

SANITARY APPLIANCE: COMPARATIVE STUDY OF AUTOMATED AND MANUAL CLEANING AND DISINFECTION PROCESSES

Utensílios sanitários: comparação entre processos de limpeza e desinfecção manual e automatizado

Utensílios sanitarios: comparación entre procesos de limpieza y desinfección manual y automatizado

Carmen Eulalia Pozzer^{1*} , Marcia Arsego² , Ivana Gottardo Rocha³ , Heloisa Helena Karnas Hoefel⁴ ,
Cinara Maisonette Duarte⁵ , Angelica Peres do Amaral⁶ , Rita Catalina Aquino Caregnato⁷ 

ABSTRACT: Objective: To compare the results of manual and automated cleaning and disinfection of Sanitary Appliance (US). **Method:** A descriptive experimental study, carried out by means of microbiological cultures of appliance used by patients bedridden in a hospitalization unit of a hospital located in the south of Brazil. Thirty three samples were collected after the cleaning and disinfection processes were carried out, eleven for each of the three methods available: automated, manual with and without supervision for microbiological evaluation. **Results:** In the automated process, pathogenic microorganisms of epidemiological relevance was now here to be found in the experiment. In the manual, in both processes performed, according to protocol established by the Institution with and without supervision, there was growth of pathogenic microorganisms. **Conclusion:** Therefore, in this study we conclude that the automated method for cleaning and disinfection has been shown to be safer for use in healthcare. The results obtained in the manual method do not confer safety. It is suggested that studies be carried out with references trains with controlled contamination.

Keywords: Patient safety. Bathroom equipment. Disinfection. Equipment and supplies, hospital.

RESUMO: Objetivo: Comparar os resultados dos processos de limpeza e desinfecção manual e automatizado de Utensílios Sanitários (US). **Método:** Estudo experimental, descritivo, realizado por meio de culturas microbiológicas de US usados por pacientes acamados em uma unidade de internação de um hospital localizado no sul do Brasil. As amostras microbiológicas foram coletadas após limpeza e desinfecção, sendo 11 amostras de cada um dos três processos testados: automatizado, manual sem supervisão e manual com supervisão. **Resultados:** No processo automatizado, não houve crescimento de microrganismos patogênicos de relevância epidemiológica. No manual, em ambos processamentos realizados, conforme protocolo estabelecido pela instituição com e sem supervisão, houve crescimento de microrganismos patogênicos. **Conclusão:** Com base nos resultados obtidos no estudo, o método automatizado demonstrou ser seguro para utilização dos US na assistência à saúde. Os resultados obtidos no método manual não conferem segurança. Sugere-se que sejam realizados estudos com conhecimento prévio do grau de contaminação controlada por meio de cepas de referência.

Palavras-chave: Segurança do paciente. Aparelho sanitário. Desinfecção. Equipamentos e provisões hospitalares.

RESUMEN: Objetivo: Comparar los procesos de limpieza y desinfección manual y por medio de un equipo automático de Utensílios Sanitarios (US). **Método:** Estudio experimental descriptivo de medio de cultivos microbiológicos de US de los que hicieron uso enfermos en piso de internación de un hospital del sur de Brasil. Las muestras microbiológicas fueron recolectadas después de la limpieza y desinfección, de las cuales 11 muestras de cada uno

¹Nurse; Master in Health Education. Coordinator of Health Products Sterilization of Santa Casa de Misericórdia de Porto Alegre – Porto Alegre (RS), Brazil.

²Nurse of Hospital Infection Control at Santa Casa de Misericórdia de Porto Alegre – Porto Alegre (RS), Brazil.

³Biologist in the Laboratory of Microbiology of Santa Casa de Misericórdia de Porto Alegre – Porto Alegre (RS), Brazil.

⁴Nurse; PhD in Nursing. Professor at the Nursing School of Universidade Federal do Rio Grande do Sul – Porto Alegre (RS), Brazil.

⁵Nurse. Hospital Manager of Hospital São Francisco da Santa Casa de Misericórdia de Porto Alegre – Porto Alegre (RS), Brazil.

