PNA | PHILIPPINE JOURNAL OF NURSING

RESEARCH ARTICLE

Surgical Scrubbing With and Without a Brush in Decreasing the Number of Germ Colonies on Hands: A Systematic Review

Adi Angriawan Bambi, MN, RN[1] and **Andi Masyitha Irwan** , PhD, RN[2]

Abstract

Purpose: This study aims to compare surgical scrubbing with and without a brush in decreasing the number of germ colonies on hands.

Background: Surgical scrubbing with and without a brush are currently popular worldwide. To date, the optimal method in decreasing the number of germ colonies on the hands is not known.

Methods: Systematic review of effectiveness was conducted. The databases and publisher websites included PubMed, Science Direct, Google Scholar, Wiley Online Library, Cochrane Library and recruitment studies published between 2009-2019. The risk of bias was assessed utilizing Cochrane Collaboration's tool.

Results: Included clinical studies consisting of five randomized controlled trials. The procedures and duration of surgical scrubbing on each study varied depending on the protocol as a reference. All clinical studies found no difference in the number of colony-forming units (CFU) on the hand between surgical scrubbing with and without a brush.

Conclusions: Scrubbing with and without a brush showed similar efficacy in terms of the number of germ colonies on the hands.

Keywords: *brush, brushless, germ colonies, surgical scrub*

PROSPERO Registration: *CRD42020195994*

Introduction

Surgical site infection (SSI) is one of the most common causes of healthcare-associated infections for patients undergoing surgery (National Institute for Health and Clinical Excellence, 2008). Data from the World Health Organization (WHO) show that in 2004, a massive operation volume was estimated at 187–281 million operations (World Health Organization, 2009a). More so, according to the WHO, in developing countries, the incidence of infection is 5–6 per 100 surgical procedures, which is higher than that in developed countries (Allegranzi et al., 2010). The bacteria that cause SSI are derived from various sources in the operating room, such as hand and surgical equipment (Izaguirre et al., 2018), considered as one of the most significant factors (Soule, 2018). Hand hygiene is the primary measure of infection prevention, which has been proven to be effective in preventing healthcare-associated infections (Nemut et al., 2021; World Health Organization, 2009b). Therefore, hand hygiene must be maintained and preserved by surgical personnel to prevent incidental infection in the operating room through standard surgical scrubbing procedures.

Surgical scrubbing is a significant method in preventing the development and transfer of nosocomial infections (Gok et al., 2016). There are some strategies involved in surgical scrubbings, such as previous washing; washing techniques; use of a sponge, brush, and nail cleaner spatula; duration of antiseptic; and antiseptic used (Izaguirre et al., 2018). The purpose of surgical scrubbing is to eliminate microorganisms, prevent their transfer, or reduce the amount of permanent flora of the hand, which will ultimately prevent the contamination of

[1] Staff Nurse, South Konawe Regional Hospital, Indonesia
[2] Assistant Professor at Faculty of Nursing, Hasanuddin University, Indonesia; Corresponding Author: citha_ners@med.unhas.ac.id

surgical wounds to microorganisms found on the hands of the surgical team (Asensio & Gregorio, 2013).

Several researchers worldwide still discuss the guideline of the surgical scrubbing procedure to identify which one is more effective in decreasing the number of germs on the hands. Surgical scrubbing with the use of soap or antimicrobial agents and plastic spatulas under running water aims to clean dust and contaminants based on the recommendations from the Association for Perioperative Practice before using antiseptics (Izaguirre et al., 2018). The Centers for Disease Control and Prevention (CDC) recommends the use of a nail cleaner, but not a fingernail brush, to clean the hands and fingers under running water during surgical scrubbing (Boyce & Pittet, 2002a). On the other hand, the WHO guidelines stated that the use of a brush is not recommended for surgical hand preparation (World Health Organization, 2009b). The Centre for Health Protection recommends cleaning the fingernails when washing the hands before surgery but not the use of a nail brush (Centre for Health Protection, 2009), while the National Institute for Health and Clinical Excellence suggests the operating team must wash their hands before surgery using an antiseptic solution with a disposable brush or nail pick and ensure that their hands and nails are clean (National Institute for Health and Clinical Excellence, 2019).

