

Original Article

Problem Identification of and Proposed Device Modification for Bedside Hygiene Care

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Abstract

Background: Bedside hygiene care is a basic but important nursing intervention for bedridden patients.

Objective: We examined the circumstances of bedside hygiene care and the problems experienced by patients and nurses to proposed modification of bedside hygiene care devices.

Methodology: This cross-sectional nationwide study was conducted in 577 hospitals in Japan with 1,477 charge nurses chosen via stratified random sampling. Data were collected via a questionnaire on participants' experiences of washing patients' hair and bathing their hands, feet, and perineum. We also simulated a hair washing procedure to confirm and identify problems with hygiene care as reported in the questionnaire.

Results: Almost half of participants (49.7%) felt dissatisfied with their own bedside hygiene care. For hair washing, we observed significant difference between dissatisfaction and problems such as "uncomfortable positions are required to fit the vessel," "physician does not allow washing," "the hair-washing device is large," and "takes time to prepare the device" (all $ps < .05$ or $.01$). For hand bathing, dissatisfaction was significantly differed to "patient joint contractures," "water spilled on the bed," "difficulty in moving hands to hot water," and "[nurses'] low back pain during preparation" ($ps < .05$ or $.01$). For foot bathing, dissatisfaction was significantly differed to patient joint contractures and low back pain during preparation ($ps < .05$). Both patient/family members and nurses had similar requests for improving bedside hygiene care. From hair washing simulation, pain at the back head of patients and its source was confirmed. Nurses' complicated preparation and cleaning stage and repeated changing position during procedure were also pointed out.

Conclusion: Nurses were concerned with patients' discomfort during bedside hygiene care. Therefore, we proposed modifications to the typical bedside hygiene care device in terms of purpose, materials, and functionality to increase quality of care and nurse satisfaction.

Key Words: bedside hygiene care, care device, foot bathing, hair washing, hand bathing

Introduction

Bedside hygiene care is a basic but crucial nursing procedure provided for bedbound patients. In her writings, Florence Nightingale emphasized the importance of cleanliness and hygiene for patients (Happ et al., 2010). 79.5% nurses felt that bedside hygiene care was their most important professional responsibility (Oliveira & Lima, 2010). Hygiene care serves the purposes of maintaining patient hygiene while refreshing them and making them feel comfortable, can help decrease body odor, stimulate circulation, remove sweat, and reduce the potential for infection (Veje & Larsen, 2014 and Coyer, O'Sullivan & Cadman, 2011). When providing bedside hygiene care, nurses have more time to interact with patients (Moller & Magalhaes, 2015). Unfortunately, rather few studies have explored the problems or deterrents related to providing bedside hygiene care.

Performing quality bedside hygiene care requires more than just consideration of the comfort and safety of patients; in fact, is similarly important to ensure the safety and comfort of the nurses performing that care. Bedside hygiene care is considered a potential burden on the nursing workload because it is exhausting work; not only does it require intense physical effort, but also multiple patients must be given bedside hygiene care during a given shift, which gives nurses little time to care for each patient (Oliveira & Lima, 2010 and Moller & Magalhaes, 2015). Of the 171 participants who reported low back pain in a study on the occupations related to such pain, 33.3% were nurses, whose profession was categorized as “work involving manually lifting 20 kg or heavier” (Matsudaira et al, 2015). However, studies on the safety of nurses performing bedside hygiene care were limited (Saito, Aoki & Kato, 2013). Thus, it would be helpful to explore both patients' and nurses' problems during bedside hygiene care.

Who is responsible for providing bedside hygiene care differs between Western and Japanese hospitals. In Western hospitals, bedside hygiene care is commonly provided by nursing aids under the supervision of nurses as a critical component of assessing the condition of patients' skin (Moller & Magalhaes, 2015). In Japanese hospitals, bedside hygiene care is directly provided by nurses and regarded as an important procedure because many patients are immobile

and bedbound for years due to weakness and old age. Following the rapidly aging Japanese population, number of heavily dependent older people in Japan also increasing almost twice fold from 290.000 people in 2000 to 515.000 people in 2009 (Japan Ministry of Health, Labour and Welfare, 2010). The quality of nurses' bedside hygiene care in Japanese hospitals has been further bolstered by a mobile device that helps in washing patients' hair. Nurses have to go to the bathroom for retrieving, changing the bath water, draining the dirty water and cleaning the device manually (Moller & Magalhaes, 2015). To bathe patients' hands, a disposable plastic vessel full of water, into which nurses insert patients' hands are used. For foot bathing device, a container made from hard plastic where patients can immerse their feet to 5 cm above the ankle were used. These care devices are uniformly used across Japanese hospital wards for patients with various conditions and complications. Outside of Japan, there is no evidence of the use of similar hair washing devices.

The wide application of bedside hygiene care devices in Japan has led to several studies on the efficiency of these devices and how they affect patient outcomes (Yokohama et al, 2014; Furushima et al, 2013 and Nakagawa et al, 2006). However, there is no research that has aimed to improve these bedside hygiene care devices and enhance care quality. Currently, bedside hygiene care devices are not extensively used worldwide, but a proposed design for device modification developed in this study would enable the production of a better device, which in turn would improve the quality of nursing care and increase nurse satisfaction. This could then benefit care throughout the world.

Aim

We examined the circumstances of bedside hygiene care in Japanese hospital wards and the problems experienced by patients and nurses during bedside hygiene care when using care devices. Further, we performed simulation to confirm the problem and design an improved bedside hygiene care device.

Methodology

Study Design

We conducted a cross-sectional nationwide survey and bedside care stimulation to design an improved bedside hygiene care device prototype.

Participants

In the nationwide study, we categorized all hospitals in Japan into 3 groups based on the number of beds: <100 beds, 100–299 beds, and 300 beds or more. Then, stratified random sampling was applied to select candidate hospitals. From these hospitals, we chose potential participants who met the following criteria: (i) either being a chief or charge nurse and (ii) being familiar with the hospital's wards and units. Part-time nurses, even those with considerable experience working in the wards, were excluded. Data were collected in 2008 in 577 hospitals in Japan and 1,477 nurses were invited to participate.

