



ORIGINAL

Efficacy of hand hygiene products: A quasi-experimental study

Eficácia de produtos de higienização das mãos: estudo quase-experimental

Eficacia de productos para la higienización de las manos: estudio cuasiexperimental

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ABSTRACT

Objective: to compare the efficacy of hand hygiene products. **Methodology:** a quasi-experimental study, of the before and after type, conducted with 15 Nursing students in the microbiology laboratory of a higher education institution in Piauí. Data collection was carried out by testing the following products: neutral detergent, alcohol gel 70%, povidone iodine 10%, and chlorhexidine 2%. The data were analyzed by means of qualitative observation of the presence of microorganisms after Gram staining in the culture media. **Results:** neutral detergent and alcohol gel 70% had a similar action regarding the presence of bacteria identified in the samples, povidone iodine 10% enabled the reduction of positive and negative Gram cocci and bacilli, and chlorhexidine 2% managed to eliminate a greater variety of bacteria, including Gram negative bacilli, sarcinas, streptobacilli and streptococci. **Conclusion:** hand hygiene with chlorhexidine 2% showed qualitatively greater potential for reducing the number of microorganisms.

Descriptors: Hand hygiene. Antisepsis. Quality control.

RESUMO

Objetivo: comparar a eficácia de produtos de higienização das mãos. **Metodologia:** estudo quase-experimental, do tipo antes e depois, realizado em laboratório de microbiologia de uma instituição de ensino superior piauiense, com 15 acadêmicos de enfermagem. A coleta de dados foi realizada a partir da testagem dos produtos: detergente neutro, álcool gel 70%, iodopovidona 10% e clorexidina 2%. Os dados foram analisados por meio da observação qualitativa da presença de microrganismos após coloração de Gram nos meios de cultura. **Resultados:** o detergente neutro e o álcool gel 70% possuíram ação semelhante quanto à presença de bactérias identificadas nas amostras, a iodopovidona 10% possibilitou a redução de cocos e bacilos Gram positivos e negativos, e a clorexidina 2% conseguiu eliminar maior variedade de bactérias, incluindo os bacilos Gram negativos, sarcinas, estreptobacilos e estreptococos. **Conclusão:** a higienização das mãos com clorexidina a 2% apresentou qualitativamente maior potencial para redução de microrganismos.

Descritores: Higiene das mãos. Antissepsia. Controle de qualidade.

RESUMÉN

Objetivo: comparar la eficacia de productos para la higienización de las manos. **Metodología:** estudio cuasiexperimental, de tipo antes y después, realizado en laboratorio de microbiología de una institución de educación superior del Estado de Piauí, con 15 estudiantes de enfermería. La recolección de datos se realizó a partir del testeo de los productos: detergente neutro, alcohol en gel 70%, iodopovidona 10% y clorhexidina 2%. Los datos fueron analizados por medio de la observación cualitativa de la presencia de microrganismos después de la coloración de Gram en los medios de cultivo. **Resultados:** el detergente neutro y el alcohol en gel 70% presentaron acción similar en cuanto a la presencia de las bacterias identificadas en las muestras, la yodopovidona 10% permitió la reducción de cocos y bacilos Gram positivos y negativos, y la clorhexidina 2% logró eliminar mayor variedad de bacterias, incluidos los bacilos Gram negativos, sarcinas, estreptobacilos e estreptococos. **Conclusión:** la higienización de las manos con clorhexidina a 2% mostró un potencial cualitativamente mayor para la reducción de microrganismos.

Descriptorios: Higiene de las manos. Antissepsia. Control de calidad.