Brushing the hands and forearms, can cause skin cells and damage the epidermis, allowing pathogenic bacteria to colonize the layers of the skin (Hsieh et al., 2006; Parlak et al., 2021), several studies have found that brushing the hands and forearms is an unnecessary or harmful practice (Carro et al., 2007; Parlak et al., 2021). While there is agreement about the harmful effects of hand brushing, some guidelines recommend single-use brushes for cleaning (National Institute for Health and Clinical Excellence, 2019; Spruce, 2013). However, the optimal method of decreasing the number of germ colonies on hands is not known. This study aims to compare surgical scrubbing with and without a brush in decreasing the number of germ colonies on hands.

Methods

Design and Study Criteria

Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) guidelines were used to guide the development of the systematic review methodology (Gilo et al., 2020; Moher et al., 2009). We have used PRISMA guidelines as well in our previous systematic review articles (Asri et al., 2022; Latif & Irwan, 2019; Yusuf & Irwan, 2021). Protocol was developed a priori and registered in the National Institute for Health Research International Prospective Register of Systematic Reviews (PROSPERO)— (Saunders-Hastings et al., 2017). The research questions were prepared using the problem/patient/population, intervention, comparison/control, and outcome (PICO) strategy (Santos et al., 2007). Using the PICO strategy, we formulated the following research question: "Is there a difference between surgical scrubbing with and without a brush in decreasing the number of germ colonies on the hands?" Keywords were based on a database in terms of all fields (Table 1).

Table 1. *Description of the keywords used in the literature searching using the problem/patient/population, intervention, comparison/control, and outcome strategy*

Database	Keywords	Result	Included Studies
PubMed	Surgical scrub OR Surgical scrubbing OR Surgical hand scrub OR Surgical hand wash AND Brush OR Scrubbing Bush OR Brushes OR Sterile brush OR Disposable Brush OR With a Brush AND Brushless OR Without brush OR Without a Brush AND Reducing bacterial counts OR Reduce bacteria OR Reduction of colony count OR Determining the types of bacteria OR Reduce the number of bacteria OR Reducing hand bacterial flora	6	1
Science Direct	Surgical scrub OR Surgical scrubbing AND Brush OR Brushes AND Brushless OR Without brush AND Reducing bacterial OR Reduce bacteria OR Reduction of colony	232	1
Google Scholar	Surgical scrub OR Surgical scrubbing AND Brush OR Brushes AND Brushless OR Without brush OR Without a Brush AND Reducing bacterial OR Reduce bacteria OR Reduction of colony OR Reduce the number of bacteria OR Reducing hand bacterial flora	972	3
Wiley Online Library	Surgical scrub OR Surgical scrubbing AND Brush OR Brushes AND Brushless OR Without brush AND Reducing bacterial OR Reduce bacteria OR Reduction of colony	278	0
Cochrane Library	Surgical scrub OR Surgical scrubbing AND Brush OR Brushes AND Brushless OR Without brush AND Reducing bacterial OR Reduce bacteria OR Reduction of colony	23	0

Meanwhile, manual retrieval was also conducted. The inclusion criteria were as follows: (1) subjects in the studies were surgical attendants and interns in a hospital operating room; (2) the intervention involved the use of a brush and antiseptic solution; (3) the control group performed brushless surgical scrubbing with an antiseptic solution; (4) the number of hand or finger bacteria before and after surgical scrubbing was measured; (5) the setting was a hospital operating room; (6) the study design was a randomized controlled trial (RCT); (7) studies were written in English; and (8) studies were published from 2009 to 2019.

Search Strategy and Study Selection

We searched the articles in the following databases and publisher websites: PubMed, ScienceDirect, Google Scholar, Wiley Online Library and Cochrane Library. One reviewer (AAB) screened the title and abstract to obtain relevant studies according to the inclusion and exclusion criteria. If the reviewers disagreed over an inclusion, then a percent agreement was made; if there was a difference, then a decision was taken by asking for additional data or clarifying something with a second reviewer (AMI) until consensus was reached. The authors retrieved a total of 1,511 articles from PubMed (6 articles), ScienceDirect (232 articles), Google Scholar (972 articles), Wiley Online Library (278 articles) and Cochrane Library (23 articles). After excluding via the criteria, 668 duplicates were removed, 109 were not full text, 720 had no research relevance and nine articles had non-relevant outcomes. Therefore, five articles were included in the review through discussion with two reviewers until consensus (Figure 1).