To confirm the nurses' complaints and requests from patients/family members as reported in the questionnaire, we performed a hair washing simulation with 2 graduate nursing students, who acted as nurses and patients interchangeably.

Data collection

The survey participants were given a questionnaire asking them about their experiences in the most recent week related hair washing and bathing of the feet, hands, and perineum. We included perineum hygiene care in this study because of the high potential for transmitted infection if the washing procedures of that area are not done properly. Furthermore, it contained questions about ward and patient characteristics, circumstances and problems relating to bedside hygiene care, and participants' satisfaction. Multiple-choice response formats with possibility to give more than answers were used. For satisfaction with care, participants answered on a scale of 1 to 4, with 1 indicating very satisfied and 4 indicating very unsatisfied. Open-answer questions to determine whether participants had any dissatisfactions and/or they had heard any requests from patients or family members related to bedside hygiene care were provided. The questionnaire was developed by researchers based on literature review related to bedside hygiene care.

For the hair washing simulation, the patient model was bedbound in a supine position to reflect patients' condition in an actual hospital ward. We posed questions by using keywords extracted from nurses and patient/family complaints reported in the questionnaire and

followed up with further questions to explore their experience in detail. In addition, we asked their suggestions on how to improve the current device.

Data analysis procedure

Quantitative data, were analyzed by Pearson's chi-square test (with a significance level of $p < .05$). SPSS Statistics 23 was used (SPSS, Armonk, NY, USA)

Qualitative data were analyzed via text mining using KH Coder. This free, open source software program was developed by Koichi Higuchi at Ritsumeikan University, Kyoto, Japan (Higuchi, 2012). This text mining is a computerized process of analyzing information from collected data that has been applied widely in health sciences research to improve the consistency of qualitative data analysis (Goto et al, 2014). We conducted three analysis steps. First, a word frequency list was generated to determine which words appeared most frequently in participants' answers to the open questions. Second, to identify groups of words, we created a co-occurrence network of words, with larger bubbles representing words most frequently used in the questionnaire. Finally, to explore details of the co-occurrence network, we employed Key Words in Context (KWIC) concordance. For the KWIC concordance, to identify requests related to the bedside hygiene care device for both nurses and patients, we selected some of the most frequently used verbs displayed in the word frequency list and verbs with large bubbles in the co-occurrence network.

Ethical considerations

This study was approved by the Niigata University Research Ethics Committee (Niigata, Japan). Participation was voluntary and anonymous. Returning the questionnaires was considered as giving informed consent. For the hair simulation, the participating nursing graduate students were directly asked for their informed consent by a researcher who was not their supervisor.

Results

Participant characteristics and care satisfaction

Of the 1,477 charge nurses contacted, 590 responded (response rate 39.9%). Table 1 shows the characteristics of participants. Thirty-six participants incompletely filled the

questionnaires, so only 554 of participants were used for the satisfaction analysis. Almost half of the participants felt dissatisfied with the bedside hygiene care that they gave to patients. Table 2 shows the number of patients given bedside hygiene care.

Patient distress and nurse problems during bedside hygiene care

As shown in Table 3, patients were often distressed during hair washing because they had to assume an uncomfortable position to fit the vessel and had to move to fit their heads into the vessel. For hand and foot bathing procedures, patients' two major distresses, as reported by nurses, were assuming an uncomfortable position to fit the vessel and joint contractures. As shown in Table 4, nurses reported low back pain during bedside hygiene care, that the hair-washing device was big and spilling water on the bed during hand and foot bathing.

Nurse dissatisfaction during bedside hygiene care

As shown in Table 5, for hair washing, there were significant differences between dissatisfaction groups in the proportions of participants who reported the following problems or patient stressors: uncomfortable positions are required to fit the vessel, physician does not allow them to do the washing, the hair washing device is big, and it takes time to prepare the device. For hand bathing, significant differences were observed between dissatisfaction groups in the proportions of participants who reported the following problems or patient stressors: patients' joint contractures, water spilled on the bed, difficulty in moving patients' hands to hot water, and nurses' low back pain during preparation. For foot bathing, there are significant differences between dissatisfaction groups in the proportion of participants who reported the problems of patients' joint contracture and low back pain during preparation.

Patients and nurses requests for bedside hygiene care

Figure 1 displays the word frequency list generated from participants' reports of the requests of patient/family members and nurses regarding bedside hygiene care. *Patient* was the most frequently used word in patient/family member requests, while *want* was most

frequently mentioned in nurse requests. Figure 2 shows the co-occurrence network of words extracted from the requests of patients/families and nurses. Further explanation of Figure 2 is placed under the figure.

Table 6 displays examples of requests from patients/family and nurses regarding the hair washing and hand and foot bathing procedures. We observed several similarities between the requests of patients/families and nurses. Regarding the hair washing procedure, a patient complained, "having the hair washed with the head down was tiring." Similarly, nurses requested "a device that would enable patients' necks to move freely to prevent discomfort." One of the unique reports from patients/families was "dirt between the fingers was not completely washed away." Additionally, nurses requested a foot-bathing device with a "vessel made from soft plastic and that had a massage function." We noted several differences between patient/family and nurses in terms of hair washing requests. Patients/family demanded a better hair-washing device in terms of "...water temperature, frequency, strength of water pressure, shampoo brand, body positions, allowing the head to be up or down, and length of time needed for washing hair." Conversely, nurses only suggested a head vessel made "...from a soft material, such as silicone."

