

CLINICAL ARTICLE

Gynecology

“Water or not water: That is the question.” Analysis of costs and consumption of the operating theaters in a greener perspective

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Abstract

Objective: To compare the amounts of water and plastic used in surgical hand washing with medicated soaps and with alcohol-based products and to compare costs and consumption in a year, based on scheduled surgical activity.

Method: This retrospective study was carried out at Udine's Gynecology Operating Block from October to November 2022. We estimated the average amount of water with a graduated cylinder and the total cost of water usage based on euros/m³ indicated by the supplier; for each antiseptic agent we collected the data relevant to wash time, amount of water and product used per scrub, number of handscrubs made with every 500 mL bottle and cost of a single bottle. We put data into two hypothetical contexts, namely WHO guidelines and manufacturers' recommendations. Data were subjected to statistical analysis.

Results: The daily amount of water using povidone-iodine, chlorhexidine-gluconate and alcohol-based antiseptic agents was 187.6, 140.7 and 0 L/day (*P* value = 0.001), respectively; A total of 69 000 L/year of water would be saved if alcohol-based products were routinely used. A single unit of an alcohol-based product allows three times as many handscrubs as any other product (*P* value = 0.001) with consequent reduction in plastic packaging.

Conclusion: Despite the cost saving being negligible, choosing alcohol-based handrub over medicated soap handrub – on equal antiseptic efficacy grounds – could lead to a significant saving of water and plastic, thus making our operating theaters more environmentally friendly.

KEYWORDS

alcohol hand rub, antiseptic agents, healthcare waste, operating theaters, plastic waste, surgical hand antisepsis, water use

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1 | INTRODUCTION

Nowadays, the concept of green economy has a great relevance in Europe as shown by the release of the latest version of Environmental Footprint methods¹ which helps companies to assess their environmental impact and optimize their use of natural resources. This also applies to the use of water, the availability of which is decreasing in a worrying way: it is estimated that about 66% of the world population (equal to 4 billion people) live in conditions of severe scarcity of water for at least 1 month a year.² Among different types of water usage, clean water and sanitation services are an important issue of public health, representing one of the main goals of the United Nations Sustainable Development program³ and European Union commitments to the Water Action Agenda.⁴

In healthcare facilities – especially after the outbreak of the COVID19 pandemic⁵ – hand washing represents a fundamental routine action and it implies the daily use of water. With reference to surgical hand scrub, the WHO guidelines identify two methods.⁶ One is the “surgical antiseptic handwashing” in which an antiseptic soap is used along with water; the other is the “surgical waterless antiseptic handrubbing” in which an alcohol-based antiseptic handrub is used with no need for water and requiring no brush, sponge, sterile towels or other devices.

A 2018 meta-analysis⁷ compared the antiseptic efficacy of surgical handwashing with chlorhexidine gluconate (CGH), povidone-iodine (PI), and surgical waterless handrub (WHR), leading to the conclusion that the WHR and the CGH group had a significantly lower residual bacterial count after washing than the PI scrub group; moreover, the antiseptic efficacy of WHR and CHG scrubs products did not differ significantly. This study confirms the results of a previous Cochrane Review of 2016.⁸

Currently, the WHO stands in favor of alcohol-based products because of their rapid action, time saving, fewer adverse effects (related to the use of brushes that can cause damage to the skin) and the lower risk of contamination related to contact with water.

In consideration of the need for a greater “environmental awareness” and the non-inferior antiseptic efficacy of the alcohol-based waterless handrubbing, the aim of this study was to compare the amount of water used in surgical scrubbing with medicated soap and with alcohol-based products, in the context of the most widely used hygiene products and the basin system of the operating theaters (OT) of the Operating Block of the Gynecology and Obstetrics Clinic of Udine's S. Maria della Misericordia hospital.

2 | MATERIALS AND METHODS

A retrospective study from October 2022 to November 2022 was conducted at the Obstetrics and Gynecology Clinic of S. Maria della Misericordia Hospital in Udine, Italy.

The basin system of the OT of the Operating Block is equipped with standard elbow taps, therefore when the surgeon performs the surgical washing, the water comes out at maximum flow; thus, this

system does not allow control of the water flow. A graduated cylinder was placed in the sink collecting the amount of water coming out in 10s; this value was then multiplied by six to obtain the quantity of water in L/min. This estimate does not take into account, in calculating water usage, the time required for the water to heat up and the time employed to turn off the tap and stop the flow of water.

