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Article

Dry Wipes for Hygiene in Hospitalized Patients: Economic and Environmental Impact, and Patient and Professional Satisfaction

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ABSTRACT: Aims: To compare traditional versus dry wipes hygiene in hospitalized, bedridden patients with regard to economic and environmental impact and patient and professional satisfaction. **Background:** Evidence shows that dry hygiene with disposable wipes can reduce the risk of infection compared to traditional hygiene with soap and water. However, there is a need to compare the costs and environmental impact (waste) between the two methods. **Design:** Environmental impact and patient and user satisfaction were assessed through an ad hoc survey and cost minimization analysis in accordance with the Consolidated Health Economic Evaluation Reporting Standards. **Methods:** The environmental impact and costs associated with traditional versus dry hygiene were compared in an observational analysis. A single-center, randomized controlled trial was performed in a tertiary hospital to assess patient and professional satisfaction in patients with a urinary catheter recovering from heart surgery between January 2019 and February 2020. **Results:** Direct hygiene costs were similar using traditional (€15.82) and dry (€14.35) methods. However, the analysis of indirect costs, including those related to the probability of contracting catheter-associated urinary tract infections, showed that the total cost per hygiene session was €1345 higher with the traditional method. When using a high-efficiency energy system from a guaranteed renewable source, dry hygiene does not lead to a higher environmental impact (220.07 g CO₂ traditional vs. 215.17g CO₂ dry). However, emissions from conventional energy systems are 840.14 g CO₂ higher when using traditional hygiene. Both patients and professionals express greater satisfaction with the dry method. **Conclusion:** Dry hygiene is not inferior to

traditional hygiene in terms of satisfaction, and it can provide environmental benefits at a significantly lower cost. **Implications for the profession and/or patient care:** This study provides evidence supporting the introduction of the dry hygiene method, which is associated with higher user and professional satisfaction, lower economic cost, and similar or lower environmental impact compared to soap and water.

Keywords: disposable wipes; hygiene satisfaction; cost-effectiveness; economic evaluation; healthcare-associated infections; cost analysis; environmental impact

1. INTRODUCTION

Personal hygiene care, including bathing, is a key nursing activity related to quality of life and patient care [1]. Bathing has been considered a ritual pleasure and a necessary daily therapeutic procedure [2], satisfying both hygiene and comfort needs [3]. Other benefits include the removal of sweat, grease, dirt and microorganisms from the skin; reduced body odor; stimulation of blood flow; and lower risk of infection [1,4,5]. Sometimes, bed bathing is the only hygiene option for patients who need help to bathe due to acute or chronic illness [6].

2. BACKGROUND

Healthcare-associated infections (HAIs) affect 5% to 10% of hospitalized patients [7–9], and over half are considered preventable [8]. The European Centre for Disease Prevention and Control estimates that 8.9 million HAIs occur each year in European hospitals and long-stay facilities [8]. Moreover, they are associated with high mortality and impose a considerable burden on the healthcare system [9,10], increasing the cost per patient by up to 77% [11]. On top of this, a 2022 report by the World Health Organization warns of high levels of antimicrobial resistance in bacteria causing potentially mortal cases of sepsis as well as in other common bacteria causing infections in the population. To reduce the rate of HAIs in hospitals, several studies have shown the need to eliminate the use of water for washing patients, replacing this traditional method of bathing with a dry method using disposable wet wipes [6,9,10].

Research shows that cleaning with water may increase the risk of HAIs, since the rubbing caused by the sponge favors water contamination. Furthermore, both the sink spout and the faucet can act as a reservoir for microorganisms [12,13] and be a source of contamination among patients [14–16]. For these reasons, wipes are presented as an effective alternative, decreasing the risk of cross-contamination due to the limited contact with different parts of the body [4,17]. In this context, the use of this method is becoming increasingly widespread [18], particularly in Europe [19,20] and the USA [21].

Dry hygiene is also beneficial for other patient outcomes. The use of wipes is associated with better preservation of the skin barrier function and reduced risk of skin breakdown, dermatitis, and pressure ulcers [18,19], leaving the patient's skin softer and more hydrated [2,5,21]. In addition, some studies suggest that it reduces agitation in dementia patients, requires less practitioner time, and saves costs [6,10], even while improving patient and practitioner satisfaction [6]. Nursing professionals find it simpler, faster, and more comfortable for patients [22]. Both methods have an environmental impact due to the use of disposable sanitary materials [23]. However, to our knowledge, there are no studies that have directly compared the two methods in terms of the magnitude of the environmental impact.