INTRODUCTION

Healthcare-Related Infections (HAIs) are epidemiologically alarming as factors strongly related to mortality at the hospital level. They have the hands of professionals as the main vehicles responsible for the spread of microorganisms, which is one of the reasons that justify the continued need for their hygiene.⁽¹⁾

Despite knowledge about the effectiveness of hand hygiene, adherence by health professionals is variable, ranging from 23.7% to 88.2% in the national scenario and, internationally, with rates below 50% (30% to 40%).⁽²⁾ This mismatch between knowledge and attitude was highlighted in a systematic review, which reported that, although 94% of the professionals agree in performing this practice, only 52% do so, this gap bringing several implications that threaten patient safety.⁽³⁾

In addition to adherence, the effectiveness of hand hygiene must be monitored from the products available for this purpose, among which the following are on the list of recommendations of the National Health Surveillance Agency (*Agência Nacional de Vigilância Sanitária*, ANVISA): neutral soap, 70% alcohol-based preparation, povidone iodine 10% and chlorhexidine 2%.⁽⁴⁾

In a study conducted by American and Asian researchers, it is warned that these solutions, in order to be considered with good effect, must be tested for: microbiological efficacy, tolerance to skin reactions, fragrance, color, texture, viscosity and ease of use; in addition to practical considerations such as: availability, convenience, distribution system, ability to avoid contamination, time to dry and cost.⁽⁵⁾ Thus, it is verified that the choice of the appropriate product is a crucial factor to achieve good results in reducing the microbial load on the hands and, therefore, breaking the cycle of cross-infections in the hospital environment.

Despite the existence of recommendations by the ANVISA regarding the use of antiseptics in the hands, it is justified to carry out this research due to the constant change in the transient microbiota of the human skin and the increase in the degree of resistance of microorganisms to these products, with the consequent need for periodic revalidations to guarantee the recommendation with microbiological safety from the applied product.

Based on the scientific premises herein presented, the question is: Which product is more effective in hand hygiene? To answer this question, the research aims to compare the efficacy of hand hygiene products.

METHODOLOGY

This is a quasi-experimental study, of the before and after type, carried out in the microbiology laboratory of a public Higher Education Institution (HEI) located in the city of Picos, Piauí.

The research population comprised the set of students regularly enrolled in the Nursing course at the aforementioned HEI, which consists of 326 students with active enrollments in the data

collection period. Subsequently, the following inclusion criteria were applied: student with active enrollment in the HEI, in the Bachelor of Nursing course, belonging to any academic period (1st to 9th). Those who reported allergies to any of the products used in the research and who were aged 18 years old or less were excluded. Thus, 286 individuals were eligible to compose the sample. 15 students were recruited from a non-probabilistic sample (draw). This number was guided by the general recommendations for experimental studies, which suggest at least 15 participants per group studied.⁽⁶⁾

Data collection took place between the months of October and November 2019. Initially, the HEI was asked to coordinate the Nursing course, the list of all students with active enrollment and, in this list, each participant was assigned a number, for a draw using the "Random UX" application, available for free on the *Play Store* platform.

The 15 students selected were invited to attend a previously scheduled meeting to explain the purpose of the study, as well as its protocol. At that moment, the Free and Informed Consent Form (FICF) was made available and, after accepting to participate in the research, a period of at least seven days was established to start collection.

In order to verify the efficacy of hand hygiene products, the following protocol was implemented: in the microbiology laboratory, samples of biological material were collected from the participants before hand hygiene, from their dominant hand, with the aid of a sterile swab, observing the following pattern: palm, back, interdigital spaces and digital pulps. Subsequently, hand hygiene was performed, without the need for any specific technique, with the following solutions: chlorhexidine 2% (first collection); povidone iodine 10% (second collection); alcohol gel 70% (third collection); and neutral detergent (fourth collection), with an interval of seven days between testing one product and another. At the end of each cleaning performed, a new sample was collected from the dominant hand with a sterile swab, respecting the same pattern previously mentioned.

It is noteworthy that, in order to circumvent possible biases in the results, the participants were asked not to have contact with any antiseptic in their hands for a period of eight hours before sample collection, as well as being examined by a nurse, as to apparent signs of dryness or hand injuries immediately prior to collection. The researchers also instructed about the removal of ornaments, such as rings, bracelets and watches.

The samples of all collections were placed in test tubes, prepared using the *Tryptic Soy Broth* (TSB) broth, and identified with the initials of the participant's name, material collected, date, time, numeric code of the product used (1- neutral detergent, 2- alcohol gel 70%, 3- povidone iodine 10%; and 4- chlorhexidine 2%) and who performed the collection. Immediately after that, they passed to the incubator for 24 hours at 37 °C.

