SURGICAL HAND ANTISEPSIS WITH ALCOHOL SOLUTION: MICROBIAL REDUCTION AT DIFFERENT APPLICATION TIMES IN THE SURGICAL CENTER

Antissepsia cirúrgica das mãos com preparação alcoólica: redução microbiana em diferentes tempos de uso no centro cirúrgico

Antisepsia quirúrgica de las manos con preparación alcohólica: reducción microbiana en diferentes tiempos de uso en el centro quirúrgico

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ABSTRACT: Objective: To evaluate the microbial reduction after surgical hand antisepsis performed with alcohol solution at different application times among surgeons. **Method:** This is a pragmatic prevalence field study carried out in a Brazilian tertiary hospital. Microbiological samples were collected from the hands of 54 surgeons after simple washing to determine the baseline microbial flora and after surgical antisepsis with an alcohol solution to evaluate the immediate microbial reduction. We categorized the microbial reduction results as mild (up to 50% bacterial flora reduction), moderate (51 to 80%), and high (more than 80%). The research was submitted to and approved by the Research Ethics Committee of the private hospital (study site) and the federal institution of higher education. **Results:** Techniques performed in less than 90 seconds showed an 80% high reduction, 6.7% moderate reduction, and 13.3% mild reduction. In applications that lasted more than 180 seconds, all samples presented bacterial count reduction, which did not occur in shorter antisepsis times. **Conclusion:** When the recommended technique and time are followed, the bacterial reduction is greater compared to lower durations.

Keywords: Antisepsis. Colony count, microbial. Disinfection. Hand disinfection. Surgical procedures, operative.

RESUMO: Objetivo: Avaliar a redução microbiana após antissepsia cirúrgica das mãos dos cirurgiões, realizada com preparação alcoólica, em diferentes tempos. **Método:** Estudo de prevalência, pragmático, de campo, realizado em hospital terciário do Brasil. Coletaram-se amostras microbiológicas das mãos de 54 cirurgiões após lavagem simples, para determinar a flora microbiana basal e, após a antissepsia cirúrgica alcoólica, para avaliar a redução microbiana imediata. Categorizaram-se os resultados da redução microbiana em redução leve (até 50% de redução da flora bacteriana), moderada (de 51 a 80%) e alta (acima de 80%). A pesquisa foi submetida e aprovada pelo Comitê de Ética e Pesquisa da instituição hospitalar privada, sede do estudo, e da instituição de ensino superior federal. **Resultados:** Nas técnicas realizadas em menos de 90 segundos, houve 80% de redução severa, 6,7% de redução moderada e 13,3% de redução leve. Nas técnicas desempenhadas em mais de 180 segundos, todas as amostras apresentaram redução de contagem bacteriana, o que não ocorreu em tempos menores de antissepsia. **Conclusão:** Quando a técnica e o tempo recomendados são seguidos, maior é a redução bacteriana, em comparação aos tempos menores.

Palavras-chave: Antissepsia. Contagem de colônia microbiana. Desinfecção. Desinfecção das mãos. Procedimentos cirúrgicos operatórios.

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RESUMEN: Objetivo: evaluar la reducción microbiana después de la antisepsia quirúrgica de las manos de los cirujanos, realizada con preparación alcohólica, en diferentes momentos. **Método:** Estudio pragmático de prevalencia de campo realizado en un hospital terciario de Brasil. Muestras microbiológicas recogidas de las manos de 54 cirujanos después de un simple lavado, para determinar la flora microbiana basal y después de la antisepsia quirúrgica alcohólica, para evaluar la reducción microbiana inmediata. Los resultados de la reducción microbiana se clasificaron como leves (hasta un 50% de reducción en la flora bacteriana), moderados (del 51 al 80%) y altos (más del 80%). La investigación fue presentada y aprobada por el Comité de Ética e Investigación de la institución del hospital privado, sede del estudio y de la institución federal de educación superior. **Resultados:** en las técnicas realizadas en menos de 90 segundos hubo una reducción severa del 80%; 6,7% de reducción moderada; 13,3% de ligera reducción. En las técnicas realizadas durante 180 segundos, todas las muestras presentaron una reducción en el recuento bacteriano, lo que no ocurrió en tiempos de antisepsia más cortos. **Conclusión:** Cuando se siguen la técnica y el tiempo recomendados, mayor es la reducción bacteriana, en comparación con los tiempos más cortos.
Palabras clave: Antisepsia. Recuento de colonia microbiana. Desinfección. Desinfección de las manos. Procedimientos quirúrgicos operativos.

