Indian J. Vet. Surg. 41(1): 31-34, June 2020

ijvs

Comparison of bacterial count of different surgical hand scrubbing techniques using chlorhexidine gluconate

Liew Wen Qi[1], Thotta Narasimhalu Ganesh[2†] and Erkihun Aklilu[3]

University Malaysia Kelantan, Campus Kota, Locked Bag 36, Pengkalan Chepa, 16100, Kota Bharu, Kelantan, Malaysia

[1]DVM student, [2]Professor, Department of Clinical Studies, [3]Senior Lecturer, Department of Paraclinical Studies, Faculty of Veterinary Medicine

Received: October, 2019

Many guidelines have been published on surgical scrubbing techniques. The aim of this study was to compare bacterial count reduction with usage of brush, without brush and application of alcohol handrub after brushless scrubbing. Four per cent of chlorhexidine was chosen as disinfectant. Fifteen final year veterinary students were randomly assigned to different groups: scrubbing with brush, scrubbing without brush and scrubbing without brush followed by application of alcohol handrub before donning surgical gloves. Bacterial counts were performed using glove juice procedure, for pre-scrubbing and one hour post-scrubbing. No significant difference between these methods was observed regardless of the significant difference in pre-scrubbing hand bacterial counts. In conclusion, the experiment does not support the mandatory use of brush in surgical scrubbing. Brushless scrubbing alone or followed by alcohol handrub could be the alternatives.

***Key words**: Alcohol, Brush, Chlorhexidine, Surgical hand scrubbing*

Historically, surgical hand preparation has been used to prevent surgical site infection. Sterile gloves contribute to preventing surgical site contamination and reduce the risk of blood borne pathogen transmission from patients to the surgical team. However, 18% (range, 5-82%) of gloves have tiny punctures after surgery and more than 80% of cases go unnoticed by the surgeon (WHO, 2016).

Various surgical hand scrubbing techniques have been developed and improved to reduce the hand bacterial count. Scrubbing is defined as brushing the hand and forearms to reduce the bacterial count to a minimum (Gardner and Anderson-Manz, 2017). This practice has been abandoned by some organisations such as World Health Organization (2009) as it increased bacterial counts by damaging the skin. The usage of nail picks and brushes may reduce bacteria, have no impact at all or, at worst, increase bacteria by causing abrasions to the fingertips (Tanner *et al.*, 2008). Brushless scrubbing is more tolerable for surgeons as it caused less injuries to the hands (Liu and Mehigan, 2016). On the other hand, surgical handrub refers to surgical hand preparation with a waterless, alcohol based handrub (WHO, 2009).

Three types of antiseptic solutions are available for surgical antisepsis. Aqueous scrubs most commonly contain chlorhexidine gluconate or povidone iodine. Alcohol rubs are alcohol based solutions available in preparations of 60% to 90% strength. On the other hand, alcohol rubs containing active ingredients such as chlorhexidine gluconate enhance the bactericidal effect of alcohol (Tanner *et al.*, 2009).

Bacterial counts in veterinary patients are likely to be higher than bacterial counts on human, resulting in higher bacterial counts on the veterinary surgeons' hand compared to the human medical doctors' hand (Verwilghen *et al.*, 2011). Veterinarians often need to perform physical examination on the patients and hence, might lead to higher bacterial counts on their hands.

The aim of this study was to compare the efficiency of different scrubbing techniques to decide on the best hand antisepsis technique.

Materials and Methods

Fifteen veterinary medical students from the University Malaysia Kelantan volunteered to be included in the study. Volunteers were made sure that they did not have cuts on their hands, no history of allergy to chlorhexidine and alcohol handrub and with short finger nail, which was less than 5 mm.

This method was adapted from American Society for Testing and Materials, ASTM E-1115, to count the resident flora (ASTM International, 2014). Bacterial count was determined on the dominant hand immediately before the scrub and one hour after the scrub using glove juice method. The dominant hands of the volunteers were placed in a

†Corresponding author; E-mail: mvctnganesh@gmail.com

sterile, loose fitting powder free latex glove containing 75 mL of sterile phosphate buffer solution (PBS), to collect the baseline specimen of the dominant hand. The wrist was secured with a tape. All surfaces of the gloved hands were massaged for one minute and the volunteers removed their gloves after the glove juice extraction. A 5 mL of aliquot juice was extracted from the glove aseptically. This was followed by one of the allocated scrub protocols, which was 3 min scrubbing with 4% chlorhexidine gluconate with brush, or brushless with 4% chlorhexidine gluconate only or brushless with 4% chlorhexidine gluconate followed by alcohol rub before donning surgical glove. On completion of the scrub, volunteers dried their hand and put on a powder free sterile glove over their dominant hand. After one hour, post-scrubbing glove juice was collected, for which 75 mL PBS was infused into the gloved dominant hand. All hand surfaces were massaged for one minute. A 5 mL of aliquot juice was extracted from the glove aseptically and collected into sterile bottle.