Following the 24-hour incubation, the sample was placed on the petri dish, containing *Tryptcase Soy Agar* (TSA), since they are the culture

media that allow the bacterial growth of Gram negative and Gram positive bacteria, enabling the evaluation of the plaque and what to grow on it. In this context, the analysis of the efficacy of the products consisted of preparing the slide, with the sample collected from the petri dish and proceeding visualization through the optical microscope in 100x objective, with double check by one of the researchers and by a biophysician, being possible to observe the colony-forming units and the morphological characteristics of the bacteria, using the Gram staining technique.

It is reiterated that, at this moment of the microbiological evaluation, in order to guarantee the blinding of the study, those responsible for the analysis were not informed about which product had been used at the time of exposure, since only the researcher responsible for collection had this information.

As for the ethical and legal aspects, all current legislation was respected, with the research being approved by the Research Ethics Committee (*Comitê de Ética em Pesquisa, CEP*) of the Federal University

of Piau , and receiving approval with number 3,579,367.

RESULTS

Most frequently, the profile of the 15 participants was characterized by the female gender (9; 60.0%), aged 23.6 (± 4.9) years old (19 to 38 years old). Regarding the enrollment period, the following distribution was found: 2 were in the second period (13.3%), 1 was in the third (6.6%), 3 in the fourth period (20%), 4 were in the fifth (26.6%), 1 in the seventh (6.6%), 2 in the eighth (13.3%), and 2 in the ninth period (13.3%).

When comparing the unhygienic hand in relation to the exposure to neutral detergent, it was verified that, in most of the participants, there was a reduction in the amount of bacteria after using the product, highlighting the reduction in Gram Negative and Gram Positive cocci. However, it was observed that the presence of Gram Negative bacilli was maintained in six samples (Chart 1).

Chart 1 - Analysis of the presence of bacteria before and after hand hygiene performed with neutral detergent. Picos, PI, Brazil, 2019. (n=15)

Slide	Unhygienic hand	After cleaning with neutral detergent
1	Cocci +; Diplococci +	Reduced cocci + and diplococci +
2	Bacilli + bacilli -; Streptobacilli +	Reduced bacilli - and streptobacilli +
3	Bacilli -; Streptobacilli +	Reduced bacilli - and streptobacilli +
4	Bacilli -	Reduced bacilli + and did not change the amount of bacilli -
5	Cocci +; Cocci -; Sarcinas +	Reduced sarcinas +, cocci + and cocci -
6	Cocci +; Cocci -	Reduced cocci + and cocci -
7	Bacilli -; Cocci +; Cocci -	Reduced cocci +, cocci - and did not change the amount of bacilli -
8	Bacilli +; Bacilli -	Reduced bacilli + and did not change the amount of bacilli -
9	Staphylococci +; Bacilli +; Bacilli -	Reduced staphylococci +, bacilli + and did not change the amount of bacilli -
10	Cocci +; Cocci -	Reduced cocci + and cocci -
11	Staphylococci +; Cocci +	Reduced staphylococci + and cocci +
12	Cocci +; Cocci -	Reduced cocci + and cocci -
13	Cocci +; Sarcinas +	Reduced sarcinas + and cocci +
14	Bacilli +; Bacilli -	Reduced bacilli +; did not change the amount of bacilli -
15	Bacilli +; Bacilli -	Reduced bacilli + did not change the amount of bacilli -

Source: Research data.

Regarding the use of 70% alcohol gel, in most of the participants there was a reduction mainly in the amount of Gram Positive bacteria after using the product, with emphasis on the reduction of staphylococci, streptococci and Gram Positive cocci. Gram Positive bacilli, which appeared in nine samples, also remained unchanged in six of them (2, 4, 7, 9, 13, 15). In addition, it was noticed that the Gram Negative bacteria remained

unchanged in four of the six samples that previously contained this group of bacteria (Chart 2).