INTRODUCTION

Healthcare-associated infections (HAIs) are important adverse events to which patients are exposed, as well as relevant indicators of the quality of care provided[1]. Since the 19th century, hand hygiene (HH) is recognized as an essential measure to prevent infections[1]. Studies by Semmelweiss have proven its impact on puerperal fever mortality rates, as the lack of HH among health professionals caused maternal death to remain above 18% in the Vienna General Hospital[1,2].

The Centers for Disease Control and Prevention (CDC) from the United States of America, one of the main guiding agencies for HH practices, publishes guidelines for this measure since the 1970s[3-6]. Surgical site infections (SSIs) are complications that can occur during surgical procedures, manifesting in the incision or the manipulated organ. In Brazil, SSIs hold the third place among the HAIs, striking 14 to 16% of hospitalized patients[5]. American data indicate that SSIs affect 500 thousand patients, resulting in a significant increase in the length of stay and hospital costs, in addition to the physical, emotional, and financial damage to patients and their families[6].

SSI is a multifactorial complication that depends on factors related to the patient, the team, and the surgery[3]. Regarding the procedure, one of the most relevant factors is the hand antisepsis of the team, as it acts on reducing the microbial load on the hands[3-9]. The traditional preoperative HH method consists of using brushes soaked in antiseptics[10]; however, alcohol solutions have been widely recommended by the World Health Organization (WHO), given their advantages, which include less time spent in hand preparation, reduction in dermatological effects, economy in the use of resources, such as water and sponges, besides the decrease in waste[10].

A study on the substitution of brushing for alcohol antiseptic at the Surgical Center (SC) of a private hospital in Southern Brazil revealed that the adherence to the proper technique for the use of alcohol solution by surgeons and scrub nurses was 35.8%[11]. Rubbing time was the main issue observed (94.2%)[11], as it was shorter than the recommended by the manufacturer of the product (2 minutes). The literature has few references that suggest lower times of alcohol antisepsis. These factors motivated the present study.

OBJECTIVE

To evaluate the microbial reduction of surgical hand antisepsis with alcohol solution performed by surgeons at different application times, under practical conditions of use in SC.

METHOD

This is a pragmatic prevalence field study conducted at the SC of a private hospital in Southern Brazil, after approval by the Research Ethics Committee. Culture processing and microbial count were performed in the Microbiology Laboratory of the Universidade Federal de Ciências da Saúde de Porto Alegre (UFCSPA). Data were collected from April to June 2017. We used the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) as a reference for the research.

The non-probabilistic sample consisted of surgeons working in the institution. Samples were collected from the hands of 54 random and non-deliberately selected surgeons before the procedure. The inclusion criteria comprised agreeing to participate in the research, signing the Informed Consent

Form (ICF), choosing to perform surgical hand preparation with the alcohol solution, employing the proper technique (step by step) for surgical hand antisepsis, not using hand jewelry/accessories (such as rings, watches, or bracelets), and having no hand lesions. We excluded surgeons who performed antisepsis for emergency procedures from the sample.

Considering a 90% power to test the difference between the mean contamination at moments 1 and 2 of the procedure, we estimated that the sample should include 44 surgeons, adopting a $p < 0.05$.

The participants signed the ICF. The study was submitted to and approved by the Research Ethics Committee of the private hospital, under the Certificate of Presentation for Ethical Consideration (*Certificado de Apresentação para Apreciação Ética* – CAAE): 59234816.9.3001.5328, and the federal institution of higher education, under CAAE: 59234816.9.0000.5345.

The product evaluated in the test was Purell Surgical Scrub® (gel), produced by GOJO Industries Inc., available in the institution for the surgical hand antisepsis of the professionals. Its formulation consists of 70% ethanol (weight/weight — w/w) in gel form. Data were collected by non-participant observation and microbiological cultures.

The first part involved direct observation of the surgical hand antisepsis with the alcohol solution to determine the application time and verify the adherence to the standardized technique, using an instrument to record the characterization of the professional, their specialty, and the time to perform the technique. The researcher did not interfere with the technique used by the surgeon for surgical antisepsis with the alcohol solution; however, she instructed the participants to proceed with simple hand washing. We considered the surgical antisepsis with alcohol solution adequate when the movements were performed as recommended by WHO[10], which succinctly proposes the hygiene of nail beds, fingers, palm and back of one hand, and forearm, followed by the same procedures in the opposite hand. The proper technique was based on the manufacturer's recommendations, which indicate an application time of 120 seconds, or 2 minutes.

