent in patients aged >65 years,[6] and it suggested that disposable baths keep the skin of elderly patients cleaner by reducing *S aureus* and moisturizing at the same time compared to towel bath.

As for participants' responses to the Japanese adult version of the POMS 2 (short form) regarding the differences between disposable and towel baths, our results showed that there were significant reductions in FI and TA when using towel bath. However, TMD decreased significantly when using disposable bath compared to towel bath. Additionally, respondents rated towel materials for disposable bath better overall than materials for towel bath. According to researchers who conducted systematic literature reviews on the outcomes of disposable bath compared to traditional bed bath, disposable bath is not inferior to traditional bed bath.[16] Likewise, it is reported that patients were equally satisfied with both types of baths.[8] The experimenters noted smoothness when using disposable baths because the disposable towels used for the present study were larger and appropriately thick and included moisturizing ingredients. The improvement in participants' negative affect and mood using the disposable bath was assumed to be because of their greater satisfaction with the towel materials. Furthermore, this study found that disposable and towel baths provided similar relaxation levels to participants.

Limitations

This study has some limitations. First, this survey was done on the skin of only the subjects' limbs and not the back or abdomen. Further surveys are needed to determine the effects on the skin in these regions. Second, the subjects were only healthy women. Further surveys are needed in healthy men and the patients who need bed bath. Third, we investigated the influence on *S aureus*, which causes BSI. Although the ingredients in disposal bath sheets used in the experiment had a certain degree of disinfection effect against *S. aureus*, further surveys are needed to determine resident skin bacteria other than *S. aureu*.

CONCLUSIONS

In our study, the use of disposable bath showed great benefits for patients. Disposable bath significantly reduced *S aureus* and was effective in maintaining stratum corneum water content. Furthermore, disposable bath was as relaxing for participants as towel bath. This study suggested that disposable bath for daily cleaning of patients' skin is more comfortable and effective than towel bath.

Acknowledgments

We would like to thank the participants who cooperated and Dr. Ruriko Okada (Ehime associate professor, Prefectural University of Health Sciences), who supported this research.

References

1. Munoz-Price LS, Hota B, Stemer A, Weinstein RA. Prevention of bloodstream infections by use of daily chlorhexidine baths for patients at a long-term acute care hospital. Infect Control Hosp Epidemiol 2009;30:1031-5.
2. Popovich KJ, Hota B, Hayes R, Weinstein RA, Hayden MK. Effectiveness of routine patient cleansing with chlorhexidine gluconate for infection prevention in the medical intensive care unit. Infect Control Hosp Epidemiol 2009;30:959-63.
3. Centers for Disease Control and Prevention. Guidelines for the prevention of intravascular catheter-related infections. Available from: https://www.cdc.gov/infectioncontrol/guidelines/pdf/bsi/bsi-guidelines-H.pdf. Accessed February 6, 2018.
4. Wisplinghoff H, Bischoff T, Tallent SM, Seifert H, Wenzel RP, Edmond MB. Nosocomial bloodstream infections in US hospitals: analysis of 24,179 cases from a prospective nationwide surveillance study. Clin Infect Dis 2004;39:309-17.
5. Marra AR, Camargo LF, Pignatari AC, Sukiennik T, Behar PR, Medeiros EA, et al. Nosocomial bloodstream infections in Brazilian hospitals: analysis of 2,563 case from a prospective nationwide surveillance study. J Clin Microbiol 2011;49:1866-71.
6. Paul C, Maumus-Robert S, Mazereeuw-Hautier J, Guyen CN, Saudez X, Schmitt AM. Prevalence and risk factors for xerosis in the elderly: a cross-sectional epidemiological study in primary care. Dermatology 2011;223:260-5.
7. Statistical Handbook of Japan 2017. Available from: https://www.stat.go.jp/english/data/handbook/pdf/2017all.pdf. Accessed December 26, 2018.
8. Nøddeskou LH, Hemmingsen LE, Hørdam B. Elderly patients' and nurses' assessment of traditional bed bath compared to prepacked single units—randomised controlled trial. Scand J Caring Sci 2015;29:347-52.
9. Larson EL, Ciliberti T, Chantler C, Abraham J, Lazaro EM, Venturanza M, et al. Comparison of traditional and disposable bed baths in critically ill patients. Am J Crit Care 2004;13:235-41.
10. Hancock I, Bowman A, Prater D. 'The day of the soft towel?': comparison of the current bed-bathing method with the soft towel bed-bathing method. Int J Nurs Pract 2000;6:207-13.
11. Popovich KJ, Hota B, Hayes R, Weinstein RA, Hayden MK. Daily skin cleansing with chlorhexidine did not reduce the rate of central-line associated bloodstream infection in a surgical intensive care unit. Intensive Care Med 2010;36:854-8.
12. Afonso E, Blot K, Blot S. Prevention of hospital-acquired bloodstream infections through chlorhexidine gluconate–impregnated washcloth bathing in intensive care units: a systematic review and meta-analysis of randomized crossover trials. Euro Surveill 2016;21:3040.
13. Afonso E, Llauradó M, Gallart E. The value of chlorhexidine gluconate wipes and prepacked washcloths to prevent the spread of pathogens—a systematic review. Aust Crit Care 2013;26:158-66.
14. Lowe CF, Lloyd-Smith E, Sidhu B, Ritchie G, Sharma A, Jang W, et al. Reduction in hospital-associated methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant *Enterococcus* with daily chlorhexidine gluconate bathing for medical inpatients. Am J Infect Control 2017;45:255-9.
15. Gillis K, Tency I, Roelant E, Laureys S, Devriendt H. Skin hydration in nursing home residents using disposable bed baths. Geriatr Nurs 2016;37:175-9.
16. Groven FM, Zwakhalen SM, Odekerken-Schröder G, Joosten EJ, Hamers JP. How does washing without water perform compared to the traditional bed bath: a systematic review. BMC Geriatr 2017;17:31.