Both pre-scrub and post-scrubbing glove juice samples were serially diluted in a 1:10 dilution with PBS. Then 1 µL of the solution was placed on to the plate count agar and was spread using spread plate method. The plates were incubated aerobically at 37°C for 24 hr. The colony count was performed using colony counters. Those plates with more than 30 and less than 300 colonies were used for counts and calculations.

The CFU/mL obtained was converted into log value for statistical purpose, using the formula of $\log_{10}$ (x+1), where x represents the pre- and post-bacterial counts. The (x+1) transformation was required to address infinity error associated with $\log_{10}$ transforming 0 values. Datasets were subjected to two-way ANOVA with method of scrubbing and time of treatment as treatment factors. The significantly different means were differentiated from each other based on their estimated marginal means of the generalized linear model procedure. A p-value, $P<0.05$, was considered significant.

Results and Discussion

For the scrubbing technique with brush, 3 out of 5 subjects showed that they had zero bacterial load despite their significant difference in pre-scrub bacterial count (Table 1). The pre-scrub values ranged from 2.1 x 10^3 CFU/mL to 8.8 x 10^7CFU/mL. The post-scrub values ranged from 0 CFU/mL to 1 x 10^3 CFU/mL.

Table 1: Bacterial count (CFU/mL) after scrubbing using brush

Subject	Bacterial counts (CFU/mL)			
	Pre-scrub	Log value	Post-scrub	Log value
1	2.1 x 10^3	3.32	0	0.00
2	2.4 x 10^4	4.38	0	0.00
3	2.3 x 10^4	4.36	0	0.00
4	3.4 x 10^6	6.53	1 x 10^3	3.00
5	8.8 x 10^7	7.94	2 x 10^1	1.32

For brushless scrubbing, 3 out of 5 subjects showed that there was no bacterial load despite their significant difference in pre-scrubbing bacterial load (Table 2). The pre-scrub values ranged from 2.1 x 10^3 Colony Forming Unit (CFU)/mL to 2.5 x 10^4 CFU/mL. The post-scrub values ranged from 0 CFU/mL to 6 x 10^2 CFU/mL.

Table 2: Bacterial counts (CFU/mL) after scrubbing without use of brush

Subject	Bacterial counts (CFU/mL)			
	Pre-scrub	Log value	Post-scrub	Log value
1	2.5 x 10^4	4.40	6 x 10^2	2.78
2	1.3 x 10^4	4.11	0	0.00
3	2.1 x 10^3	3.32	0	0.00
4	9 x 10^1	1.96	0	0.00
5	3.2 x 10^3	3.51	2 x 10^1	1.32

For the brushless scrubbing followed by alcohol hand rub before donning gloves, 4 out of 5 subjects' hands had no bacterial counts after scrubbing without brush followed by alcohol handrub (Table 3). The pre-scrub values range from 2.7 x 10^3 CFU/mL to 2.5 x 10^4 CFU/mL. The post-scrub values ranged from 0 CFU/mL to 1.5 x 10^2 CFU/mL.

Table 3: Bacterial counts (CFU/mL) after scrubbing without brush followed by alcohol handrub before donning gloves

Subject	Bacterial counts (CFU/mL)			
	Pre-scrub	Log value	Post-scrub	Log value
1	2.7 x 10^3	3.43	0	0.00
2	2.4 x 10^5	5.38	1.5 x 10^2	2.18
3	3.2 x 10^3	3.51	0	0.00
4	2.1 x 10^4	4.32	0	0.00
5	1.8 x 10^4	4.26	0	0.00

All subjects started with significantly different bacterial load from each other. However, regardless of treatment, the post-scrubbing bacterial load did not differ significantly across treatment. There was no significant interaction effect between methods and time of treatments.

Results from this study show that there is no significant difference in post-intervention bacterial count between scrubbing with brush and scrubbing without brush. Application of alcohol before donning gloves has no effect in reducing bacterial counts. This study has found no significant difference in the number of post-intervention bacterial counts among the 3 groups.

This study has proven that it is not necessary to use brush during surgical scrubbing. It is optional to scrub using brush if the surgeons' hands are visually contaminated. Nail picks and brushes do not offer additional decontamination (Tanner *et al*., 2009). It is not uncommon to notice the veterinary surgeons with hand eczema and dermatitis. This condition is further worsened by the usage of the brush during scrubbing, especially in institutions that require surgeons scrub their hands with brush every time when they need to conduct surgery. Scrubbing without brush causes less skin damage than traditional scrubbing techniques (Liu and Mehigan, 2016). In addition, usage of surgical brush incurs additional operational cost to the veterinary clinic or hospital compared to the brushless scrubbing.

Skin contamination in animal practitioner may be different from human medical doctor because veterinarians often need to perform physical examination, pre-operatory preparation and patient placement on the surgical table. However, a study done by Edwards *et al.* (2017) in an equine hospital concluded that chlorhexidine or alcohol hand rub gel has the same efficacy in reducing bacterial counts.