Culture samples were collected after hand washing to determine the baseline microbial flora of the professional and after the surgical hand antisepsis with the alcohol solution to identify the immediate microbial count reduction.

The surgeon removed the resident hand flora by simple hand washing with the triclosan-based antiseptic soap available in SC, using the standard technique of the institution. The distal phalanges of both hands were rubbed for 1 minute in a Petri dish containing 10 mL of tryptic soy broth (TSB) and neutralizers (3% polysorbate 80, 3% saponin, 0.1% histidine, and 0.1% cysteine) to determine the colony-forming unit (CFU) values in the two collection times (pre- and post-antisepsis). A 0.1-mL aliquot of this broth, as well as the same amount of broth diluted in 1 mL (1:10) and 0.1 mL of the latter preparation diluted in 1 mL (1:100), was streaked onto a tryptic soy agar (TSA) plate. The interval between collection and streaking did not exceed 30 minutes. The plates were transported to the laboratory of the university for incubation at 37°C±2°C and read after 24 hours.

We chose this methodology based on studies that used the EN-12054 European method[12,13], but with adaptations:

- the methodology proposes intentionally contaminating the hands with strains of *Escherichia coli*; however, this research evaluated the microbiota in real conditions, that is, in the work environment of health professionals;
- the comparison performed in this study was not between the antiseptic solution and the reference product, as indicated by the methodology. We compared the microbial counts of hands cleaned with the same product, but at different application times;
- the plates were incubated for 24 hours at 37°C±2°C.

We identified the number of CFUs for each dilution and multiplied this value by the dilution factor to find the number of CFUs per mL of liquid sample. We used CFU counts at the 1:10 dilution to compare the pre- and post-antisepsis moments. The difference between pre- and post-antisepsis counts was established, followed by its representation in percentage and logarithmic reduction factor ($\log_{10}$). We categorized the percentage of reduction as mild (up to 50%), moderate (51 to 80%), and high (above 80%). This classification is not referenced in the literature and was proposed to enable comparisons between the reductions, stratifying them by time categories. We grouped the results of microbial reduction in three categories of application time: up to 90 seconds, 90 to 180 seconds, and above 180 seconds.

This work was presented orally as an education session of AORN Global Surgical Conference & Expo in the United States of America, in 2019, under the title "A comparison of microbial counts with different procedure lengths of alcoholic surgical hand antisepsis."

RESULTS

Samples were collected from 54 subjects, and nine (16.7%) were excluded for suspicion of contamination, evidenced by the significant number of CFUs in the post-antisepsis cultures. Thus, the research comprised 45 participants.

The distribution of surgeons by specialty was: orthopedics and traumatology (n=14, 31%); general surgery (n=12, 27%); head and neck (n=5, 11%); vascular surgery (n=4, 9%); urology (n=3, 7%); gynecology (n=3, 7%); plastic surgery (n=2, 4%); and neur surgery (n=2, 4%).

Out of the 45 samples considered valid, seven (15.5%) showed no bacterial count reduction after antisepsis with the alcohol solution. We calculated the logarithmic reduction factor of microbial count for each sample by subtracting the post-antisepsis count value from the pre-antisepsis sample, obtaining the data presented in Table 1.

Considering only the samples that showed microbial count reduction (n=38), we estimated the percentage of microbial reduction in post-antisepsis samples when compared to pre-antisepsis cultures, classifying them according to the expression of this reduction. Figure 1 demonstrates this distribution.

The mean application time was 116±97 seconds. Table 2 presents and describes the distribution of microbial count reduction grouped by the application time category.

The findings are heterogeneous in their distribution, making unreliable the comparisons between the categories. For this reason, we regrouped the time categories into ≤ 90 seconds and > 90 seconds so that the comparisons could be consistent (Table 3). We also excluded cases with no microbial reduction from the analysis, totaling 38 procedures.

Table 1. Descriptive analysis of the logarithmic reduction in the bacterial count and standard deviation pre- and post-hand antisepsis among surgeons.