Figure 1. *A flow diagram for the selection and inclusion studies*

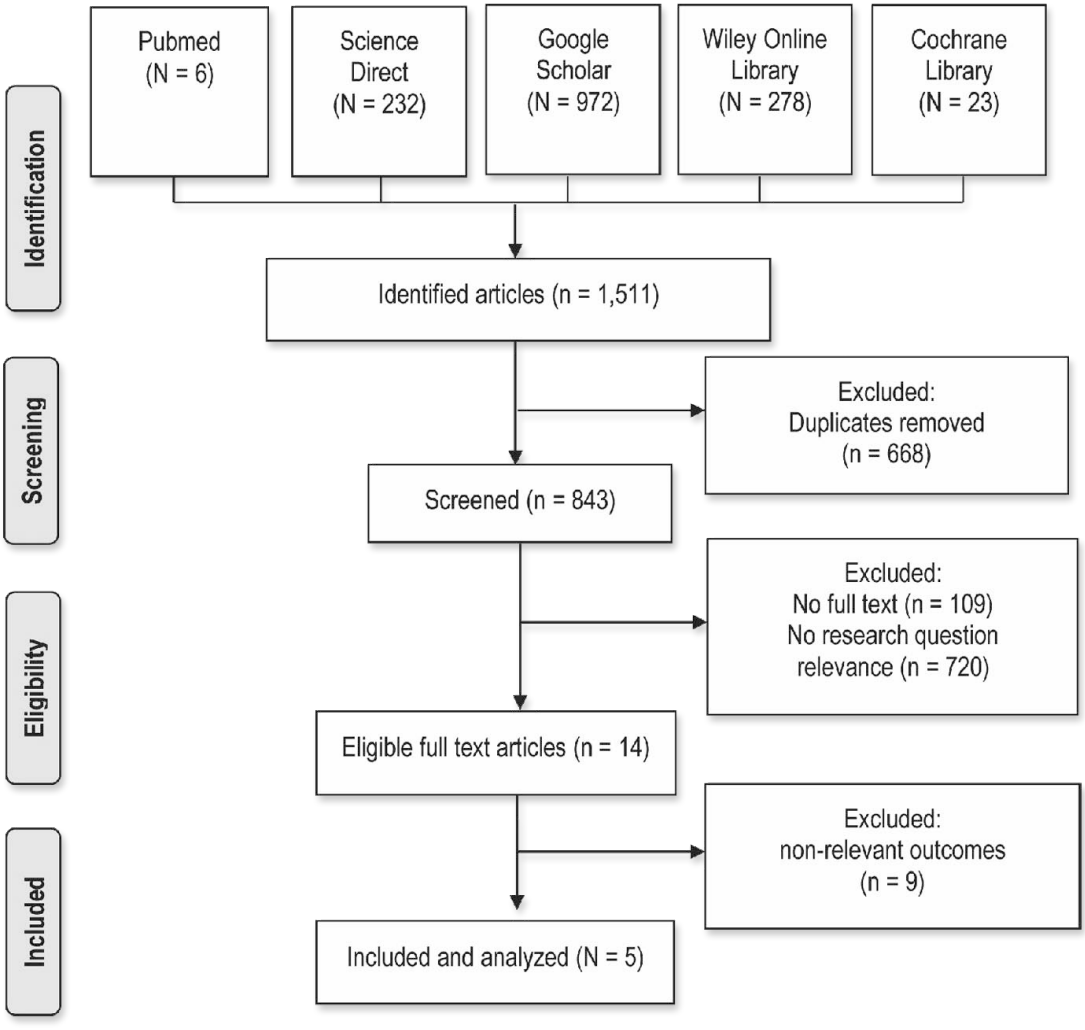

Table 2. *Bias Risk Assessment*

Author (Year)	Random Sequence Generation (Selection Bias)	Allocation Concealment (Selection Bias)	Blinding of Participants and Personnel (Performance Bias)	Blinding of Outcome Assessment (Detection Bias)	Incomplete Outcome Data (Attrition Bias)	Selective Reporting (Reporting Bias)	Other Sources of Bias (Other Bias)
Paliama et al., 2018	+	-	+	+	+	+	-
Abdelatiff et al., 2014	+	-	+	+	+	+	-
Alcan & Korkmaz, 2012	+	-	+	+	+	+	-
Asdornwised et al., 2011	+	-	+	+	+	+	-
Tanner et al., 2009	+	-	+	+	+	+	-