The calculation of the amount of water used was entered in two hypothetical contexts:

- Comparison of the amount of water used in surgical scrub with medicated soap and in waterless surgical handrubbing according to the times and procedural methods indicated by the WHO, who encourage the application of its guidelines in hospitals across the world.⁶ In the first case the procedure lasts 3 min per arm on average, hence a total of 6 min, whereas in the second case the basic procedure lasts 60s on average and must be repeated 3 times, hence a total of 3 min.
- Comparison of the amount of water used in three surgical washing methods using the products available at Udine's Gynecology Clinic, that is chlorhexidine scrub (based on 4% chlorhexidine gluconate – Neo sterixidina soap by Germocare), povidone-iodine scrub (based on 7.5% povidone-iodine – LH iodio 75 by Lombarda H) and ethanol-based handrub (ethanol 89 g/100 g – Skinman Soft Protect by Ecolab). The calculation of the amount of water took into account the times and procedural methods indicated by the manufacturer: for chlorhexidine scrub the manufacturer recommends applying 5 mL of product on the hands for 1 min, repeating this washing and prolonging it for another 2 min; for povidone-iodine scrub, the manufacturer recommends using 5 mL of product for 2 min, subsequently repeating this procedure with another 5 mL of product; for ethanol-based handrub the manufacturer recommends the use of 3 mL of product for a contact time of 90s.

The number of washes performed with each 500 mL bottle (unit available in our hospital) was calculated and an average cost of 2.5 euros per bottle of antiseptic product was estimated on purchase records.

Statistical analyses were performed using SPSS version 19.0 (IBM, Armonk, New York, USA). Quantitative variables were described using mean. Groups were compared using the *t*-test or Kruskal Wallis test for continuous variables and the χ^2 test or Mann-Whitney test for categorical variables, as appropriate. A *P* value less than 0.050 was considered statistically significant (2-tailed test). Multivariate analysis was not performed since only one variable was considered for each outcome.

No informed consent was needed since human participants were not included. No institutional review board approval was required for this study.

3 | RESULTS

In the OT of Udine's Gynecology Clinic, the scheduled operating activity involves, from Monday to Friday, two major surgical

operations per day with an operating room team made up of three operators (3 gynecologic surgeons) and an average of five minor surgeries with an operating room team composed of two operators (2 gynecologic surgeons); the team is completed by a scrub nurse, an anesthetist, a nurse anesthetist and a healthcare assistant. The scheduled operating activity takes place 245 days out of 365 days a year, thus resulting in 1715 scheduled gynecologic surgeries a year.

In major surgeries, surgical hand washing is performed each time by four team operators (3 surgeons and the scrub nurse), whereas in minor surgeries it is performed each time by three operators (2 surgeons and the scrub nurse).

In 10s the amount of water that comes out of the tap is 0.34 L hence 2.04 L of water in 1 min. Taking this value into account, the results obtained are summarized in [Tables 1](#) and [2](#).

[Table 1](#) shows the amount of water used for each scrub in the context of the basin system of Udine's Gynecology OT in the case of antiseptic handwashing and waterless antiseptic handrub according to the procedure indicated by the WHO. In the first case, the amount of water used is equal to 2.04 multiplied by six (minutes needed to complete the procedure) for a total of 12.24 L/scrub; in the second case, the amount of water used is 0 L, since its use is not necessary, which leads to a statistically significant difference (P value = 0.001).

Considering the number of gynecologic surgeries per day and the number of surgical handwashing performed for each surgery depending on the number of team operators, the volume of water used in 1 day, in the case of handwash with medicated soap, amounts to 281.5 L/day.

[Table 2](#) compares the amount of water used following the procedural indications of the manufacturers of the three products available in Udine's Gynecology OT. In the case of chlorhexidine scrub, the amount of water used is obtained by calculating 2.04 L multiplied by 3 min totaling 6.12 L of water used per scrub; the quantity of product recommended per scrub is 10 mL. Consequently, 50 washes can be performed with each 500 mL bottle of product. In the case of povidone-iodine scrub, the amount of water used in 1 min is multiplied by the 4 min needed to complete the procedure totaling 8.16 L of water used per scrub; the recommended quantity per scrub is 10 mL, therefore 50 washes can be performed with each 500 mL bottle of product. Finally, in the case of ethanol-based handrub the

amount of water used is 0 L; the amount of product needed per scrub is a total of 3 mL, therefore 167 washes can be performed with each 500 mL bottle of product. Making the necessary calculations, the daily amount of water used for surgical handwashing amounts to 140.7 L/day for chlorhexidine scrub, 187.6 L/day for povidone-iodine scrub and 0 L/day for alcohol-based handrub.