3. THE STUDY

This study derives from previous research at our center, the Germans Trias i Pujol University Hospital (HUGTP), a public tertiary hospital in Catalonia (Spain). Specifically, the Nosocomial Infection Control team compared soap and water hygiene versus dry hygiene with wipes impregnated with soap and moisturizing lotion for reducing catheter-associated urinary tract infections (CAUTI) in the same group of patients [24]. The results showed that the probability of

contracting a CAUTI with the traditional hygiene method is 16.5%, compared to 5.9% with the alternative method—a statistically significant difference.

In order to extend the findings of the initial investigation, this study aims to compare soap and water hygiene versus the dry method in patients with a urinary catheter who were recovering from heart surgery, looking at the environmental impact, economic cost, and patient and professional satisfaction.

4. . METHODS

4.1. . *Study design and setting*

The study had two components: the cost and environmental impact of the two hygiene methods were compared through an observational study, whereas patient and professional satisfaction were assessed using a single-center randomized controlled trial.

The HUGTP is a public tertiary hospital providing highly complex health care to a population of around 800,000 people in northern Barcelona province. It is also a referral hospital for a catchment population of 1.2 million. The hospital is part of the Catalan Health Institute, a public company and the main health care provider in Catalonia.

The Catalan health system provides universal healthcare coverage, publicly funded through tax revenue and free at the point of service. The system is mixed: it guarantees equitable access to a wide range of services provided through a single network of public healthcare resources, but not all of these are publicly owned. The health network includes a variety of organizations, such as mutuals, foundations and health trusts, which have historically provided health care. Approximately one in three people in Catalonia has supplementary private healthcare insurance, which does not affect their right to access public health services [25].

HUGTP is part of the Green Hospitals network, whose mission is to reduce the carbon footprint generated by healthcare centers. Thus, one of the hospital's strategic lines of work is the minimization of its environmental impact. This includes the prevention and control of air, wastewater and soil pollution and the sustainable use of natural resources.

4.2. *Participants*

A random sample was selected from among patients admitted to HUGTP from January 2019 to February 2020 for heart surgery; they were initially admitted to the cardiac intensive care unit and subsequently transferred to the cardiology ward, where they received postoperative care. Patients had to have a urinary catheter and give their informed consent to participate in the study. Those who were missing records, came from other units, had a history of previous bacteriuria, or had significant language barriers were excluded. In addition, patients could be withdrawn from the study if they were hypersensitive or allergic to any component, were transferred to other wards, voluntarily opted out of the study, or died during admission.

Participants were randomized to a control group (N = 85) who received hygiene with soap and water or an intervention group (N = 85) who received dry hygiene using wipes impregnated with soap and moisturizing lotion, without the need for rinsing. The professionals who administered dry hygiene were trained prior to the study in accordance with an internal protocol of the center, based on the indications for the hygiene of the bedridden patient.

4.3. *Study variables and data collection*

To calculate the costs associated with each hygiene method, the quantity of resources used for a patient during a hygiene session was multiplied by the corresponding unit price. Personnel costs were determined based on the assumption that one nurse and one auxiliary nurse technician delivered the hygiene. Data on the use of materials and the time necessary for a hygiene session were collected via a survey administered to professionals. To calculate the additional hygiene resources associated with CAUTIs, the probability of infection (16.5% in traditional hygiene and 5.9% in dry hygiene) was obtained from a previous study in the same patient sample and weighted by the

resources associated with their cost based on a systematic review [26]. The remaining costs are specific to the HUGTP, were calculated for the year 2023, and do not include VAT (Table 1).

Table 1. Costs associated with hygiene-related resource use.

Resource	Cost (€)	Unit of analysis
Nurse workload	0.45	Minute
Auxiliary nurse technician workload	0.31	Minute
Sponge	0.04	Unit
Conventional wipe	0.02	Unit
Towel	0.36	By session
Pads	0.07	Unit
Cardboard tray	0.48	Unit
Wipe impregnated with soap and moisturizing lotion	0.59	Unit
Additional resources associated with CAUTI	12.674	By infection

Patient and professional satisfaction were assessed via four ad hoc surveys, one for each hygiene method and group (Table 2). The survey items were formulated as yes/no questions, with one item on overall satisfaction rated on a Likert scale. Results are presented as the percentage of affirmative answers out of the total responses received.