Data Extraction and Review of the Selected Studies

Data were obtained in the form of data extraction predetermined by AAB and examined by AMI, no external evaluators. Furthermore, AAB and AMI used Cochrane Collaboration's tool for assessing risk of bias (Table 2) (Higgins et al., 2011).

Data Analysis

Owing to the significant variability in the treatment effect due to difference in clinical characteristics, such as Treatment/intervention level (e.g., characteristics of the brush, the procedure, and the duration of scrubbing), study setting (e.g., time of year, geographic setting), it was not possible to create a statistical meta-analysis. Results, therefore, are presented in narrative and tabular form.

Results

Study Characteristics

In this systematic review, we included five clinical studies that met the inclusion criteria and were in line with the objectives of this review. These studies were randomized clinical trials that investigated surgical scrubbing with and without a brush in decreasing the number of germ colonies. These articles were published from 2009 to 2018. The research was conducted in Indonesia, Saudi Arabia, Thailand, Turkey, and the United Kingdom. The respondents in these articles were nurses, intern students, and operating department staff with a sample of 32–164 individuals (Table 3).

Differences in the Number of Germ Colonies

From the results of the study, surgical scrubbing with a brush was found to be not significant than that without a brush in decreasing the number of germs on the hand ($Z = -1.437$ and $p = 0.151$). However, the decrease in germ percentage in the intervention group (with a brush) was lower than that in the control group (without brush) (44.67% vs. 25.93%, respectively) (Paliama et al., 2018). On the other hand, analysis of variance was used to analyze the group difference between after surgical scrubbing and after one hour of using hand gloves. It was found that there was no significant difference between scrubbing with a sterile brush and that without a brush. However, an increase of 16% in the number of staphylococci was observed in the group with surgical scrubbing with a sterile brush after 1 hour of using hand gloves (Abdelatiff et al., 2014).

Thus, the average number of bacteria on the hands before surgical scrubbing was lower in the brushless surgical scrubbing group than that in the other groups (with nail pick and brush groups). However, the difference was not statistically significant ($F=1.047$; $p=0.357$; $p>0.05$). Moreover, the average bacterial counts in the brushless surgical scrubbing group 1 h after surgical scrubbing were lower than those in the other groups. Again, the difference was not statistically significant ($F=2.063$; $p=0.136$; $p>0.05$) (Alcan & Korkmaz, 2012).

Table 3. *Description of research on surgical scrubbing with and without a brush in decreasing the number of bacterial colonies*

Author, year	Country	Treatment	Subject	Duration of surgical scrubbing	Agent used	Tool or measure-ment index the number of germs	Key findings or results
Paliama et al., 2018	Indonesia	Surgical scrubbing with a brush	32 nurses	3-5 min.	Chlorhexidine gluconate 4%	Swabs sample	Surgical scrubbing with or without a brush is equally effective in reducing the number of bacterial colonies
Abdelatiff et al., 2014	Saudi Arabia	Surgical scrubbing with a sterile brush	50 apprentices	5 min. or l0 min.	Antimicrobial soap	Sterile swabs	Scrubbing with a brush does not provide additional decontamination compared with brushless scrubbing
Alcan & Korkmaz, 2012	Turkey	Using a nail pick and brush during surgical scrubbing	60 nurses	6 min.	Chlorhexidine gluconate 4%	Glove juice method	Using a nail pick and brush during surgical scrubbing does not provide additional decontamination
Asdornwise d et al., 2011	Thailand	Surgical scrubbing with and without a brush.	45 operating health workers	6 min.	Chlorhexidine gluconate 4%	Microbial cultures	Brushless and waterless surgical scrubbing is more effective in reducing the number of skin bacterial colonies compared with surgical scrubbing with a brush
Tanner et al., 2009	United Kingdom	Surgical scrubbing plus a nail pick and a nail brush	164 operating department staff	2 min.	Chlorhexidine gluconate 4%	Glove juice method ASTM E115-02	No difference between the groups in reducing the number of hand bacteria

