Original Research
JCAM

A study of the effects of three gloves donning techniques on the contamination

Milad Hosseini[1], Ahmad Ghadami[2], Seyed Mozafar Hashemi[3]
[1]M.sc student in operating room, Student Research Center, School of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan,
[2]PhD in Nursing, Ulcer Repair Research Center, Department of Operating Room, School of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan,
[3]Associate Professor of Surgery, Faculty of Medicine, University of Medical Sciences, Isfahan, Iran

Abstract

Aim: hospital personnel's hands are considered as the most important way of transmission of pathogens such as methicillin-resistant Staphylococcus aureus and spore bacteria such as Clostridium. Wearing gloves correctly and in a standard way is an essential principle to prevent the surgical site infections. The present study aimed to investigate the effects of three gloves donning techniques on the contamination of operating room personnel's sterile gloves and gown. Material and Method: this research was a field trial study. 96 pairs of gloves were randomly and equally divided between three groups and three ways were determined to wear the gloves: open, closed-gloving techniques and open staff-assisted. After obtaining informed consents, three operating room personnel were selected according to the research objective and they were placed in the three groups. They were taught how to wear gloves and they were controlled in terms of wearing gloves standardly and correctly. After washing hands standardly and glitterbug powder was applied to them and the gown was worn, one of the three mentioned techniques was selected to wear the gloves by random allocation. Each techniques was repeated 32 times. One hour after surgery, the gloves and gown were taken off and contamination of them was checked by irradiation of UV and it was recorded in a related list. The data was analyzed using SPSS V.23 and performing analytical and descriptive statistical tests. Results: in the closed-gloving techniques, the mean contamination of gloves was statistically less compared to two other techniques. The mean contamination in open staff-assisted was less compared to open-gloving technique (p-value < 0.05) (open-gloving technique: 157.34±64.15 VS closed-glovingtechnique: 58.02±34.34 and open staff-assisted: 86.22±45.48). Also, total mean contamination of gown (glitterbug powder) in open-gloving technique was significantly greater than closed-gloving technique and open staff-assisted (p-value < 0.05) (open-gloving technique: 221.92±104.08 VS closed-gloving technique: 121.14±133.21 and open staff-assisted technique: 72.72139.03). Discussion: according to the results, it is recommended that the policy and protocol of wearing gloves with open staff-assisted technique and closed-gloving technique are emphasized in order to reduce contamination more by operating room personnel. Also, more research is needed in this area.

Keywords

Surgical Gloves; Contamination; Operating Room; Gown; Gloves Donningtechnique

DOI: 10.4328/JCAM.5508 Received: 16.04.2017 Accepted: 02.06.2017 Printed: 01.12.2017 J Clin Anal Med 2017;8(suppl 4): 458-63
Corresponding Author: Ahmad Ghadami, PhD in Nursing, Ulcer Repair Research Center, Department of Operating Room, School of Nursing and Midwifery Isfahan, Iran. T.: 00983132589632 F.: 00983132589632 E-Mail: A.Ghadami83@gmail.com

Introduction

Nosocomial infections are a major problem for the health care system. According to the World Health Organization, nosocomial infections are those infections which are created within 48 hours after admission to the hospital or staying in health care centers and at the time of admission, the patient did not have it and were not even in the incubation period [1]. The prevalence of nosocomial infections is estimated from 5 to 30 percent in different countries and its rate in developing countries such as Iran, has been reported %25 [2, 3, 4]. According to the Center for Disease Control and Prevention, nearly 2 million Americans suffer from this type of infection and cost of more than $ 11 billion is imposed to the hospitals in the country and in %16 of them, resistance to antibiotics used to treat them, has been reported [5].

The contamination existing in the equipment, environment and personnel of operating room are the factors causing nosocomial infections in the patients [1]. The studied performed show the rate of microbial contamination in operating rooms from %2.5 to more than 50 percent [6, 7]. So the operating room can be a great source of nosocomial infection [8].

Surgical site infections are the most common nosocomial infection that are included as %31 of nosocomial infections in the hospitalized patients [9]. The mortality rate associated with surgical site infection is 3% and 3/4 of this amount is directly caused by the surgical site infection itself [10].

The principles of prevention of surgical site infections are defined in three before, during and after surgery. Appropriate attire for patients and staff, cutting the hair of surgical site, bowel preparation, the use of two pairs of gloves and antibiotic prophylaxis can be noted as the cases before surgery [8, 11]. In addition to them, scrubbing hands is an integral part of disinfection process but it is necessary to know that the bacteria tend to remain on the hands as much as possible even after scrubbing [12]. Hospital personnel's hands are considered as the most important way of transmission of pathogens such as methicillin-resistant Staphylococcus aureus and spore bacteria such as Clostridium difficile. Washing hands plays a key role in preventing infections. In addition to disinfecting hands, wearing gloves is an important and essential part of a multi-barrier strategy for hand hygiene [13]. Gloves act as a mechanical barrier and prevent the transmission of infection from patients to operating room personnel and vice versa, when contacting with blood, body fluids, secretions, wounds, mucous membranes, chemicals and dangerous drugs [14]. There are various techniques of wearing gloves in the operating room: open- and closed-gloving technique and open-gloving technique with assistance of scrub staff [15]. Closed-gloving technique is theoretically a gold standard of wearing gloves [16]. There are a few studies performed to compare gloves donningtechniques but in all of them two techniques (closed-gloving technique and open-gloving technique, closed staff-assisted and open staff-assisted) were compared [12, 16 and 17] and no study has been performed to compare the three techniques with each other. Nowadays, two open-gloving technique and open staff-assisted technique are used more. In the open technique, there is the possibility of contamination and non-sterilization of surgical equipment and field during surgery due to randomly return of gloves cuff to back, causing contamination of equipment [12]. Surgical gown is worn on operating room clothing as a personal protective equipment to participate in the sterile surgical field. The purposes of wearing a surgical gown are to prevent transmission of contamination between operating room clothing and sterile field and to distinct sterile individuals from non-sterile ones. Gloves donning technique affects the contamination of gown [15]. The results of previous studies can be affected by individuals' skill and performance or environmental conditions and not doing some of them in the operating room (done in vitro). Control of the above was considered in the present study. The presents study has been conducted to compare the effects of three gloves donning techniques (open, closed-gloving techniques and open staff-assisted technique) on the contamination of operating room personnel's sterile gloves and gown.