Professionals voluntarily completed a 10-item paper-based survey at the end of their shift. A total of 54 professionals using traditional hygiene responded, along with 79 for dry hygiene. The patient survey consisted of eight questions and was administered by a nurse specialist in charge of infection control on the day prior to discharge. In total, 46 patients undergoing traditional hygiene and 56 patients undergoing dry hygiene participated, representing response rates of 54% and 63%, respectively, out of the total number of patients in the sample.

Table 2. Topics covered in the ad hoc satisfaction surveys administered to professionals and patients.

Professionals		Patients	
Traditional hygiene	Dry hygiene	Traditional hygiene	Dry hygiene
Ease of washing	Preferred technique	Comfort of the hygiene	Sensation of the wipe
Water temperature	Amount of material needed	Respect for privacy	Lack of water use
Time required	—	Water temperature	—
Patient comfort	—		—
Impact on the skin	—		
Overall assessment		Overall assessment	

In parallel, the environmental team recorded the weight of each type of material used in each hygiene session. To compare the environmental impact of the two methods, the CO₂ emissions associated with each type of hygiene were calculated by multiplying the weight of each material by its corresponding waste emissions factor, according to the emissions calculator of the Voluntary

Agreements of the Generalitat de Catalunya [27–29]. In addition to the material used, primary packaging (containers or bags) and secondary packaging (boxes or pallets) were also considered. The impact of transport and contamination generated by chemicals was not taken into account (Table 3).

Table 3. Weight (g) of the materials used per hygiene session.

Material		Weight (g)
<i>Disposable material</i>		
Sponge	Sponge	25.00
	Packaging	13.80
Disposable wipe	Wipe	156.00
	Packaging	1.80
Pad	Pad	51.00
	Packaging	4.28
Cardboard tray	Tray	165.00
	Packaging	11.18
Wipe impregnated with soap and moisturizing lotion	Wipe	287.58
	Packaging	18.91
<i>Reusable material</i>		
Towel*		19.50

*Estimated lifespan of 80 washes.

In addition, the carbon emissions associated with the use of water as a raw material and the energy needed to heat it were calculated. To calculate energy consumption, both the HUGTP’s decentralized electric system for instant generation of domestic hot water (DHW) and the centralized system with a water tank and gas boiler, common in most hospitals, were considered. The following emissions factors were used: 0.385 kg CO₂ eq/m³ for water as a raw material, 0.252 kg CO₂/kWh for gas-powered energy to heat the water, and 0 kg CO₂/kWh for renewable energy to heat the water. For traditional hygiene, an estimated 4 L of DHW are used for the hygiene itself, 35 L of cold sanitary water to make the pulp for the cardboard trays, and 14.91 L for washing towels, according to the laundry service.

In contrast, no water was used for dry hygiene. To calculate the energy consumption for DHW, the following factors were considered: 0.25 kWh/L for heating water with the centralized water tank using a gas boiler and 0.03 kWh/L with the decentralized system using an electric instant water heater. Energy consumption for towel washing was calculated as 0.15 kWh/L per hygiene session, based on data provided by the laundry company.

4.4. Data analysis

Data processing and analysis were undertaken using the Excel program in the Microsoft Windows Office package. To compare the results of the satisfaction surveys, the chi-square test and the student t test were used. P values of less than 0.05 were considered statistically significant. The R Studio statistical program (version 4.3.3) was used.

Regarding the economic evaluation, a one-year time horizon and a social perspective were used. The analysis follows the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) [30].

4.5 . Ethical Considerations

The study was performed in accordance with the guidelines set out in the Declaration of Helsinki. The Clinical Research Ethics Committee of the HUGTP (protocol code PI-18-173) approved the study. An information sheet was provided to the participants explaining in detail what the study consisted of and the benefits and risks to which they were exposed, always making clear the participants’ freedom to leave the study at any time. They were asked to sign informed consent form if they agreed to participate in the study.

5. . RESULTS

5.1 . Economic analysis

According to the survey results, hygiene with soap and water takes health personnel a mean 17 minutes (standard deviation [SD] 6.51), while dry hygiene takes an average of 12.64 minutes (SD 5.23). Regarding materials, the traditional method uses 6.42 (SD 1.50) sponges, 2.60 (SD 4.05) conventional wipes, 3.89 (SD 0.55) towels, 5.14 (SD 3.36) pads, and 2 (SD 0.00) cardboard trays per hygiene session, versus 8.17 (SD 1.35) wipes impregnated with soap and moisturizing lotion when using dry hygiene.