⁶Nurse at Santa Casa de Misericórdia de Porto Alegre – Porto Alegre (RS), Brazil.

⁷PhD in Education. Professor at the Nursing Department of Universidade Federal de Ciências da Saúde de Porto Alegre – Porto Alegre (RS), Brazil.

*Corresponding author: pozzer@santacasa.org.br

Received: 09/15/2018 – Approved: 06/10/2019

DOI: 10.5327/Z1414-4425201900030002

de los tres procesos probados: automático, manual sin supervisión y manual con supervisión. **Resultados:** En el proceso con el equipo automático, no hubo crecimiento de microorganismos patógenos de relevancia epidemiológica. En los dos procesos manuales con y sin supervisión, conforme protocolo establecido por la institución, hubo crecimiento de microorganismos patógenos. **Conclusión:** Por los resultados obtenidos en el estudio, se concluye que el la limpieza e nel equipo automático ha demostrado seguridad para usar los US en cuidados a La salud. Se sugiere que se realicen estudios con conocimiento previo del grado de contaminación controlada por medio de cepas de referencia.

Palabras clave: Seguridad del paciente. Aparatos sanitarios. Desinfección. Equipos y suministros de hospitales.

INTRODUCTION

Good practices and proper processing of Health Products (HP) are essential for a safe nursing care. The traditional classification of appliances, according to their criticality levels, in critical, semi-critical and non-critical, as to the invasion of such appliances in the human body, is still used worldwide and is quoted in publications directed to the practices related to the control and prevention of Health Care-Associated Infections (HCAI)¹. Non-critical appliances, which are the objects of this study, have contact with a healthy skin, requiring at least a cleaning process¹.

Cleaning aims at removing organic matter, thus reducing the Colony-Forming Units (CFU). The requirement for processing of non-critical health products is smaller compared to the treatment to be applied for a safe use, because it only has contact with healthy skins^{2,3}.

The indiscriminate use of antimicrobials contributed to the development of multidrug-resistant bacteria through selective pressure. Thus, the concerns to adopt preventive measures increased, involving materials and environments that contribute to control the transmission of such microorganisms. Materials that come in contact only with healthy skins, but that are reused by different people, should be closely analysed after their use, when they were previously contaminated with organic matter that may contain a higher total of CFU.

Several HP used in patient care in the Health Care Facilities (HCF) are reused (after undergoing the cleaning and disinfection processes) by different patients. Thus, they may be vehicles of infectious agents if there are failures in the cleaning and disinfection processes. Sanitary appliances (SA), such as bedpans and portable urinals used by patients who are unable to use the toilet, can be an important source of cross-contamination⁴. Feces are comprised of organic matter with a large amount of microorganisms. Therefore, the containers

that receive them must be processed and comply with the good processing practices.

The pathogenic microorganisms include Enterobacteria (enteropathogenic *Escherichia coli*, *Salmonella*, *Shigella*, *Citrobacter*, *Klebsiella*, *Serratia*, *Enterobacter*, *Proteus*, and *Providencia*), which cause urinary tract, enteric and systemic infections, bacteraemia, pneumonia, and meningitis⁵.

In the manual cleaning of SA, mechanical friction is performed with specific objects, running water or under pressure and detergent solution, while automated cleaning is conducted with equipment that use water jets under pressure and detergent solution⁶. One of the disadvantages of SA manual cleaning is excreta handling by the worker, who is at risk of biological contamination. Although the contact with organic matter may also occur during automated cleaning, the risks are lower.

SA washing machines, also known as discharge washers, enable to remove excreta (feces, urine, secretions and blood) by cleaning and disinfecting non-critical materials, thus decreasing the risk of infections in patients, occupational risk of workers, and environmental impacts. They have been designed for use in the hospitalization units and should be installed in places where there are purification procedures and are connected to power, water, and sewage. The advantages are the possibility of cleaning more than one product simultaneously; of optimizing natural resources, such as water; of preventing occupational, biological and chemical hazards; and of performing the process in a standardized way³. To guarantee the performance of such equipment, the manufacturer states that it is essential to maintain the preventive intervention and its periodic qualification, which is defined by the HCF, in an annual basis⁶.