Simulation of bedside hygiene care

In the simulation of hair washing, the average amount of water spent for 1 person was 20 L for two applications of shampoo and one of conditioner. We saved the amount of water used in rinsing away the shampoo and conditioner by absorbing them into a towel before rinsing participants' hair with water. From the simulated patients' perspectives, pain in the back of the head continued as the shoulder discomfort as part of efforts to stabilize the head when the nurses turned or moved the patient's head for shampooing or rinsing. We identified that the narrow headrest attached to the middle of the head vessel was responsible for the pain and discomfort in the back of the head. The patients also suggested that it would be better for the shower holes to be adjustable so that they could be made smaller or fewer to prevent them from getting unnecessarily wet, especially when closely rinsing sensitive areas such as their ears.

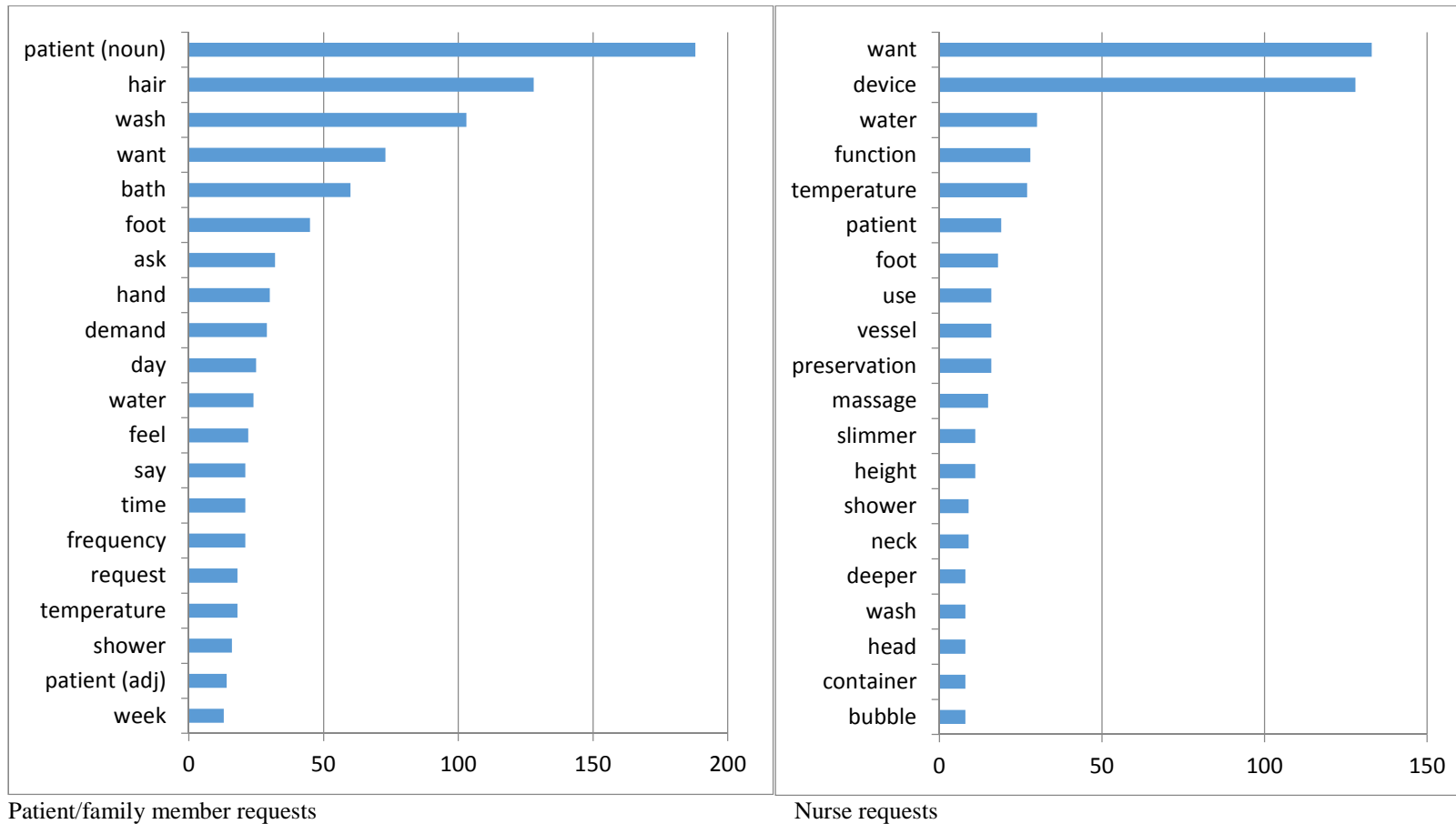


Figure 1. Word frequency lists used by respondents regarding bedside hygiene care