		Mean log_{10} (SD)		
		Initial bacterial count	Final bacterial count	Reduction factor (pre/post)
Application time	Up to 90 s N=18	1.53 (0.60)	1.74 (0.60)	0.79 (0.54)
	90 to 180 s N=22	178 (0.88)	0.67 (0.69)	1.12 (0.86)
	More than 180 s N=5	1.40 (0.72)	0.48 (0.66)	0.92 (0.90)

SD: standard deviation.

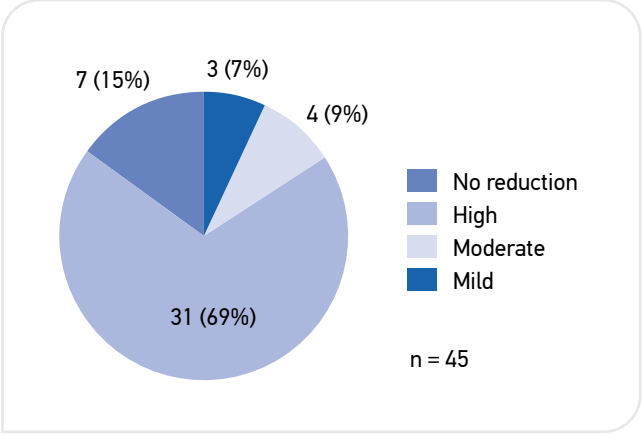

Figure 1. Samples according to the category of microbial count reduction post-hand antisepsis among surgeons.

Table 2. Classification of microbial count reduction according to hand antisepsis time among surgeons.

Classification of microbial count reduction					
Application time	Mild	Moderate	High	No reduction	Total
<90 seconds (absolute number)	2	1	12	4	19
% of the application time	11%	5%	63%	21%	
% of the total sample	4%	2%	27%	9%	
90–180 seconds (absolute number)	0	2	16	3	21
% of the application time	0%	10%	76%	14%	
% of the total sample	0%	4%	36%	7%	
>180 seconds (absolute number)	1	1	3	0	5
% of the application time	20%	20%	60%	0%	
% of the total sample	2%	2%	7%	0%	
Total	3	4	33	7	45

Table 3. Classification of microbial count reduction according to hand antisepsis time among surgeons, after regrouping the time categories.

Classification of cases with reduction					
Application time	**Mild**	**Moderate**	**High**	**No reduction**	**Total**
<90 seconds (absolute number)	2	1	12	15	
% of the application time	13.30%	6.70%	80.00%	100.00%	
% of the total sample	5.30%	2.60%	31.60%	39.50	
>90 seconds (absolute number)	1	3	19	23	
% of the application time	4.30%	13.00%	82.60%	100.00%	
% of the total sample	2.60%	7.90%	50.00%	60.50%	
Total	3	4	31	38	

We used the χ^2 test to check the equivalence of proportions or independence between application time and the outcome analyzed (microbial count reduction), confirming the lack of significant association between them (χ^2 1.284; p = 0.526).

DISCUSSION

With respect to sample characterization, the surgical specialties participating in the study were compatible with the production distribution of the hospital. In total, 15% (n=7 of the 45 analyzed) of the samples showed no bacterial count reduction after the performance of the technique. This fact is alarming, since the transient bacterial flora on the hands prepared for the surgical procedure should be eliminated, and the resident flora should be reduced to the minimum possible[3].

The use of sterile gloves is an additional barrier to the transference of bacteria from hands to the surgical site; nonetheless, sterile gloves have a perforation rate of around 11%, which are imperceptible to the surgical team in 31 to 34% of cases in surgeries lasting more than 2 hours[14,15]. The median and mean application time were 97 and 116 seconds, respectively. These values are compatible with a Finnish study, in which the mean identified was 110 seconds, but below the recommended by the manufacturer[16].

While grouping the time frequencies, we found similarities between the number of professionals who performed the technique in 90 seconds (n=19) and 90 to 180 seconds (n=21), with lower frequency in the category above 180 seconds (n=5). A study shows that the antisepsis lasted 180 seconds in 42% of observations, contrary to the percentage detected in this investigation – 11% (n=5)[16]. When considering the application time recommended by the manufacturer – 120 seconds –, this study presented only 40% (18/45) adherence. These findings demonstrate the difficulties of the surgical team in adhering to the indicated antisepsis technique. Since the professionals were being observed during the procedure, the Hawthorne effect (subject's change of behavior as a result of knowing they are being watched) may have occurred. Thus, the results related to adherence to the application time indicated might be worse in the daily routine. A previous study conducted in the same institution where this research took place revealed that time was the main issue in the antisepsis technique employed by surgeons[11]. Another study identified the same scenario, reporting that 10% of participants performed the surgical antisepsis with alcohol solution in less than 60 seconds[17].