Based on this reflection, we established the research problem: What is the microbial difference in SA when performing the processes of automated and manual cleaning and disinfection?

OBJECTIVE

To compare the results of manual and automated cleaning and disinfection of SA.

METHOD

This is an experimental and descriptive study carried out in a HCF with 1,200 beds, located in the South of Brazil at a hospitalization unit with 16 beds.

The study was performed using SA microbiological cultures, after they were used for faecal and urinary eliminations of patients hospitalized in this unit. The sample consisted of 11 SA for each type of cleaning and disinfection process, from which microbiological cultures were collected after the manual or automated process. Samples were collected by the nurse that received guidance by a microbiologist and they were numbered independently of the process, from 1 to 33, and sent to the laboratory. Only the collector had the cleaning type identification before the final analysis result. All collections were immediately done after the processing conclusion. The mean number of samples was estimated based on a daily control worksheet during 90 days of SA use with feces and urine, used in the unit where the study was performed.

There were three types of processes for cleaning and disinfecting SA, as described below:

- Manual without the nurse's supervision, in which a licensed practical nurse reported that the process followed the Standard Operating Procedure (SOP): excreta were thrown in the purge of the purification step; then, they were washed with hospital neutral detergent and SA-specific cleaning brush in running cold water; they were dried with a clean compress and disinfected with a compress soaked in 70% alcoholic solution, through friction in the inner and outer surfaces. The procedure was repeated three times;
- Manual cleaning according to SOP: the same process described in the previous item was performed, but with the nurse's direct supervision;
- Automated cleaning: SA collected by the licensed practical nurse and introduced with excreta into a slot inside the washer, which initiated the automatic command; after the completion of the process, the

SA was removed from the equipment; a discharge washer was used with the following characteristics: standards for thermal disinfection of temperature between 85 and 90°C⁷, with short cycles; low consumption of water, energy, and detergent; washing with 12 jets, four with rotation function; standard cycle of five minutes, consumption of 13 liters of cold water and 13 liters of hot water in the standard cycle.

To prepare the samples, 100 mL of sterile peptone water was inoculated in the interior, passing through the entire internal surface of each SA after each process performed in the purification step. From this volume, 50 mL were recovered and placed in the original vial with a sterile syringe. The samples were identified, conditioned, and sent to the Laboratory of Microbiology.

In the Laboratory of Microbiology, the quantitative method was used to determine the microbial load (viable bacteria and fungi), a technique called Spread Plate in US⁸. The acceptable reference value is 1×10^2 CFU/mL. Tryptic Soy Agar (TSA) and Sabouraud Dextrose Agar with Chloramphenicol (SDA) were respectively used for bacterial and fungal cultures. The samples inoculated in TSA were incubated at the temperature (T) of $32.5^\circ\text{C} \pm 2.5^\circ\text{C}$, from 3 to 5 days; and SDA at the T of $22.5^\circ\text{C} \pm 2.5^\circ\text{C}$, from 5 to 7 days. The readings were performed every 24 hours; the results reported in the Worksheets (WS), and later typed into the system and released. For the expression of results, CFU per mL was used. In the qualitative method, microorganisms of epidemiological importance were isolated.

In the qualitative method, we used the inoculation of 1.0 mL of sample, containing peptone water in flasks with 100 mL of sterile Trypticase soy broth (TSB). Samples were incubated in an oven at a T of $32.5^\circ\text{C} \pm 2.5^\circ\text{C}$, from 3 to 5 days. The readings were performed daily; if apparent turbidity was observed in TSB, we isolated the possible microorganisms in solid selective culture media (for gram-negative and gram-positive bacteria), with incubation at $32.5^\circ\text{C} \pm 2.5^\circ\text{C}$, for 24 and 48 hours. If growth was observed in the period, the microorganism was identified and an antimicrobial susceptibility testing (AST) was conducted for the carbapenem class (imipenem, meropenem, and ertapenem). In case of full resistance to carbapenems, the AST would be repeated with the standardized antibiotic battery at the institution.