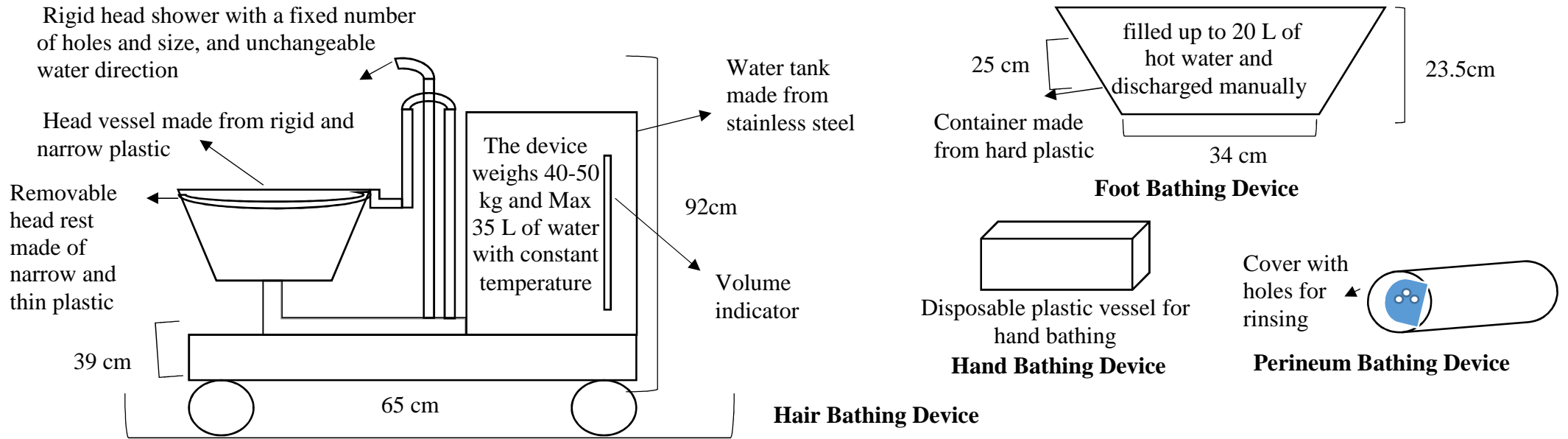


Figure 3. Current hair washing and hand, foot and perineum bathing devices

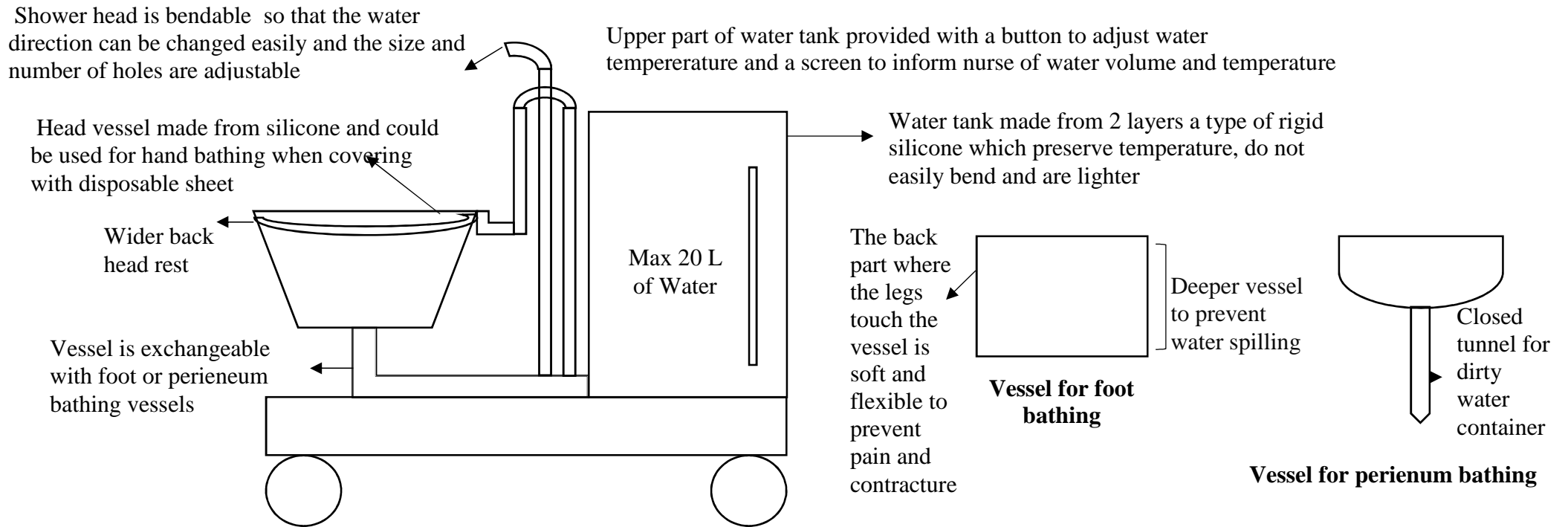


Figure 4. Design of modified bedside hygiene care device

Table 1 Subject characteristics according to

Variable	Total		Satisfied		Dissatisfied		p ^c
	N	(%)	N	(%)	N	(%)	
Number of hospital beds^a							
<100	348	(62.8)	168	(48.3)	180	(51.7)	.55
100–299	152	(27.4)	66	(43.4)	86	(56.6)	
≥300	54	(9.7)	27	(50.0)	27	(50.0)	
Number of beds per ward/unit^a							
Unknown	26	(4.7)	11	(42.3)	15	(57.7)	.17
<20	7	(1.3)	5	(71.4)	2	(28.6)	
20–49	300	(54.2)	149	(49.7)	151	(50.3)	
50–99	214	(38.6)	95	(44.4)	119	(55.6)	
>100	7	(1.3)	1	(14.3)	6	(85.7)	
Type of wards/units^b							
Internal medicine	163	(29.4)	71	(43.6)	92	(56.4)	.28
Orthopedic	117	(21.1)	50	(42.7)	67	(57.3)	.29
Internal surgery	109	(19.7)	43	(39.4)	66	(60.6)	.07
Neurology	71	(12.8)	38	(53.5)	33	(46.5)	.25
Neurosurgery	59	(10.6)	26	(44.1)	33	(55.9)	.62
Ophthalmology/Otology	58	(10.5)	26	(44.8)	32	(55.2)	.71
Nephrology	54	(9.7)	19	(35.2)	35	(64.8)	.07
Dermatology	40	(7.2)	16	(40.0)	24	(60.0)	.35
Hematology	29	(5.2)	11	(37.9)	18	(62.1)	.31
Long-term care	25	(4.5)	13	(52.0)	12	(48.0)	.62
Rehabilitation	23	(4.2)	14	(60.9)	9	(39.1)	.18
Psychiatric	20	(3.6)	10	(50.0)	10	(50.0)	.79
Radiology	16	(2.9)	10	(62.5)	6	(37.5)	.21
Palliative care	2	(0.4)	0	(0.0)	2	(100.0)	.18
Intensive care	6	(1.1)	4	(66.7)	2	(33.3)	.34
Obstetrics and Gynecology	52	(9.4)	25	(48.1)	27	(51.9)	.88
Pediatrics	48	(8.7)	20	(41.7)	28	(58.3)	.43
Neonatal intensive care	1	(0.2)	0	(0.0)	1	(100.0)	.35

^aMissing data: 36^bMultiple answers possible; the total number of answers in these wards/units: 942^cPearson's chi-square test