As for the quantity of water used per scrub, the amount of antiseptic agents used per scrub and the number of scrubs that can be performed with one bottle, there was a statistically significant difference between groups of comparison (P value = 0.001).

In comparison with PI and CGH, ethanol-based handrub leads to a 62.5% and 50% time saving (P value = 0.023) and to an overall 70% antiseptic product saving.

Finally, considering the estimated cost of about 2.5 euros/bottle and the number of washes that can be performed per bottle, each scrub with povidone-iodine and each scrub with chlorhexidine costs 0.05 euro/scrub whereas each scrub with alcohol-based handrub costs 0.01 euro/scrub, which leads to an 80% cost saving.

4 | DISCUSSION

With a view to adopting more environment-friendly behaviors in daily practice, the results obtained favor waterless handrubbing over alcohol-based products mainly for two reasons.

The first reason lies in the saving of significant amounts of water, that is, 68967.5 L/year in Udine's Gynecology Operating Block. Our results are consistent with those of similar studies in the literature.^{9,10}

Comparing different antiseptic products available in daily practice, this reduction is greatest when ethanol-based handrub is preferred and particularly so if chlorhexidine scrub is used instead of povidone-iodine scrub (45962 L/year of water used in the case of PI vs. 34471 L/year of water used in the case of CGH with a saving of around 11000 L/year). It is clear that the choice of the antiseptic agent depends greatly on the surgeon's preference, its acceptability and tolerability. According to Udine's Hospital's guidelines, surgeons can use their preferred method of scrubbing as long as they ensure surgical hand antisepsis according to WHO definition and by exclusively using hand antiseptics that are registered as medical surgical devices in conformity with the Italian

TABLE 1 Comparison of wash time and water consumption according to procedural methods indicated by the WHO.

Variable	Univariate ^a	
	Risk ratio (95% CI)	P value
Wash time		
Antiseptic handwashing (handwashing with medicated soap)	2.675 (1.344–3.484)	0.001
Waterless antiseptic hand rub (ABHR-alcohol based hand-rub) ^b		
Water used		
Antiseptic handwashing (handwashing with medicated soap)	4.856 (2.659–8.978)	0.001
Waterless antiseptic hand-rub (ABHR-alcohol based hand-rub) ^b		

Abbreviation: CI, confidence interval.

^aMultivariate analysis was not performed since only one variable was considered for each outcome.

^bReference category.

TABLE 2 Comparison of wash time, water consumption, use of product quantities and use of number of bottles according to the procedural methods indicated by the manufacturers of three products used in the operating rooms of Udine's hospital.

Variable	Univariate ^a	
	Risk ratio (95% CI)	P value
Wash time		
Chlorhexidine - gluconate scrubs (CGH)	1.675 (1.188–2.580)	0.023
Povidone-iodine scrubs (PI)		
Alcohol-based hand-rub (ABHR) ^b		
Water used		
Chlorhexidine - gluconate scrubs (CGH)	2.856 (1.659–4.918)	0.001
Povidone-iodine scrubs (PI)		
Alcohol-based hand-rub (ABHR) ^b		
Amount of antiseptic agent/scrub		
Chlorhexidine - gluconate scrubs (CGH)	2.298 (1.788–5.027)	0.001
Povidone-iodine scrubs (PI)		
Alcohol-based hand-rub (ABHR) ^b		
Number of surgery hand preparation procedures/500 mL bottle		
Chlorhexidine - gluconate scrubs (CGH)	2.439 (1.705–3.193)	0.001
Povidone-iodine scrubs (PI)		
Alcohol-based hand-rub (ABHR) ^b		

Abbreviation: CI, confidence interval.

^aMultivariate analysis was not performed since only one variable was considered for each outcome.