In the qualitative stage, the fungi were not identified because they were of saprophytic etiology, except if yeast elements grew, which did not occur.

The project was submitted to the Hospital Research Ethics Committee (REC) and approved according to CAAE No. 64628217.3.0000.5335.

RESULTS

Microbiological cultures performed in SA showed different results. Table 1, with automated cleaning results, shows <01 CFU in all analyzed samples.

In the automated cleaning, there was no growth of viable fungi and bacteria in any of the 11 analyzed samples.

The results of routine manual cleaning methods with and without supervision, shown in Table 2, presented non-detectable and detectable isolates. Of the 11 analyzed samples, seven were positive for bacteria of epidemiological relevance and 12 Gram-Negative Bacilli (GNB) were isolated of these, seven from the *Enterobacteriaceae* family and five from the non-fermenting GNB family.

Regarding the microbial load, we verified that of the 11 samples, six had a count in the interval from <01 CFU/mL to 630 CFU/mL (6.3×10^2), and GNB were isolated in samples one and two.

Table 1. Washing/cleaning methods, counting of bacteria and viable fungi (CFU/mL).

Sample	Automated Cleaning		Manual Cleaning (N/S)		Manual Cleaning (W/S)	
	Bacteria	Fungi	Bacteria	Fungi	Bacteria	Fungi
1	<01	<01	50	41	15,000	14,000
2	<01	<01	630	47,000	19	12
3	<01	<01	<01	40	44	39
4	<01	<01	1680	40	375	91
5	<01	<01	124,000	33,200	154	20
6	<01	<01	130	30	327	208
7	<01	<01	162	155,000	216,000	12,000
8	<01	<01	90	20	65,000	37,000
9	<01	<01	770,000	200,000	3,000,000	127,000
10	<01	<01	2,860,000	380,000	143,000	33,000
11	<01	<01	141,000	108,000	3,000,000	37,000

N/S: no supervision; W/S: with supervision.

Table 2. Methods of manual washing and isolated bacteria.

Sample	Manual Cleaning (N/S)			Manual Cleaning (W/S)		
	Isolate 1	Isolate 2	Isolate 3	Isolate 1	Isolate 2	Isolate 3
1	<i>P. aeruginosa</i>	ND	ND	<i>Pseudomonas sp.</i>	<i>K. pneumoniae</i>	ND
2	<i>E. cloacae</i>	ND	ND	<i>E. cloacae</i>	<i>S. marcescens</i>	ND
3	ND	ND	ND	<i>P. putida</i>	ND	ND
4	<i>E. cloacae</i>	ND	ND	<i>E. cloacae</i>	<i>Pseudomonas sp.</i>	ND
5	<i>E. cloacae</i>	<i>Pseudomonas sp.</i>	<i>P. putida</i>	<i>Pseudomonas sp.</i>	ND	ND
6	ND	ND	ND	<i>P. putida</i>	ND	ND
7	ND	ND	ND	<i>E. cloacae</i>	ND	ND
8	ND	ND	ND	<i>E. cloacae</i>	<i>Pseudomonas sp.</i>	ND
9	<i>E. cloacae</i>	<i>S. marcescens</i>	ND	<i>E. cloacae</i>	<i>Enterobacter sp.</i>	<i>Pseudomonas sp.</i>
10	<i>K. oxytoca</i>	<i>P. aeruginosa</i>	ND	<i>P. putida</i>	ND	ND
11	<i>K. oxytoca</i>	<i>P. aeruginosa</i>	ND	<i>K. oxytoca</i>	<i>P. aeruginosa</i>	ND

N/S: no supervision; W/S: with supervision; ND: non-detectable.