Table 2 Number of patients requiring hair wash and hand, foot, and perineal baths per week

Variable	Hair Wash		Hand Bath		Foot Bath		Perineal Wash with Foley Catheter		Perineal Wash Without Foley Catheter	
	1–3/week	>3/week	1–3/week	>3/week	1–3/week	>3/week	1–3/week	>3/week	1–3/week	>3/week
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Internal medicine	52 (5.5)	22 (0.3)	71 (7.5)	69 (7.3)	75 (8.0)	76 (8.1)	28 (3.0)	117 (12.4)	27 (2.9)	134 (14.2)
Orthopedic surgery	33 (3.5)	22 (2.3)	60 (6.4)	30 (3.3)	64 (6.8)	40 (4.3)	20 (2.1)	70 (7.4)	20 (2.1)	93 (9.9)
Internal surgery	38 (4.0)	8 (0.8)	51 (5.4)	37 (4.0)	53 (5.6)	43 (4.6)	22 (2.3)	74 (7.8)	23 (2.4)	75 (7.7)
Neurology	27 (2.9)	8 (0.8)	32 (3.4)	30 (3.2)	34 (3.6)	28 (2.9)	13 (1.4)	53 (5.6)	7 (0.7)	65 (6.8)
Neurosurgery	11 (1.2)	9 (0.9)	30 (3.2)	22 (2.3)	33 (3.5)	20 (2.1)	7 (0.7)	46 (4.9)	3 (0.3)	55 (5.7)
Ophthalmology/otology	12 (1.3)	8 (0.8)	28 (3.0)	13 (1.3)	34 (3.6)	14 (1.4)	14 (1.5)	29 (3.1)	16 (1.7)	34 (3.5)
Nephrology	17 (1.8)	4 (0.4)	27 (2.9)	18 (1.8)	30 (3.2)	20 (2.1)	6 (0.6)	38 (4.1)	11 (1.2)	39 (4.2)
Dermatology	16 (1.7)	1 (0.1)	19 (2.0)	13 (1.3)	21 (2.2)	19 (1.6)	8 (0.8)	27 (2.9)	6 (0.6)	32 (3.3)
Hematology	14 (1.5)	5 (0.5)	14 (1.5)	13 (1.3)	12 (1.3)	15 (1.6)	5 (0.5)	20 (2.0)	4 (0.4)	21 (2.2)
Long-term care	1 (0.1)	0 (0.0)	7 (0.7)	6 (0.6)	9 (1.0)	2 (0.2)	7 (0.7)	12 (1.2)	2 (0.2)	20 (2.1)
Rehabilitation	7 (0.7)	1 (0.1)	5 (0.5)	8 (0.8)	6 (0.6)	9 (0.9)	8 (0.8)	12 (1.3)	4 (0.4)	17 (1.8)
Psychiatric	3 (0.3)	0 (0.0)	9 (1.0)	2 (0.2)	12 (1.3)	2 (0.2)	9 (1.0)	5 (0.5)	4 (0.4)	10 (1.0)
Radiology	9 (1.0)	2 (0.2)	7 (0.7)	4 (0.4)	7 (0.7)	7 (0.7)	5 (0.5)	7 (0.7)	4 (0.4)	10 (1.0)
Palliative care	0 (0.0)	1 (0.1)	0 (0.0)	3 (0.3)	0 (0.0)	3 (0.3)	0 (0.0)	2 (0.2)	0 (0.0)	3 (0.3)
Intensive care unit	4 (0.4)	0 (0.0)	3 (0.3)	2 (0.2)	3 (0.3)	3 (0.3)	0 (0.0)	5 (0.5)	0 (0.0)	4 (0.4)
Obstetrics and gynecology	21 (2.2)	5 (0.5)	21 (2.2)	11 (1.1)	26 (2.8)	18 (1.9)	20 (2.1)	22 (2.3)	16 (1.7)	24 (2.5)
Pediatrics	19 (2.0)	5 (0.5)	19 (2.0)	14 (1.4)	24 (2.5)	14 (1.4)	20 (2.1)	14 (1.4)	11 (1.2)	32 (3.3)
Neonatal intensive care unit	1 (0.1)	0 (0.0)	1 (0.1)	0 (0.0)	1 (0.1)	0 (0.0)	1 (0.1)	0 (0.0)	1 (0.1)	0 (0.0)

Table 3 Patients’ state, care purpose, and distress experienced during bedside hygiene care (N = 590)

Variable *	Hair Washing		Hand Bathing		Foot Bathing	
	N	(%)	N	(%)	N	(%)
Patient State						
Immobilized	369	(62.5)	346	(58.6)	344	(58.3)
Terminal	259	(43.9)	263	(44.6)	274	(46.4)
Post-operative	234	(39.7)	132	(22.4)	185	(31.4)
Low level of consciousness	194	(32.9)	237	(40.2)	212	(35.9)
Low immune system functioning	104	(17.6)	108	(18.3)	129	(21.9)
Extreme fatigue	136	(23.1)	96	(16.3)	121	(20.5)
Insomnia	34	(5.8)	27	(4.6)	106	(18.0)
Other	46	(7.8)	55	(9.3)	71	(12.0)
Purpose of Care						
Cleansing	567	(96.1)	548	(92.9)	535	(90.7)
Refreshing	477	(80.8)	354	(60.0)	392	(66.4)
Care of scalp and hair/skin	331	(56.1)	329	(55.8)	334	(56.6)
Patient satisfaction	315	(53.4)	105	(17.8)	164	(27.8)
Relaxing	263	(44.6)	254	(43.1)	349	(59.2)
Observation of scalp and hair/skin	213	(36.1)	244	(41.4)	307	(52.0)
Softening nails for easier trimming	N/A		217	(36.8)	207	(35.1)
Facilitating blood flow	138	(23.4)	324	(54.9)	441	(74.7)
Opportunity for communication	97	(16.4)	103	(17.5)	114	(19.3)
To improve sleep at night	86	(14.6)	51	(8.6)	224	(38.0)
To create a daily rhythm	79	(13.4)	54	(9.2)	69	(11.7)
As motivation against an illness	76	(12.9)	51	(8.6)	76	(12.9)
Facilitating effective treatment	34	(5.8)	46	(7.8)	94	(15.9)
Stimulating cognition	28	(4.7)	36	(6.1)	49	(8.3)
Decreasing pain	13	(2.2)	55	(9.3)	127	(21.5)
Other	6	(1.0)	14	(2.4)	14	(2.4)
Distress						
Patients must assume uncomfortable positions to fit the vessel	330	(55.9)	356	(60.3)	343	(58.1)
Patients must move to fit their head/hand/foot in the vessel	309	(52.4)	206	(34.9)	288	(48.8)
Shampoo/soap remains on the scalp & hair because of a lack of hot water	84	(14.2)	77	(13.1)	71	(12.0)
Shampoo/soap is not washed away completely ¹	158	(26.8)	40	(6.8)	34	(5.8)
Patients have neck ² and extremity pain	110	(18.6)	266	(45.1)	272	(46.1)
Joint contracture	N/A		334	(56.6)	354	(60.0)
Water temperature sometimes does not comply with patients’ request	50	(8.5)	49	(8.3)	89	(15.1)
Other	31	(5.3)	15	(2.5)	10	(1.7)