In other study results, Asdornwised et al., (2011) reported that the reduction of bacteria after 3 weeks of hand antiseptic product use was found to be statistically significant ($p < 0.0001$). Brushless and waterless surgical scrubbing using 1% CHG, 61% ethyl alcohol, and emollients (method C) had a higher reduction of colony-forming units (CFU) than brushless surgical scrubbing using 4% CHG (method A) and surgical scrubbing with a brush using 4% CHG (method B). There was no significant difference between methods A and B. The effect of each sequence period was not statistically significant. The covariance of fundamental CFU values □□was significant ($p < 0.0001$). Furthermore, Tanner et al., (2009) reported that the comparison of CFU 1 h after surgical scrubbing with CHG alone and CHG with a nail brush was not significant ($p = 0.09$), with a difference in post-intervention of 0.24 (−0.04, 0.51). Similarly, the comparison between surgical scrubbing with CHG alone and that with CHG and a nail pick was also not significant ($p = 0.34$), with a difference in post-intervention of 0.13 (−0.14, 0.40). Based on these results, it can be interpreted that no significant difference was observed in the number of CFU on the hand after surgical scrubbing with CHG alone, CHG with a nail pick, and CHG with a nail brush.

Review of the Selected Studies

In this review, a risk assessment of bias was carried out using the Cochrane Risk of Bias Assessment Tool. Five articles were at high risk of selection bias because they did not clearly explain the missing data on sample recruitment until the study ended (Abdelatiff et al., 2014; Alcan & Korkmaz, 2012; Asdornwised et al., 2011; Paliama et al., 2018; Tanner et al., 2009). Meanwhile, another source of bias found that five articles had a high risk of other bias because different additional treatments for each intervention and control provided (Abdelatiff et al., 2014; Alcan & Korkmaz, 2012; Asdornwised et al., 2011; Paliama et al., 2018; Tanner et al., 2009).

Discussion

The results of the clinical study analysis found that there is no significant difference in the number of germs on the hands between surgical scrubbing with a brush and that without a brush. The use of a brush in surgical scrubbing does not provide additional benefit. In fact, in some studies, surgical scrubbing without a brush seems to be better for the skin than that with a brush (Liu & Mehigan, 2016).

According to the study of the Society for General Microbiology in 2011, microbes were 1,000 times more easily spread on wet hands than dry hands (Meliana & Permana, 2017). Sebaceous skin area, the moist and dry sites dry are some factors that determine the overall number and composition of the skin microbiota (Cundell, 2016). Moreover, the varied duration of scrubbing in clinical studies led to the results varied obtained results. The CDC highly recommends that prolonged scrubbing is not required (Boyce & Pittet, 2002a). The recommended duration of surgical scrubbing is between 3 and 5 minutes. It shows that 3 and 5 minutes have the same effectiveness (Hingst et al., 1992). According to the WHO, the hands and arms should be washed for a more extended period, as recommended by the manufacturer of the antiseptic, usually 2–5 min (World Health Organization, 2016).

The risk assessment of bias using the Cochrane Risk of Bias Assessment Tool guidelines reported to have such a high risk of bias, due to missing data on sample recruitment and different additional treatments. Poor sample representation threatens the ability of research to generate valid data (Palareti et al., 2016). Validity refers to the integrity and application of the methods and the precision in which the findings accurately reflect the data, and reliability refers to the consistency within the analytical processes (Smith & Noble, 2014).