From the *Enterobacteriaceae* family, the species of epidemiological relevance were isolated, *Enterobacter cloacae*; four isolates were resistant to Meropenem, one isolate was resistant to Ertapenem and there was no resistance to Imipenem. There was no resistance to carbapenems for *Klebsiella oxytoca* (two isolates) and *Serratia marcescens* (one isolate). In the five remaining samples, with quantification between 1,680 (1.6×10^3) and 2,860,000 (2.9×10^6) CFU/mL, GNB were isolated with epidemiological relevance.

As to the method of manual cleaning with supervision, the results show in Table 2 that of the 11 analyzed samples, there was growth for 17 GNB, eight from the *Enterobacteriaceae* family and nine from non-fermenting GNB family.

Of the isolated species, an *Enterobacter sp.* and four *Enterobacter cloacae* samples, two isolates presented an intermediate sensitivity to Imipenem and Meropenem; a resistant isolate and an isolate with intermediate resistance to Ertapenem. There was no resistance to carbapenems for *Klebsiella pneumoniae* (one isolate), *Klebsiella oxytoca* (one isolate), and *Serratia marcescens* (one isolate).

From the group of non-fermenting GNB, five *Pseudomonas sp.*, three *Pseudomonas putida* and one *Pseudomonas aeruginosa* were isolated, and there was no resistance to carbapenems.

As to the microbial load of the 11 samples, five had a count in the range of 19 (1.9×10^1) to 375 (3.7×10^2) CFU/mL, and GNB were isolated in samples 2, 3, 4, 5, and 6.

In the six remaining samples (54.5%), with a quantification between 1,500 (1.5×10^3) and 3,000,000 (3.0×10^6) CFU/mL, GNB were isolated with epidemiological relevance.

DISCUSSION

This study suggests a benefit in the use of automated cleaning for SA applied in the eliminations of feces and urine of dependent patients. Lack of knowledge as to the level of contamination of AS prior to hygiene and decontamination processes are considered study limitations. However, considering that feces have the highest number of CFUs per gram and all the tested SA initially had feces, this limitation becomes less relevant, because, after the automated process, the microbial count (viable fungi and bacteria) was <01 CFU/mL in all samples. Microbial load reduction is a concern identified by other authors due to the positive

impact on HCAI after cleaning of materials that make contact with the patient^{9,10,11}.

The found microorganisms differ from a French study, in which most of the 25 automatic washing machines were gram-positive bacteria, *Staphylococcus sp.*, in addition to other GNB in a lower quantity⁴. In this study, they were not found in the automated cleaning, and GNB were found in manual washings.

Another aspect to be discussed is whether the process is supervised or not. The Hawthorne phenomenon was expected to occur during supervised cleaning and disinfection; however, it did not occur. Although the sample number was insufficient for statistical significance tests, it was clear, regardless of supervision or not, that the automated method was safer for handling SA by professionals. It allows a safe reuse among patients. Other authors also confirmed the impact of environmental cleaning on HCAI reduction¹⁰. This observation similarly suggests that SA cleaning would have an equal impact, considering it comes into direct contact with patients, as shown in the present study. Likewise, recommendations from experts on infected fomites have been the subject of recent discussions regarding the impact on the environment and on HCAI¹¹.

Excreta that contain modified microbiota of patients are eliminated and contaminate the environment, gradually modifying the hospital microbiota. Materials and surfaces contaminated with modified microorganisms come into contact with other patients, infecting or colonizing them, thus creating an endless infection chain¹². The detection of differences among the identified isolates proves that SA are contaminated by them, exposing users to both resistant and intermediate isolates, as well as antimicrobial susceptible ones. Other authors identified that the intervention in the hygiene of patient fomites reduces the dissemination of resistant microorganisms¹³.

CONCLUSION

Based on the study data, the automated method for cleaning and disinfection proved to be safer when using SA in health care. Results obtained in the manual method proved it was not safe. Further studies with previous knowledge as to the level of controlled contamination through reference strains are needed.