Chlorhexidine with 4% concentration has the same effectiveness for all three scrubbing techniques regardless of their significantly different pre-scrubbing hand flora. It has been proven that the contact time affects the effectiveness of chlorhexidine (Stinner *et al.,* 2011). In this study, in all the 3 methods the volunteers have scrubbed using chlorhexidine for 3 min. This could be the reason why these were not statistically different from each other, since the contact time with chlorhexidine was the same.

The use of the surgical scrub is imperative and there is no recent literature supporting the usage of brush for surgical scrubbing. Lister and Price were the pioneers who established the guidelines on using the brush during surgical scrubbing in the 19th century (Lister, 1894; Price, 1938). Surgical gloves might not be widely available at that time, which made thorough and frequent scrubbing with brush necessary.

A study has been done in Japan, by Furukawa *et al*. (2005), which revealed that sterile water is not necessary for surgical scrubbing. No bacteria were detected in the tap water supply in Japan. The researchers recommend that a quick alcohol hand rub should be used, the concentration of free chloride in water should be maintained at over 0.1 PPM and the bacterial level of the water should be checked, cleaned and sterilised regularly.

In short, it has been proven by the study that it is not necessary or should be considered optional to use brush in surgical scrubbing and alcohol hand rub before donning gloves. There was no significant difference in colony forming units between scrubbing with brush, scrubbing without brush and application of alcohol handrub before donning glove, regardless of the significant pre-scrubbing colony forming units.

In conclusion, the result of this experiment does not support the mandatory use of brush in surgical scrubbing as there was no significant difference in bacterial court between the use of brush in surgical scrubbing and brushless scrubbing. Brushless scrubbing or brushless scrubbing followed by alcohol hand rub could be an alternative.

Acknowledgements

The authors thank Professor Dr. Goh Yong Meng of University Putra Malaysia for the guidance in analysing and interpreting the data. Assistance provided by Mdm. Norsyamimi Farhana Bin Mat Kamir and Ms. Nani Izreen Bin Mohd Sani for the laboratory work is acknowledged herewith. Special thanks to the DVM students who volunteered for the study.

References

ASTM International. 2014. Standard test method for evaluation of surgical hand scrub formulations. (designation: E 1115-11).

Edwards, R., Riley, C., Howe, L., Burrows, E., Riley, K. and Frellstedt, L. 2017. Comparison of an alcohol-based hand sanitation product with a traditional chlorhexidine hand scrub technique for hand hygiene preparation in an equine hospital. New Zealand Vet. J. **65:** 242-247.

Furukawa, K., Tajiri, T., Suzuki, H. and Norose, Y. 2005. Are sterile water and brushes necessary for hand washing before surgery in Japan. J. Nippon Med. School **72:** 149-154.

Gardner, D. and Anderson-Manz, E. 2017. How To perform surgical hand scrubs. Retrieved January 17, 2019, from Infection Control Today website: https://www. infectioncontroltoday. com/hand-hygiene/how-perform-surgical-hand-scrubs.

Lister, B.J. 1867. The classic: on the antiseptic principle in the practice of surgery. Br. Med. J. Sep 21; **2(351)**: 246-248.

Liu, L.Q. and Mehigan, S. 2016. The effects of surgical hand scrubbing protocols on skin integrity and surgical site infection rates: a systematic review. AORN J. **103**: 468-482.

Price, P.B. 1938. The bacteriology of normal skin; a new quantitative test applied to a study of the bacterial flora and the disinfectant action of mechanical cleansing. J. Inf. Dis. **63:** 301-318.

Stinner, D.J., Krueger, C.A., Masini, B.D. and Wenke, J.C. 2011. Time-dependent effect of chlorhexidine surgical prep. J. Hosp. Inf. **79:** 313-316.

Tanner, J., Khan, D., Walsh, S., Chernova, J., Lamont, S. and Laurent, T. 2009. Brushes and picks used on nails during the surgical scrub to reduce bacteria: a randomised trial. J. Hosp. Inf. **71:** 234-238.

Tanner, J., Swarbrook, S. and Stuart, J. 2008. Surgical hand antisepsis to reduce surgical site infection. The Cochrane Database of Systematic Reviews (1).

Verwilghen, D.R., Mainil, J., Mastrocicco, E., Hamaide, A., Detilleux, J., van Galen, G. and Grulke, S. 2011. Surgical hand antisepsis in veterinary practice: evaluation of soap scrubs and alcohol based rub techniques. Vet. J. **190:** 372-377.

WHO 2009. WHO guidelines on hand hygiene in health care. Retrieved December 23, 2018, from WHO website: https://www.who.int/gpsc/5may/tools/9789241597906/en/.

WHO 2016. Summary of the systematic review on surgical hand preparation. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK401149.