It is necessary to note that to understand the purpose of the various approaches in the cleaning of the hands, knowledge about healthy bacterial skin flora is essential. The total number of bacteria on the hands of medical personnel ranges from 3.9×10^4 to 4.6×10^6. The bacteria to be washed out of the hands are divided into two categories: transient and resident (Cundell, 2016). Transient flora in the superficial skin layers is easier to be wiped with routine handwashing, while resident flora, attached to the deeper skin layers, is more resistant to handwashing (Boyce & Pittet, 2002b). Therefore, the use of brush adds no significant difference in the decreasing of germ colonies on the hands. The author recognizes limitations in this study. First, The limited randomized controlled design in the included studies. Second, the search was restricted to studies available in the English language. Finally, the characteristics of the brush, the procedure, and the duration of scrubbing are not clear and vary, making it prone to inconsistency in decreasing the number of germ colonies on the hands.

Conclusions and Recommendations

The number of germ colonies on the hands between scrubbing with and without a brush showed similarities. Specifically, this systematic review shows the use of a brushless scrub offers advantages in terms of easy application and low level of skin irritation. However, it is also worth considering using surgical scrubbing with a brush when hands are visibly dirty. Health care workers including nurses can use brushless scrubs as an alternative to surgical management of site infections.

References

Abdelatiff, D. A., Haiyk, K. S. El, Ghobashi, N. H., Qudaa, R. F. El, & Sabouni, R. S. El. (2014). Comparing of using sterile brush during surgical scrubbing versus brushless for surgical team in operating room. *Life Science Journal*, *11*(1), 387–393. http://www.lifesciencesite.com

Alcan, A. O., & Korkmaz, F. D. (2012). Comparison of the efficiency of nail pick and brush used for nail cleaning during surgical scrub on reducing bacterial counts. *American Journal of Infection Control*, *40*, 826–829. https://doi.org/10.1016/j.ajic.2011.10.021

Allegranzi, B., Nejad, S. B., Combescure, C., Graafmans, W., Attar, H., Donaldson, L., & Pittet, D. (2010). Burden of endemic health-care-associated infection in developing countries□: systematic review and meta-analysis. *Thelancet*, *10*(4), 1–14. https://doi.org/10.1016/S0140-6736(10)61458-4

Asdornwised, U., Prechakul, B., Trakulsomboon, S., Rojananin, S., Rongrungreng, Y., Supenya, Warothai, Pumsuwan, V., Vaithayaphichet, S., Piputtanakulchai, D., & Walters, S. (2011). An Evaluation of Brush , Brushless , and Waterless Surgical Hand Scrubs among Health Care Workers in Operating Rooms at a University Hospital in Thailand*. *Journal of Nursing Science*, *29*(3), 17–27.

Asensio, A., & Gregorio, L. de. (2013). Practical experience in a surgical unit when changing from scrub to rub. *Journal of Hospital Infection*, *83*(SUPPL. 1), S40–S42. https://doi.org/10.1016/S0195-6701(13)60009-2

Asri, M., Irwan, A. M., Sjattar, E. L., & Hardianto, Y. (2022). Effectiveness of a low-salt diet in rural hypertensive patients: A systematic review. *Clinical Epidemiology and Global Health*, *15*(July 2021), 101024. https://doi.org/10.1016/j.cegh.2022.101024

Boyce, J. M., & Pittet, D. (2002a). Guideline for Hand Hygiene in Health-Care Settings: Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. In *Centers for Disease Control and Prevention* (Vol. 51). MMWR. https://doi.org/10.1097/01.idc.0000129851.34508.48

Boyce, J. M., & Pittet, D. (2002b). Guideline For Hand Hygiene In Health-Care Settings: Recommendations Of The Healthcare Infection Control Practices Advisory Committee And The HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. *Infection Control & Hospital Epidemiology*, *23*(12). https://doi.org/10.1086/503164

Carro, C., Camilleri, L., Traore, O., Badrikian, L., Legault, B., Azarnoush, K., Dualé, C., & De Riberolles, C. (2007). An in-use microbiological comparison of two surgical hand disinfection techniques in cardiothoracic surgery: hand rubbing versus hand scrubbing. *Journal of Hospital Infection*, *67*(1), 62–66. https://doi.org/10.1016/j.jhin.2007.06.016

Centre for Health Protection. (2009). *Recommendations on Prevention of Surgical Site Infection* (Issue February).