*Multiple answers possible

¹On the back of the head, n = 146; on the back of the ears, n = 29; on the forehead, n = 16

²Reasons: Patients must bend their neck laterally, n = 110; the plastic vessel is very hard, n = 81; the neck rest of the vessel is too narrow, n = 17

Table 4 Nurses’ problems with patients’ states during bedside hygiene care (N = 590)

Variable *	Hair Washing		Hand Bathing		Foot Bathing	
	N	(%)	N	(%)	N	(%)
Nurse Problems						
Physician does not allow the patient to be washed	146	(24.7)	106	(18.0)	127	(21.5)
Water is spilled on the bed	NA		379	(64.2)	361	(61.2)
It is difficult to move patient’s hands (including wrists) and feet (including knees) into the hot water	NA		349	(59.2)	361	(61.2)
The hair washing device is big	216	(36.6)	N/A		N/A	
It takes time to prepare caregiving goods and devices	203	(34.4)	38	(6.4)	76	(12.9)
It takes time to clean caregiving goods and devices	183	(31.0)	32	(5.4)	63	(10.7)
It takes time to prepare hot water at its optimal temperature	74	(12.5)	32	(5.4)	68	(11.5)
Temperature of hot water cools during care	74	(12.5)	97	(16.4)	100	(16.9)
Low back pain during preparation	91	(15.4)	42	(7.1)	169	(28.6)
Low back pain during washing	352	(59.7)	227	(38.5)	343	(58.1)
Other	49	(8.3)	13	(2.2)	11	(1.9)

*Multiple answers possible

Table 5 Nurses’ dissatisfaction with patients’ states, distress, and problems with hair washing and hand and foot bathing (N = 590)

Variable	Hair Wash			Hand Bath			Foot Bath		
	Satisfaction	Dissatisfaction	p	Satisfaction	Dissatisfaction	p	Satisfaction	Dissatisfaction	p
	N (%)	N (%)		N (%)	N (%)		N (%)	N (%)	
Patient State									
Immobilized	356 (64.3)	188 (52.8)	0.96	333 (60.1)	178 (53.5)	0.74	329 (59.4)	176 (53.5)	0.73
Terminal	245 (44.2)	131 (53.5)	0.81	249 (44.9)	135 (54.2)	0.57	261 (47.1)	137 (52.5)	0.86
Post-operative	225 (40.6)	113 (50.2)	0.30	125 (22.6)	59 (47.2)	0.15	177 (31.9)	86 (48.6)	0.17
Low level of consciousness	186 (33.6)	102 (54.8)	0.51	224 (40.4)	119 (53.1)	0.93	197 (35.6)	108 (54.8)	0.50
Low immune system functioning	99 (17.9)	57 (57.6)	0.30	105 (19.0)	59 (56.2)	0.45	124 (22.4)	69 (55.6)	0.49
Extreme fatigue	126 (22.7)	65 (51.6)	0.74	89 (16.1)	42 (47.2)	0.24	114 (20.6)	52 (45.6)	0.08
Insomnia	33 (6.0)	19 (57.6)	0.58	27 (4.9)	17 (63.0)	0.28	99 (17.9)	55 (55.6)	0.56
Other	39 (7.0)	21 (53.8)	0.90	49 (8.8)	24 (49.0)	0.57	68 (12.3)	35 (51.5)	0.80
Distress									
Patients must assume uncomfortable positions to fit the vessel	314 (56.7)	184 (58.6)	0.00**	331 (59.7)	183 (55.3)	0.17	321 (57.9)	181 (56.4)	0.05
Patients must move to fit their head/hand/foot in the vessel	294 (53.1)	165 (56.1)	0.11	198 (35.7)	108 (54.5)	0.56	272 (49.1)	153 (56.3)	0.12
Shampoo/soap remains on the scalp & hair because of a lack of hot water	80 (14.4)	43 (53.8)	0.87	71 (12.8)	42 (59.2)	0.26	67 (12.1)	39 (58.2)	0.35
Shampoo/soap is not washed away completely	151 (27.3)	87 (57.6)	0.17	39 (7.0)	19 (48.7)	0.59	34 (6.1)	21 (61.8)	0.28
Patients have neck and extremity pain	106 (19.1)	62 (58.5)	0.20	251 (45.3)	139 (55.4)	0.29	256 (46.2)	141 (55.1)	0.34
Joint contracture	NA			319 (57.6)	181 (56.7)	0.03*	335 (60.5)	189 (56.4)	0.04*
Water temperature sometimes does not comply with patients’ request	47 (8.5)	27 (57.4)	0.51	45 (8.1)	26 (57.8)	0.49	82 (14.8)	49 (59.8)	0.18
Other	30 (5.4)	17 (56.7)	0.67	15 (2.7)	8 (53.3)	0.97	10 (1.8)	6 (60.0)	0.65
Nurse Problems									
Physician does not allow the patient to be washed	137 (24.7)	85 (62.0)	0.01*	101 (18.2)	53 (52.5)	0.93	120 (21.7)	64 (53.3)	0.91
Water is spilled on the bed	N/A			354 (63.9)	202 (57.1)	0.01**	343 (61.9)	191 (55.7)	0.09
It is difficult to move the patient’s hands (including wrists) and feet (including knees) into the hot water	N/A			328 (59.2)	190 (57.9)	0.00**	341 (61.6)	188 (55.1)	0.18
The hair washing device is big	203 (36.6)	122 (60.1)	0.01**	N/A			N/A		
It takes time to prepare caregiving goods and devices	190 (34.3)	117 (61.6)	0.00**	36 (6.5)	15 (41.7)	0.16	72 (13.0)	43 (59.7)	0.21
It takes time to clean caregiving goods and devices	173 (31.2)	97 (56.1)	0.37	31 (5.6)	15 (48.4)	0.61	59 (10.6)	37 (62.7)	0.11
It takes time to prepare hot water at its optimal temperature	70 (12.6)	35 (50.0)	0.61	30 (5.4)	18 (60.0)	0.42	62 (11.2)	38 (61.3)	0.16
Temperature of hot water cools during care	70 (12.6)	32 (45.7)	0.20	89 (16.1)	49 (55.1)	0.66	93 (16.8)	49 (52.7)	0.97
Low back pain during preparation	85 (15.3)	48 (56.5)	0.47	39 (7.0)	27 (69.2)	0.03**	160 (28.9)	96 (60.0)	0.03*
Low back pain during washing	334 (60.3)	186 (55.7)	0.10	210 (37.9)	110 (52.4)	0.85	323 (58.3)	176 (54.5)	0.37
Other	49 (8.8)	29 (59.2)	0.36	13 (2.3)	8 (61.5)	0.53	11 (2.0)	8 (72.7)	0.18