Although the application time was not adequate in comparison to the recommended, when we analyzed the sample distribution according to the category of microbial count reduction, most cases (82%) showed high reduction after antisepsis.

Among the professionals who performed antisepsis in up to 90 seconds, 80% (n=12 out of 15) presented high reduction, a frequency similar to that found in the category above 90 seconds – 82.6% (n=19 out of 23). The χ^2 analysis confirmed the lack of association between application time and the category of microbial reduction (χ^2 1.284; p = 0.526). Even though 90 seconds of application time is not recommended by WHO or referenced by the European standard (EN-12791)[3,18,19], a study demonstrated that its effectiveness could be equivalent to that of 2 or 3 minutes with the use of formulations containing isopropanol and n-propanol, as well as mecetronium ethylsulfate, which do not correspond to the tested product[20].

In applications that lasted more than 180 seconds, all samples presented bacterial count reduction, which did not occur in shorter times. This finding implies that the odds of bacterial reduction are higher when the recommended technique and time are followed when compared to lower durations,

despite the lack of association between application time and bacterial reduction. We underline that only five professionals performed antisepsis for more than 180 seconds, which restricts the use of this information.

The logarithmic reduction factor identified in our study was 1.72±0.74, that is, above the recommended for experimental studies aimed at validating products complying with the EN-12791 standard. According to this standard, an alcohol product for surgical hand antisepsis is considered effective when it presents values not significantly greater than those of the reference product listed in the regulation (60% n-propanol), immediately after its application and after 3 hours. In this standardization, the median logarithmic reduction was 3.27±1.13 for that specific alcohol formulation. In contrast, the study identified that the expected reductions in the resident microbiota are between 1 and 1.3 log10 for formulations containing 70% ethanol[21,22]. Therefore, the reduction values found in this test were not satisfactory in comparison with the product referenced in the standard. However, compared to the study mentioned, which evaluated only ethanol-based products, our results proved to be acceptable.

This research aimed to identify the effect of the product tested on reducing the microbial population on the hands of surgeons in real conditions of use and relate the results with application time. The findings showed no significant association between application time and the category of microbial reduction on the hands. Nevertheless, when antisepsis time was higher than 180 seconds, all cases presented reduction, contrary to the other time categories. Based on this information, we can infer that the longer the application time, the greater the (high) microbiological reduction in absolute percentage, but with non-significant χ^2.

The present study has some limitations, among which we highlight: the volume of alcohol solution used by the professionals was not controlled, which may have influenced the microbial count values on the hands after antisepsis. Also, the Hawthorne effect may have influenced the technique employed by surgeons for hand preparation, interfering with its quality and duration[23]. Moreover, the results cannot be generalized because the sample by specialty was not significantly representative of the population of surgeons of the institution. In addition, we tested only one brand of alcohol solution, which prevents us from extrapolating the findings to other products available in the market. Another variable that can be considered a limiting factor is the fact that, despite the adequate sample calculation, the extracts generated restricted the comparisons between them.

This study demonstrates the importance of using antisepsis techniques with application times validated and recommended by the manufacturer to reduce the microbial load on the hands. The effective performance of the technique allows a safe surgical procedure, ensuring the safety of patient care. In this scenario, the nursing staff, in its active role of promoting risk-free care, may guide and encourage other professionals to apply the proper hand antisepsis technique following an evidence-based practice.

CONCLUSION

After evaluating the surgical hand antisepsis with alcohol solution performed by surgeons at different application times under practical conditions of use in SC, we found bacterial count reduction in most cases when the technique was executed in ≤90 seconds and >90 seconds; however, the difference was not statistically significant. In applications that lasted more than 180 seconds, all samples presented bacterial count reduction, which did not occur in shorter times. The results show that bacterial reduction is greater when the recommended technique and time are followed, as indicated by WHO, compared to lower durations. Experimental studies with adequate control of variables are necessary to confirm this hypothesis.

The mean application time found in this study was 116 seconds, lower than the recommended by WHO. Application time remains a major challenge for surgical hand antisepsis with an alcohol solution.

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