Cundell, A. M. (2016). Microbial Ecology of the Human Skin. *Microbial Ecology*, *76*(1), 113–120. https://doi.org/10.1007/s00248-016-0789-6

Gilo, E. L. C., Garma, Paul Froilan U., R., & Delgado, N. V. D. (2020). A Rapid Review Of Nurses' Experiences Working In Hospital Settings During The Covid-19 Pandemic. *Philippine Journal of Nursing*, *90*(3), 10–21.

Gok, F., Hergul, F. K., & Ozbayir, T. (2016). Surgical hand washing: A systematic review. *International Journal of Antisepsis Disinfection Sterilization*, *1*(1), 23–32. https://doi.org/10.14744/ijads.2016.32042

Higgins, J. P. T., Altman, D. G., Gøtzsche, P. C., Jüni, P., Moher, D., Oxman, A. D., SavoviĆ, J., Schulz, K. F., Weeks, L., & Sterne, J. A. C. (2011). The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ (Online)*, *343*(7829), 1–9. https://doi.org/10.1136/bmj.d5928

Hingst, V., Juditzki, I., Heeg, P., & Sonntag, H. G. (1992). Evaluation of the efficacy of surgical hand disinfection following a reduced application time 3 instead of 5 min. *Journal of Hospital Infection*, *20*, 79–86. https://www.ncbi.nlm.nih.gov/pubmed/1348766

Hsieh, H. F., Chiu, H. H., & Lee, F. P. (2006). Surgical hand scrubs in relation to microbial counts: Systematic literature review. *Journal of Advanced Nursing*, *55*(1), 68–78. https://doi.org/10.1111/j.1365-2648.2006.03876.x

Izaguirre, A., Govela, A., Delgado, I., Troncoso, C. M., Parra, M., & Viana, E. A. (2018). Surgical hand antisepsis: experimental study. *Annals of Surgical Treatment and Research*, *95*(1), 1–6. https://doi.org/10.4174/astr.2018.95.1.1

Latif, A. I., & Irwan, A. M. (2019). Models and benefits of palliative care for the quality of life of people with hiv: A systematic review. *HIV Nursing*, *19*(4), 80–85.

Liu, L. Q., & Mehigan, S. (2016). The Effects of Surgical Hand Scrubbing Protocols on Skin Integrity and Surgical Site Infection Rates: A Systematic Review. *AORN Journal*, *103*(5), 468–482. https://doi.org/10.1016/j.aorn.2016.03.003

Meliana, S., & Permana, O. (2017). Efektivitas Mencuci Tangan Dengan Sabun Cuci Tangan Cair Berbahan Aktif Triclocarban Pada Mahasiswa Fakultas Kedokteran Universitas Jambi Angkatan 2015. *Jambi Medical Journal*, *5*(1), 49–58. https://doi.org/10.22437/jmj.v5i1.3699

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The PRISMA Group. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *Plos Medicine*, *6*(7), 1–6. https://doi.org/10.1371/journal.pmed.1000097

National Institute for Health and Clinical Excellence. (2008). *Surgical site infection: prevention and treatment of surgical site infection* (Issue October). RCOG Press.

National Institute for Health and Clinical Excellence. (2019). *Surgical site infections: prevention and treatment*. NIHCE. https://www.nice.org.uk/process/pmg6/resources/the-guidelines-manual-pdf-2007970804933

Nemut, T., Dede, C., Menekse, D., Cinar, N., & Peksen, S. (2021). Being attendant at pediatric clinics can increase bacterial contamination risk on hands? *Bangladesh Journal of Medical Science*, *20*(2), 263–267. https://doi.org/10.3329/bjms.v20i2.51533

Palareti, G., Legnani, C., Cosmi, B., Antonucci, E., Erba, N., Poli, D., Testa, S., & Tosetto, A. (2016). Comparison between different D-Dimer cutoff values to assess the

individual risk of recurrent venous thromboembolism: Analysis of results obtained in the DULCIS study. *International Journal of Laboratory Hematology*, *38*(1), 42–49. https://doi.org/10.1111/ijlh.12426

Paliama, A., Suatmaji, Wati, I.D.A.R.N., Yani, Y. S., & Oktaviana, W. (2018). Effetiveness of adding disposable brush to the surgical scrub routines in reducing hand bacterial flora. *International Journal of Sciences: Basic and Applied Research*, *37*(3), 212–218.