Missing data = 36

All significance values are for Pearson’s chi-square test

*p < .05 **p < .01

Table 6 Requests concerning bedside hygiene care

Kind of care	Before	Word	After
Common requests for bedside hygiene care by patient/family members			
Hair washing	Patient	complained	that hair washing with the head down was tiring. He/she wanted to have his/her hair washed with the head up.
	Pediatric patients, after having surgery, were afraid of pain, so they	asked	for the bare minimum of water pressure during hair washing.
Foot bathing	Patient	wanted	to immerse his/her foot deeper in the water.
	Patient	wanted	the nurse to notice the water temperature.
Common requests for bedside hygiene care by nurses			
Hair washing	I	wanted	a temperature preservation device and shower regulator.
	I	wanted	a device that enables patients to freely move their neck to prevent discomfort.
Foot bathing	I	wanted	a deeper container to prevent spilling water.
	I	wanted	a device with temperature preservation and a plantar massage function.
Unique requests for bedside hygiene care by patient/family members			
Hair washing	Many patients	wished	to have their hair cut along with their hair wash. We have been asked about outside support for haircuts.
	The patients' demands concerning the frequency of shampooing	applied	to the water temperature, frequency, strength of water pressure, shampoo brand, body positions, whether the head was up or down, and length of time needed for washing hair.
Hand bathing	The patient said that because they	could	not shower, they wanted to have their hair washed with hot water.
	The patient said that their hands were cold. If someone	could	warm their hands, they would be so happy.
	The patient	said	that dirt between the fingers was not washed away completely.
Foot bathing	The patient said that the smell did not	go	away if his/her hand was only wiped.
	The patient's foot was cold, so he/she wanted to	warm	it by having a foot bath.
	Patient said that Patient wanted to have a foot bath to be	having able	a foot bath felt similar to showering. to sleep.
Unique requests for bedside hygiene care by nurses			
Hair washing	I wanted a device with a vessel	made	from a soft material, such as silicone.
	I wanted a slimmer device so that it	could	be used in wards with narrow halls.
	I wanted a device that was easier to	clean	after usage and that had a drying function.
Foot bathing	I wanted a foot-bathing device that could be	used	while patients were still in bed.
	I wanted a vessel made from soft plastic and that had a massage function, in addition to a device that	had	germanium stones in the water.

From the participants' perspectives when they were acting as nurses, the device was very heavy, especially when it was full of water. Furthermore, the inability to adjust the water direction due to the rigid head shower complicated hair rinsing, especially on the back of the head. They also pointed out that preparing and cleaning the devices is quite complicated and tiring, and requires the nurses to repeatedly switch between the standing and bending positions.

Discussion

Problems with bedside hygiene care

More than half of nurse participants were dissatisfied with the hair washing and hand and foot bathing of bedridden patients, and this dissatisfaction was significantly differed with variables such as low back pain during hair washing. Moller and Magalhaes (2015) revealed that bedside hygiene procedures involve health risks for nurses because of the intense physical effort they require. Musculoskeletal disorders (MSD) are highly prevalent among nurses working in a variety of settings, with low back pain being the most frequently occurring MSD (with a prevalence of 30–60%) because of strenuous activities, manual handling, repetitive tasks, and job strain (Trinkoff et al, 2002 and Smith et al, 2003). The fact that nurses must repeatedly fetch water and prepare the hygiene devices for each patient provides some indication of the exhaustion caused by this care and its impact on nurses' workloads. Heavy hair washing devices can further create low back pain problems for nurses.

Furthermore, one of the most important factors influencing job satisfaction and nurses' evaluations of the quality of care is the availability of adequate resources, including care devices. If nurses are unable to perform their nursing interventions at an appropriate standard, they tend to feel dissatisfied with their jobs. This suggests that the quality of care can be increased by adjusting the factors influencing job satisfaction (Kvist et al, 2014). Therefore, enabling lighter and simpler bedside hygiene care devices would be crucial for improving nurses' care satisfaction.