There was a statistically significant difference in the cost per hygiene session between the traditional method versus the dry method (€15.82 vs. €14.35). In both cases, most of the cost derived from the professional’s workload. If only the cost of the material is taken into account, the difference is slightly larger, with a cost of €3 for traditional hygiene and €4.82 for dry hygiene (Table 4).

Table 4. Total cost per hygiene session.

Resource	Traditional hygiene		Dry hygiene		P value
	Cost (€)	% total	Cost (€)	% total	
Workload	12.82	81.04%	9.53	66%	<0.05
Wipe impregnated with soap and lotion			4.82	34%	
Sponge	0.24	1.52%			
Conventional wipe	0.04	0.25%			
Towel	1.41	8.91%			
Pad	0.35	2.21%			
Cardboard tray	0.96	6.07%			
Total	15.82	100%	14.35	100%	

If we also include the additional indirect costs associated with the risk of a CAUTI (16.5% for traditional vs. 5.9% for dry hygiene), estimated at 12,674€ per infection, the cost per hygiene session with the traditional method comes to 2,107.04€, while that of dry hygiene amounts to 762.12€, representing a theoretical savings per hygiene valued at 1,344.92€.

A sensitivity analysis was performed to modify the assumed risk of contracting a CAUTI with dry hygiene by increasing and decreasing it by 5%. In the first case, the expected cost of hygiene using wipes amounted to €1,395.83, reducing the savings by almost half, to €711.21. If the risk of a CAUTI decreased by an additional 5% with the dry method, the expected cost per hygiene session dropped to 128.42€, increasing the savings to 1,978.63€. The results show that substituting traditional hygiene with dry hygiene saves costs in both scenarios.

5.2. Patient and professional satisfaction

The results of the patient satisfaction survey suggest that dry hygiene is more comfortable, more respectful of the patient’s privacy, and leaves patients with a greater sense of cleanliness compared to traditional hygiene, although the differences were not statistically significant.

Patients who received traditional hygiene rated it with a mean score of 8.71 out of 10, with most (96%) indicating that the water temperature was adequate. Patients who received dry hygiene assigned it a similar rating (8.69 points). In addition, the vast majority (98%) liked the feel of the wipe and did not miss the lack of water (95%) (Table 5).

Table 5. Results of the patient satisfaction survey.

Survey item	Traditional hygiene	Dry hygiene	p value
The hygiene was comfortable.	43 (93%)	56 (100%)	0.053
It respects privacy.	45 (98%)	56 (100%)	0.272
The water temperature was adequate.	43 (93%)	-	-
The wipe felt good on the skin.	-	55 (98%)	-
The hygiene felt cold.	3 (7%)	4 (7%)	0.902
It left me feeling clean.	44 (96%)	56 (100%)	0.117
I missed the use of water.	-	3 (5%)	-
Overall score (1–10) (standard deviation)	8.71 (1.22)	8.69 (1.03)	0.91

The results of the professional satisfaction survey showed statistically significant differences between the two methods. Professionals reported that dry hygiene was more comfortable for the patient and better preserved the qualities of the skin. In addition, the overall rating among professionals was significantly more favorable with the new technique (8.58 points), compared to traditional hygiene with soap and water (7.29 points).

Furthermore, professionals reported that dry hygiene was easier to perform and required less time and material than traditional hygiene, although these differences were not statistically significant. In addition, 90% of the professionals who performed dry hygiene preferred that technique to the traditional one (Table 6).

Table 6. Results of the professional satisfaction survey.

Survey item	Traditional hygiene	Dry hygiene	p value
It's easy to use.	52 (96%)	79 (100%)	0.086
It requires a lot of time.	17 (31%)	-	-
It takes less time than traditional hygiene.	-	79 (100%)	-
It's comfortable for the patient.	25 (46%)	72 (91%)	p<0.05
It requires less material than traditional hygiene.	-	79 (100%)	-
It preserves the qualities of the skin.	23 (43%)	79 (100%)	p<0.05
It's my preferred technique.	5 (10%)	71 (90%)	p<0.05
The water temperature is good.	22 (41%)	-	-
Overall score (1–10) (standard deviation)	7.29 (1.32)	8.58 (1.19)	p<0.05

5.3. Environmental impact

When using guaranteed renewable energy and instant generation of DWH, as in the HUGTP, there was no difference in the emissions generated between the two hygiene methods (220.07 g CO₂ for traditional hygiene and 215.17 g CO₂ for dry hygiene). However, if using the conventionally

sourced energy (water tank and gas boiler), traditional hygiene emissions per session would be higher (1,055.31 g CO₂) than those of dry hygiene (215.17 g CO₂).