Parlak, E. A., Iyigun, E., Albay, A., & Bedir, O. (2021). Impact of methods and duration of surgical hand scrub on bacterial count: A randomized controlled trial. *American Journal of Infection Control*, *49*(11), 1376–1383. https://doi.org/10.1016/j.ajic.2021.05.006

Santos, C. M. da C., Pimenta, C. A. de M., & Nobre, M. R. C. (2007). The Pico Strategy For The Research Question Construction And Evidence Search. *Rev Latino-Am Enfermagem*, *15*(3), 508–511.

Saunders-Hastings, P., Crispo, J. A. G., Sikora, L., & Krewski, D. (2017). Effectiveness of personal protective measures in reducing pandemic influenza transmission: A systematic review and meta-analysis. *Epidemics*, *20*, 1–20. https://doi.org/10.1016/j.epidem.2017.04.003

Smith, J., & Noble, H. (2014). Bias in research. *Evidence-Based Nursing*, *17*(4), 100–101. https://doi.org/10.1136/eb-2014-101946

Soule, B. M. (2018). *Evidence-Based Principles and Practices for Preventing Surgical Site Infections*. Joint Commission International. https://www.jointcommissioninternational.org/assets/3/7/JCI_SSI_Toolkit.pdf

Spruce, L. (2013). Back to basics: Hand hygiene and Surgical Hand Antisepsis. *Current Opinion in Infectious Diseases*, *98*(5), 449–460. https://doi.org/10.1097/QCO.0000000000000080

Tanner, J., Khan, D., Walsh, S., Chernova, J., Lamont, S., & Laurent, T. (2009). Brushes and picks used on nails during the surgical scrub to reduce bacteria: a randomised trial. *Journal of Hospital Infection*, *71*, 234–238. https://doi.org/10.1016/j.jhin.2008.11.023

World Health Organization. (2009a). *WHO Guidelines for Safe Surgery 2009: Safe Surgery Saves Lives*. WHO Press. https://apps.who.int/iris/bitstream/handle/10665/44185/9789241598552_eng.pdf;jsessionid=5D7F3313F3C57D7299E44CA49B66156C?sequence=1

World Health Organization. (2009b). *WHO Guidelines on Hand Hygiene in Health Care: a Summary*. WHO Press.

World Health Organization. (2016). *Global guidelines for the prevention of surgical site infection*. WHO Press.

Yusuf, Y., & Irwan, A. M. (2021). The influence of nurse leadership style on the culture of patient safety incident reporting: A systematic review. *British Journal of Health Care Management*, *27*(6), 1–7. https://doi.org/10.12968/bjhc.2020.0083

ABOUT THE AUTHORS

Adi Angriawan Bambi, MN., RN is currently working in South Konawe Regional Hospital, Indonesia as a staff nurse in the operation room. He completed his BSN from Avicenna Institute of Technology and Health, Kendari City, Indonesia. He obtained his MN from the Faculty of Nursing, Hasanuddin University, Indonesia. His research interests include medical-surgical nursing and pressure injury.

Andi Masyitha Irwan , PhD., MAN., RN is an Assistant Professor at Faculty of Nursing, Hasanuddin University, Indonesia. She had her BSN from Nursing Program Study at Hasanuddin University, Indonesia. She obtained her MAN from the College of Nursing, University of The Philippines, Manila and earned her Ph.D. in Nursing from Graduate School of Health Sciences, Kanazawa University, Japan. Currently, she is a post-doctoral fellow at the School of Nursing, University of Michigan, USA and a Collaborative Professor at Kanazawa University, Japan. Her research and publication focusing on older people and chronic diseases area.

Acknowledgment

We appreciate the time and support provided by the supervisor in this systematic review. The author is very grateful to the lecturers and staff of the Faculty of Nursing, Hasanuddin University, for facilitating the smooth implementation of the study.

Nurses are a unique kind. They have this insatiable need to care for others, which is both their greatest strength and fatal flaw.

Jean Watson, *American nurse theorist and nursing professor*

https://www.usa.edu/blog/nursing-quotes/