REFERENCES

1. Rutala WA, Weber DJ. Disinfection, sterilization, and antisepsis: an overview. *Am J Infect Control* [Internet]. 2016 [acessado em 10 abr. 2019];44(5 Supl.):e1-6. Disponível em: <https://doi.org/10.1016/j.ajic.2015.10.038>
2. Groa E, Wohl RL, Coepferthwaite L, Beaty K, Jones K, Ladny C. Association of periOperative Registered Nurses (AORN). Sterilization and disinfection. In: *Guidelines for Perioperative Practice*. Denver: AORN; 2018. p. 957-83.
3. Kulkarni K, Kaczorowski D, Bonkowski A, Kovach S, Basile R. Safe to handle? Comparing manually and machine-washed medical devices. *Biomed Instrum Technol* [Internet]. 2016 [acessado em 10 abr. 2019];50(s2):18-22. Disponível em: <https://doi.org/10.2345/0899-8205-50.s2.18>
4. Bros A, Deboscker S, Mielcarek M, Foeglé J, Hernandez C, Ménard C, et al. Bacteriological quality evaluation of bed pans in a university hospital. *Int J Infect Control* [Internet]. 2018 [acessado em 10 abr. 2019];14(1):1-6. Disponível em: <http://www.ijic.info/article/view/17934>
5. Jandhyala SM, Talukdar R, Subramanyam C, Vuyyuru H, Sasikala M, Reddy DN. Role of the normal gut microbiota. *World J Gastroenterol* [Internet]. 2015 [acessado em 10 abr. 2019];21(29):8787-803. Disponível em: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4528021/>
6. Sociedade Brasileira de Enfermeiros de Centro Cirúrgico, Recuperação Anestésica e Centro de Material e Esterilização (SOBECC). *Diretrizes de práticas em enfermagem cirúrgica e processamento de produtos para a saúde*. 7ª ed. São Paulo: SOBECC/Barueri: Manole; 2017.
7. International Organization for Standardization. ISO 15883: Washer disinfectors [Internet]. Genebra: ISO; 2006 [acessado em 10 abr. 2019]. Disponível em: <https://www.iso.org/standard/41076.html>
8. United States Pharmacopeia. 37ª ed. Rockville: United States Pharmacopeia l Convention; 2014.
9. Ramphal L, Suzuki S, McCracken IM, Addai A. Improving hospital staff compliance with environmental cleaning behavior. *Proc (Bayl Univ Med Cent)* [Internet]. 2014 [acessado em 10 abr. 2019];27(2):88-91. Disponível em: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3954653>
10. Everett BR, Sitton JT, Wilson M. Efficacy and cost-benefit analysis of a global environmental cleaning algorithm on hospital-acquired infection rates. *J Patient Saf.* [Internet]. 2017 [acessado em 10 abr. 2019];13(4):207-10. Disponível em: <https://doi.org/10.1097/PTS.0000000000000141>
11. Quinn MM, Henneberger PK, Braun B, Delclos GL, Fagan K, Huang V, et al. A. Cleaning and disinfecting environmental surfaces in healthcare: toward an integrated framework for infection and occupational illness prevention. *Am J Infect Control* [Internet]. 2015 [acessado em 10 abr. 2019];43(5):424-34. Disponível em: <https://www.ajicjournal.org/article/S0196-6553%2815%2900075-9/pdf>. <http://dx.doi.org/10.1016/j.ajic.2015.01.029>
12. Hoefel HH, Lautert L, Schmitt C, Soares T, Jordan S. Vancomycin administration: mistakes made by nursing staff. *Nurs Stand* [Internet]. 2008 [acessado em 10 abr. 2019];22(39):35-42. Disponível em: <https://doi.org/10.7748/ns2008.06.22.39.35.c6567>
13. Datta R, Platt R, Yokoe DS, Huang SS. Environmental cleaning intervention and risk of acquiring multidrug-resistant organisms from prior room occupants. *Arch Intern Med* [Internet]. 2011 [acessado em 10 abr. 2019];171(6):491-4. Disponível em: <https://jamanetwork.com/journals/jamainternalmedicine/article-abstract/226851>