Uncomfortable positions during hygiene procedures (e.g., having to move to fit the vessel) and insufficient water for washing patients

completely were major causes of patient distress during bedside hygiene care. Joint contractures were also reported to cause patient distress during hand and foot bathing. Previous studies have similarly noted that necessary movements in the bed during bedside hygiene procedures might become painful for the patient (Moller & Magalhaes, 2015). Although bedside hygiene care is crucial and conveys abundant physiological and psychological benefits to patients, distress due to the use of inappropriate devices might keep them from obtaining the optimal positive effect (Potter and Perry, 2001).

The qualitative data, as displayed in the text-mining analysis, supports the quantitative results. Both patient/family members and nurses had similar requests regarding bedside hygiene care devices. For the hair-washing device, both parties were concerned about the discomfort caused by restricted movement in the neck and head. As for the foot-bathing device, both patient/family members and nurses requested deeper containers that enabled patients to immerse their feet deeper into the water while also preventing the water from spilling. Some of the patients also complained about the current devices used, in particular stating that dirt between the fingers and smells had not been removed during hand bathing. Hand and foot care is a part of basic nursing care that helps promote extremity health and maintain skin moisture (Potter & Perry, 2001 and Chan et al, 2012). Because the skin can harbor harmful microorganisms, it is necessary to remove excess body secretions, and dirt between the fingers (Veje & Larsen, 2014). Thus, proper hand and foot bathing with better devices are needed to prevent bacterial infections. More practical solutions demanded by patient/family members and improvement of care devices materials suggested by nurses as identified in qualitative data analysis are essential in modifying bedside hygiene care devices. By identifying problems with bedside hygiene care, in particular those related to the care devices, we intended to propose a modified prototype design to ensure higher quality care. This is described in the following section.

Proposed design of the improved bedside hygiene care device

We describe the current hair washing and bathing devices based on typical form sold by companies

in Japan in Figure 3.

For perineum bathing, nurses use a bottle of water that contains small holes in the upper portion. The water used to rinse the perineum is absorbed using a diaper sheet placed on the bed. Although the bottle is initially filled with hot water, it is often cool by the time it is used on patients, which can cause them discomfort. Additionally, repeated usage of the bottle for different patients can increase the risk of transmitted disease.

Based on the results of this study, we proposed a prototype of a bedside hygiene care device that is lighter, more compact, comprises of three interchangeable vessels based on types of hygiene care; a vessel for hair washing and hand bathing and the other two were for foot and perineum bathing and made from soft material. For a lighter and more compact device, we proposed changing the material from stainless steel to a type of waterproof and rigid silicone. The silicone is not only lighter but also could similarly preserve water temperature. Furthermore, to prevent the vessel from bending and thereby avoid heat injury during its use, we built the vessels of two layers of this silicone. Based on the water measurements made during the simulation and to reduce the weight of the device, we limited the water capacity to 20 L. Additionally, the result of this study has shown that the majority of nurses perform hair washing and foot and hand bathing for one to three patients per week. Given the above considerations, a full tank of this bedside hygiene care device could be used to wash the hair and thoroughly bathe the hand, foot, and perineum for one patient at a time.

To prevent neck pain during hair washing, we replaced the head vessel material with silicone, which is flexible and can conform to the shape of the patient's head. We also suggested a 20° head angle position during the hair washing procedure in order to prevent neck pain, which was based on the findings of Nakagawa et al (2006). Additionally, we widened the size of the headrest to minimize discomfort during the hair washing procedure.

Regarding the foot bathing vessel, the shape is similar to a shopping basket albeit deeper so that patients can immerse more of their legs and prevent water from spilling. To prevent pain and contractures when patients' feet are immersed

during the care procedure, the back of the vessel is soft and flexible, although it is rigid enough to support patients' legs.

Although we did not ask nurses' opinions on perineum bathing, in consideration of the risk of transmitted disease and the low water temperature problem of the current device, we designed a perineum vessel that can be integrated into the improved bedside hygiene care device. To our knowledge, this vessel is the first prototype that can be attached to a mobile bedside hygiene care device. The vessel, which contains a closed tunnel in the middle to catch the rinsed water (thus acting as the diaper sheet used currently), is placed underneath the patient's perineum during the bathing procedure. For rinsing the perineum and buttocks, and for fitting with the multipurpose design of this new hygiene device, we modified the shower head so that it can be bent in any direction. Furthermore, nurses can now adjust the number of holes and water pressure by turning the showerhead to the left and right. For adjusting the water temperature and provides information on the current water temperature and remaining water volume, we added a screen and button on the water tank. To prevent disease contamination among and within patients during hygiene care, we provide a disposable vessel to cover the vessels. Figure 4 shows the design of our improved bedside hygiene care device. This study has some limitations. Although randomization was performed, low response rate could have affected the results. Because of some patients' unconscious or weakened states, we could not obtain information directly from patients or their families. Therefore, patient/family member requests were obtained secondhand through nurses. Additionally, the qualitative data analysis was aimed at visually describing complaints and suggestions from patients/families and nurses regarding bedside hygiene care using word frequencies without generating any themes. Design of modified bedside hygiene care device are not assessed yet, therefore further research to test its efficiency is required.

Conclusion

Nurses were concerned about patients' discomfort during bedside hygiene care. The necessity of assuming uncomfortable positions to fit the vessels, the large size of hair devices, and

the time required to prepare the devices were significantly differed to care dissatisfaction during hair washing. Furthermore, joint contractures in patients, water spilling on the bed during the procedure, difficulty in moving the patient's hands, and low back pain during preparation were significantly differed with care dissatisfaction during hand and foot bathing. Both patients/family members and nurses had similar requests for improving bedside hygiene devices. Based on these findings, we proposed modifications to the purpose, materials, and functionality of the currently used bedside hygiene care devices to improve quality of bedside hygiene care and nurse satisfaction.

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