^bReference category.

legislation. In the literature, several studies demonstrate that ABHR is more accepted by surgeons than handwashing, probably because it requires less time and is associated with fewer skin reactions.^{11–13} On the other hand, should the surgeon's choice fall on handwashing, the green awareness of the OT could still make use of another water-saving mechanism: installation of a modern basin system that includes motion-active taps equipped with photocells to reduce the flow of water to a minimum during the procedure. This could also be the starting point for future comparative studies on the extent of water savings with this system.

The second reason is related to plastic saving. If with a single bottle of 500 mL of alcoholic solution it is possible to carry out more washes, it means that fewer bottles must be disposed of as plastic waste and this reduction amounts to more than one third (167 washes/bottle vs. 50 washes/bottle). Although the precise amount of plastic waste in hospitals is not known, it is calculated that plastic represents 30% of healthcare waste, a value that rises to 46% in Italy.¹⁴ The importance of reducing the use of plastic in the medical field is therefore evident, starting with medical packaging.¹⁵ In this view, the choice of alcohol-based handrubbing would allow further saving of plastic, considering that no brushes/sponges (made of plastic) and drying towels (individually wrapped in plastic packages) are used in this procedure. Furthermore, non-use of brushes could explain the lower incidence of damage and irritation to the skin - which represents a further point in favor of this procedure. A 2016 systematic review¹⁶ highlighted how skin reaction and damage are more frequently observed after surgical hand scrub with chlorhexidine than after use of an alcohol-based solution probably due to an excessive elimination of the superficial layers of the skin caused by scrubbing with a brush.

Another important issue to consider is the cost of health. Global health expenditure represents 10% of world gross domestic product.¹⁷

Considering that 30% of healthcare costs are attributable to wastage, 70% of which come from OT¹⁸ and given that several studies have highlighted how there is a lack of cost awareness among surgeons and operating room staff,^{19,20} it is clear that the saving of relevant volumes of water and the reduction of the number of medical supplies used (brushes, non-reusable drying towels, bottles of antiseptic agents) also have an economic impact by reducing operating room costs. In the specific case of Udine's Gynecology Operating Block, as regards the medical supplies, knowing the scrub/day cost for each available product (1.15 euro/day in the case of PI and chlorhexidine and 0.23 euro/day in the case of an alcohol based antiseptic agent) a total saving of 225.4 euros/year would be obtained (281.7 euros/year vs. 56.3 euros/year). This estimate does not include the cost of plastic disposal; however, it is reasonable to say that use of povidone-iodine and chlorhexidine antiseptic agents is more expensive because of the larger amount of plastic used that needs to be disposed of, given the number of scrubs that can be done with each bottle.

As far as water is concerned, this saving would amount to 68 967.5 L (water savings/year) times 0.00077 euro/L (0.77 euro per cubic meter being the price indicated by the main water supplier of Udine's hospital), that is, 53.10 euro/year. In comparison with the relevant amount of water saved, on the economic side that saving results to be irrelevant. This is probably due to the fact that Italian hospitals benefit from discounted rates for public use of water.

Finally, it should be emphasized that the choice of waterless handrubbing is harmless for the patient since, as extensively demonstrated in the literature,^{6–8} alcohol-based products do not have less germicidal activity than CG and PI-based products and indeed it seems that they reduce the bacterial counts on hands and have greater antimicrobial effect on antimicrobial-resistant organisms,

enveloped and non-enveloped viruses, Mycobacteria and fungi. Future studies will be conducted to compare the incidence of postoperative infectious complications between different antiseptic agents, in order to contribute to the assessment of the best choice regarding surgical handscrubbing.

5 | CONCLUSION

The consumption of water in the operating theaters can be reduced by favoring alcohol-based surgical handrub before surgery. Given its non-inferior antiseptic efficacy, this water-saving and plastic-saving procedure is easy and, if routinely adopted by surgeons, it would allow the use of such a precious resource as water to be optimized, thus making operating theaters “greener”.

AUTHOR CONTRIBUTIONS

Conceptualization and supervision, Stefano Restaino and Giuseppe Vizzielli; writing—original draft preparation, Veronica Tius; review and editing, Martina Arcieri, Stefano Restaino; supervision, Anna Biasioli, Giulia Pellecchia, project administration, Lorenza Driul. All authors have read and agreed to the published version of the manuscript.

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The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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