Regarding the comparison between the samples of the unhygienic hands and after the use of povidone-iodine 10%, in most of the participants it was verified that the presence of cocci was eliminated or reduced, whether Gram Positive or Gram Negative, as well as the that the amount of Gram Positive bacilli was reduced. Sarcinas, which appeared in two

of the samples, were completely eliminated (Chart 3).

The use of chlorhexidine 2% caused the complete elimination of Gram Negative bacilli and reduced the amount of Gram Positive bacillus colonies in seven

samples. The elimination of streptobacilli and sarcinas and the scarcity in the amount of Gram Positive cocci in eight slides analyzed were verified (Chart 4).

Chart 2 - Qualitative microbiological analysis of hand hygiene performed with alcohol gel 70%. Picos, PI, Brazil, 2019. (n=15)

Slide	Unhygienic hand	After cleaning with alcohol gel 70%
1	Cocci +; Diplococci +	Reduced Cocci + and diplococci +
2	Bacilli + bacilli -; Streptobacilli +	Reduced bacilli - and streptobacilli +
3	Bacilli -; Streptobacilli +	Reduced bacilli - and streptobacilli +
4	Bacilli -	Reduced bacilli + and did not change the amount of bacilli -
5	Cocci +; Cocci -; Sarcinas +	Reduced sarcinas +, cocci + and cocci -
6	Cocci +; Cocci -	Reduced cocci + and cocci -
7	Bacilli -; Cocci +; Cocci -	Reduced cocci +, cocci - and did not change the amount of bacilli -
8	Bacilli +; Bacilli -	Reduced bacilli + and did not change the amount of bacilli -
9	Staphylococci +; Bacilli +; Bacilli -	Reduced staphylococci +, bacilli + and did not change the amount of bacilli -
10	Cocci +; Cocci -	Reduced cocci + and cocci -
11	Staphylococci +; Cocci +	Reduced staphylococci + and cocci +
12	Cocci +; Cocci -	Reduced cocci + and cocci -
13	Cocci +; Sarcinas +	Reduced sarcinas + and cocci +
14	Bacilli +; Bacilli -	Reduced bacilli +; did not change the amount of bacilli -
15	Bacilli +; Bacilli -	Reduced bacilli + did not change the amount of bacilli -

Source: Research data.

Chart 3 - Analysis of hand hygiene performed with povidone-iodine 10%. Picos, PI, Brazil, 2019. (n=15)

Slide	Unhygienic hand	After cleaning with povidone-iodine 10%
1	Bacilli +	Reduced bacilli +
2	Bacilli +; Bacilli -	Eliminated bacilli + Reduced bacilli -
3	Cocci +; Bacilli -; Streptococci +	Eliminated cocci +, streptococci + Reduced bacilli -
4	Bacilli +; Cocci +; Streptococci +	Eliminated streptococci + Reduced bacilli + and cocci +
5	Bacilli -; Bacilli +; Streptococci +	Eliminated streptococci and bacilli - Reduced bacilli +
6	Bacilli -; Cocci +	Eliminated cocci + Reduced bacilli -
7	Bacilli +; Cocci +; Cocci -	Eliminated cocci +, cocci - Reduced bacilli +
8	Bacilli +; Sarcinas +	Eliminated sarcinas + Reduced bacilli +
9	Streptococci +; Bacilli -; Bacilli +	Reduced streptococci +, bacilli - and bacilli +
10	Cocci -; Cocci +	Eliminated cocci - Reduced cocci +
11	Cocci +; Cocci -; Bacilli +	Eliminated cocci +, cocci - Reduced bacilli +

12	Streptococci +; Bacilli +	Reduced Streptococci + and bacilli +
13	Cocci +; Cocci -; Sarcinas +	Eliminated sarcinas + Reduced cocci - and cocci +
14	Cocci +; Streptococci +; Cocci -	Eliminated cocci - and streptococci + Reduced cocci +
15	Bacilli -; Bacilli +	Reduced bacilli + and bacilli -

Source: Research data.