The reasons for this difference reside primarily in the energy needed to heat and use water for traditional hygiene, which account for 81.11% of total emissions. Another 16.40% comes from the emissions generated by disposable material waste, 1.12% from packaging waste, and 1.37% from reusable material. In dry hygiene, almost all emissions (99.50%) are generated by waste from disposable material, and only 0.50% come from packaging (Table 7).

Table 7. Emissions generated per hygiene session.

Source of emissions	Traditional hygiene (g CO ₂)	% total	Dry hygiene (g CO ₂)	% total
Waste from disposable materials	173.05	16.40%	214.10	99.50%
Waste from primary and secondary packaging	11.84	1.12%	1.07	0.50%
Reusable waste	14.48	1.37%	0	0.00%
Water and associated energy	855.94	81.11%	0	0.00%
Water and associated energy from renewable source	20.70	-	0	-
Total	1055.31	100%	215.17	100%
Total (renewable energy)	220.07	-	215.17	-

6. . DISCUSSION

Our study shows that replacing traditional hygiene with dry hygiene significantly reduces costs while yielding similar outcomes in terms of patient and professional satisfaction and environmental impact. The reduction in costs is mainly due to the decreased risk of acquiring a CAUTI (16.5% in traditional hygiene vs. 5.9% in dry hygiene). If the resources needed to deal with these infections are accounted for, the hygiene costs are €1,344.92 lower when using the dry method. However, if the resources linked to UTIs are not taken into account, the price per hygiene session between the two techniques is practically the same (€15.82 traditional vs. €14.35 dry).

These results are consistent with those reported elsewhere. For example, studies by Larson and Nøddeskou estimated a cost of €16.56 and €12.67 per session of dry hygiene, respectively, without taking the risk of CAUTIs into account, values very similar to those obtained in this analysis. In both cases, the cost of dry wipes was similar to the traditional method, and the health professional workload represented the most significant expense. Furthermore, previous studies have estimated that the mean time needed for hygiene decreases by 19.4% to 30.7% when using the dry method. Our data are within this range, with an estimated reduction of time of 25.6%. However, we cannot account for CAUTIs in this comparison, since, to our knowledge, there is no scientific evidence in this regard.

Dry hygiene has a smaller carbon footprint than traditional hygiene when using conventional energy systems (215.17 g CO₂ vs. 1,055.31 g CO₂), mainly because dry hygiene does not require any water. In settings where renewable energy is used, the environmental impact is nearly the same (215.17 g CO₂ vs. 220.07 g CO₂).

Regarding the patient experience, our results do not show significant differences in satisfaction between the two methods. However, other studies report that patients feel more comfortable, fresher and cleaner with the dry hygiene method [19,31]. In the case of the professional satisfaction, our study coincides with Nøddeskou's in underlining the clear preference for dry hygiene. Additionally, their study highlighted that dry hygiene minimized the impact on the environment due to a substantial decrease in waste.

The beneficial outcomes associated with dry hygiene help explain why this technique is being increasingly adopted in clinical practice across many healthcare centers. In short, this new method represents an investment in CAUTI prevention and quality of care.

The study has several limitations. First, there were resources used that could not be quantified. In the hygiene with wipes, these resources consisted of disposable gloves, and in traditional hygiene, of lotion, soap, and disposable gloves. Secondly, there were patients who withdrew from the study due to discharge, death or worsening health status. Thirdly, the satisfaction surveys used were designed for this study and were not validated. As responses were subjective and obtained from a specific group of hospitalized patients, they may be at risk of social bias and cannot be extrapolated to other patients. Fourthly, the conclusions presented here are conditional on the results of the study by Castellà, L., et al, which estimated the risk of acquiring a CAUTI when receiving traditional and dry hygiene.

7. CONCLUSIONS

The results of the present study demonstrate that replacing traditional hygiene with dry hygiene based on the use of disposable wet wipes has a positive impact. Dry hygiene provides the same effectiveness in terms of satisfaction, has a similar or lower impact on the environment, and comes at a significantly lower cost.

8. RELEVANCE TO CLINICAL PRACTICE

From an economic, environmental and satisfaction point of view, it is beneficial to replace the traditional hygiene method using soap and water with dry hygiene method using disposable wet wipes. These results are relevant for improving patient care during hygiene and for estimating the economic and environmental impact of this change.

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