Chart 4 - Analysis of hand hygiene performed with chlorhexidine 2%. Picos, PI, Brazil, 2019. (n=15)

Slide	Unhygienic hand	After cleaning with chlorhexidine 2%
1	Bacilli +; Cocci +	Eliminated cocci +; Reduced bacilli +
2	Bacilli +; Cocci +; Cocci -	Eliminated cocci -; Reduced bacilli + and cocci +
3	Bacilli +; Bacilli -; Cocci +	Eliminated bacilli +, bacilli -; Presented scarce amount of cocci +
4	Cocci +; Bacilli +; Streptobacilli +	Eliminated streptobacilli + and bacilli + Presented scarce amount of cocci +
5	Cocci +; Streptococci +; Bacilli +	Eliminated bacilli +; Reduced cocci + and streptococci +
6	Cocci +; Bacilli +; Bacilli -	Eliminated bacilli -; Presented scarce amount of bacilli + and cocci +
7	Cocci +; Bacilli +	Eliminated bacilli +; Presented scarce amount of cocci +
8	Bacilli +; Streptobacilli +	Eliminated streptobacilli +; Reduced bacilli +
9	Cocci +; Streptococci +; Bacilli +; Bacilli -	Eliminated streptococci +, bacilli + and bacilli -; Presented scarce amount of cocci +
10	Cocci +; Streptobacilli +; Bacilli +	Eliminated streptobacilli + and bacilli + Reduced cocci +
11	Cocci -; Bacilli +	Eliminated bacilli +; Presented scarce amount of cocci -
12	Cocci +; Cocci -; Bacilli +	Eliminated cocci - and cocci +; Reduced bacilli +
13	Cocci +; Cocci -; Bacilli +	Eliminated cocci - and bacilli +; Reduced cocci +
14	Cocci -; Bacilli +; Streptobacilli +	Eliminated streptobacilli +; Reduced cocci - and bacilli +
15	Cocci -; Sarcinas +; Bacilli +; Bacilli -	Eliminated bacilli - and sarcinas +; Reduced bacilli + and cocci -

Source: Research data.

DISCUSSION

In view of the immense vulnerability of students, health professionals and patients with respect to cross-infection, it is necessary to use actions that enable safer care, since the hands are the main vehicle for the transmission of microorganisms. Their correct hygiene, with the use of an appropriate antiseptic, is considered one of the most effective methods to guarantee professional and patient safety.⁽⁷⁻⁹⁾

Hand hygiene is defined as the most real way to mitigate the risk of infection transmission, considering that the skin is able to house and transfer microorganisms from one surface to another, by

direct contact, skin to skin, or indirect contact, or through objects. Thus, it is necessary that this action be carried out through the selection and use of effective products.⁽¹⁰⁾

Historically, the understanding of the importance of hand hygiene has changed, mainly due to the validation of a specific technique for this purpose, as well as to the emergence of alcohol-based products and other antiseptics, which, on the one hand, has expanded the access to various solutions but, on the other hand, technical criteria for their use were not immediately defined.⁽¹¹⁾

Regarding the species of bacteria found in the hands of the students of this research, a similar study, developed with Dentistry students,

corroborates the findings when reporting the presence of several Gram Positive bacteria before hand washing, such as: *Coagulase-negative Staphylococcus*, *Staphylococcus aureus* and *Streptococcus ssp.* Another study, carried out with medical students in the first semester of undergraduation, also found, before hand washing, a frequency of 16.6% of methicillin-resistant *Staphylococcus aureus* while, among students in the sixth semester, the frequency was 25% of MRSA samples, demonstrating that continuous exposure in the health services is a factor that increases the need for hand hygiene.^(9,12,13)

With regard to hand hygiene with neutral detergent, most of the students' analyzed hands showed a reduction in Gram Negatives and Gram Positive Cocci, but in six samples, it was evidenced that the Gram Negatives had no change in their amount, which can be related to the low sensitization of this type of microorganism.

Researchers reinforce that neutral soap associated with the triclosan compound is what has been most used in the routines of the health services, but warn that, despite being characterized as an antiseptic, this solution has chemical characteristics similar to ordinary soap and, therefore, without sufficient data to be determined as a validated product for hand hygiene in healthcare providers.⁽¹⁴⁾

In relation to the use of alcohol, other researches have already shown that their adherence is more frequent due to the minimum time spent for hand hygiene,^(2,5) but it must be considered that the efficacy of the alcohol-based preparation intended for this purpose depends on variables such as: type of alcohol used (ethyl or isopropyl), concentration, volume applied and contact time.⁽¹⁵⁾

A number of studies point out that the use of alcohol can reduce the number of microorganisms in the hands of the health workers, thus cooperating to reduce infection rates, especially hospital infections. A controlled clinical trial, carried out before and after hand hygiene with water and glycerin soap and after application of glycerin ethyl alcohol gel 70%, showed that the use of alcohol gel produced a greater reduction in the number of colony-forming units.⁽¹⁶⁻¹⁸⁾

However, the use of a 70% alcohol-based preparation can replace hand hygiene with water and neutral soap, as long as there is no dirt on the hands, as it is not removed using 70% alcohol. Still in this context, it is emphasized that hand hygiene with 70% alcohol only has more adherence due to its duration of around 20 to 30 seconds, not being necessary to dry with paper towels.⁽⁴⁾

Regarding the use of hand washing with iodopolividone 10%, it obtained a more effective result when compared to the use of water and neutral soap and/or 70% alcohol, as the majority of the participants obtained elimination and reduction of the presence of cocci (Gram Positive or Gram Negative), in addition to all the sarcinas being eliminated. The use of this solution is evidenced in the literature for triggering the occurrence of dermatitis, causing skin irritation when regular use of this substance.⁽¹⁹⁾

Chlorhexidine 2% was identified as the solution that has the greatest potential for elimination in the variety of bacteria. It is presented in the literature as one of the main degermants that eliminate *Staphylococcus aureus*, a bacterium commonly found to cause HAIs and, above all, it has greater acceptability when compared to solutions containing iodine, because its regular use does not cause frequent occurrences of dermatitis.⁽²⁰⁾

As presented in the specialized literature, chlorhexidine 2% is considered as the most suitable detergent for hand hygiene, especially before invasive procedures, skin hygiene in surgical procedures, in bathing infected newborns, preparing patients for heart surgeries, implants and burns.⁽¹⁸⁾

In this context, a study carried out in Dentistry clinics from Teresina, capital of Piauí, when comparing the efficacy of brushing and surgical hand washing with two sanitizers, chlorhexidine 2% and iodopolividone 10%, concluded that careful and correct pre-operative hand antisepsis is more relevant than the choice of the antiseptic.⁽²¹⁾

In view of the availability of the various degermants within a health unit, for the practice of hand hygiene, priority must be given to the preferential use of chlorhexidine 2%, followed by neutral detergent, 70% alcohol and, finally, iodopolividone 10%, which, even though it has a minimally inferior action than chlorhexidine 2%, becomes less recommended for this practice, due to the fact that hand hygiene is frequent during the provision of health care, favoring its greater potential to cause dermatitis. Above all, when using any of these degermants, it is recommended to perform the specific technique in this process.

As a limitation of the study, the scarcity of material resources (standard agar count and 1/1000 [1 microliter] calibrated loop) to perform the counting of colony-forming units is considered, which could contribute to improving the results regarding the quantitative information of bacteriological growth.

This research offers results that benefit the scientific community regarding the promotion of knowledge about the microbiota in the hands of university students and discussions focused on the most effective antiseptic product for the elimination of bacteria. By proposing a priority in the use of antiseptics for hand hygiene, according to availability, it allows for the dissemination of this knowledge to the health professionals working in care, enabling its usability and contributing to the prevention of infections related to health care, benefiting patient care and promoting their safety.

CONCLUSION

The microbiological control of the hands using antiseptics is a reality and, of the antiseptics tested (neutral detergent, alcohol gel 70%, povidone iodine 10%, and chlorhexidine 2%), chlorhexidine 2% was the one that presented qualitatively greater potential for reduction of microorganisms.

In this sense, it is recommended implement permanent education programs in the health

services, in addition to teaching good hand hygiene practices in the university population, not only for students attending health courses, but also for the community of users of the health services. It is important to note that this research arouses interest in new studies that encourage discussions involving the main sites of cross-infection and the respective professionals working and investigate the related mechanisms.

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