Material and Method

This research was a field trial study. The objective of it was to compare the effects of three gloves donning techniques on the contamination of operating room personnel's sterile gloves and gown at Al-Zahra Hospital affiliated to Isfahan University of Medical Sciences. The samples were 96 pairs of gloves which were equally and randomly divided into three open, closed-gloving techniques and open staff-assisted. Closed-gloving technique was considered as control group because it is an approved method in the literature. Inclusion criteria were sterile surgical gloves, the scrub staff should have no sensitivity to gloves without powder and glitterbug powder. Exclusion criteria were the existence of holes in the gloves and the time of surgery was less than an hour. After obtaining informed consents, three operating room personnel were selected with the criterion of having work experience of 5 years and having the knowledge of wearing gloves standardly and they were placed in the three open-, closed-gloving and open staff-assisted. They were taught how to glove and also, they were controlled in terms of gloving correctly and standardly.

A pair of Ansell Gammex pf latex gloves without power was used for each test. Glitterbug powder was used as material revealing Ultraviolet (UV) and UVA light with a long wavelength (Glow bar) was used to display powder revealing UV. The sterile fabric gowns routinely provided at hospitals, were used.

Glitterbug powder revealing UV was sterilized by the plasma device. The personnel were taught how to apply powder to their hands. After washing hands standardly, a personnel gets glitterbug powder from a third party who also wear sterile gloves and applies it to his hands (palms and backs of hands and between fingers) from the fingertips to the metacarpal surface and then he wears the gown. After wearing gown, one of open-, closed-gloving and open staff- assisted was selected by random allocation. Each technique was repeated 32 times. In open-gloving technique, the scrub staff wears the gown and then brings out his hands from the cuff and gloves but in the closed-gloving technique, the hands are kept in the gown's cuff and the gloves are worn. In the open staff-assisted, scrub staff opens the package of gloves and helps team members in gloving. An hour after surgery, the personnel's gloves and gown were taken off by a third party who wore disposable gloves (he changed them for each time), and this was similar for all the samples (in all

samples, the gloves was firstly taken off from right hand and then left hand) so that he got the edge of gloves and shoulder of gown and took off them from the personnel's hands carefully and slowly. Immediately researcher used UV lamp in a relatively dark place and put it under gloves and opposite of gown to detect contamination (glitterbug powder) on the gloves and different areas of gown (contaminated areas of gloves and gown become white after shining UV light to them). The areas of contaminated areas of gloves and gown were measured in cm (because the areas of contaminated areas were great) by ruler and recoded in check list. The data was recoded and analyzed by a person who didn't know how the personnel worn the gloves (in a blind way) in (Figure 1).

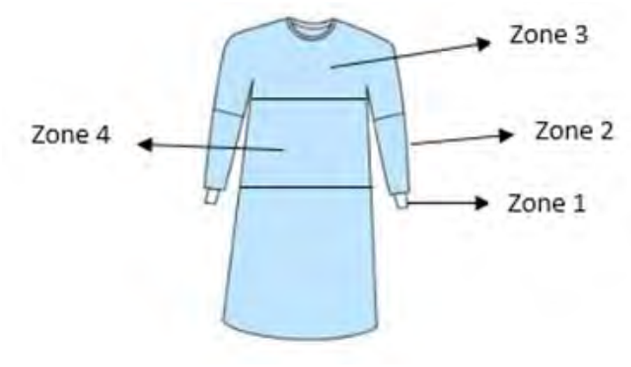


Figure 1: Different zones of gown

In order to determine the content validity of check list, 10 faculty members of operating room and nursing department, Nursing and Midwifery school, Isfahan University of Medical Sciences, were asked to comment on its items and then it was corrected so that its content validity would be approved. In order to estimate reliability of research tools, test-retest method was used so that in 5 cases of applying powder to hands, the number of contaminated areas was counted in the same conditions by several persons. In order to estimate the reliability of the UV lamp, glitterbug powder was applied to a 1*1 (cm^2) (cm^2) area and UVA lamp was shined on it and the area of contaminated zone was measured. After 15 minutes, UVA lamp was shined again and the area of contaminated zone was measured. According to Pearson's coefficient, its reliability was estimated 0.98, confirming high reliability. The data was analyzed using SPSS V.23 and performing analytical and descriptive statistical tests, including One-Way ANOVA, Tukey, Chi-square test, paired t-test and non-parametric Kruskal-Wallis tests.

Results

In the present study (field trial), 96 pairs of gloves used by three elective operating room personnel at the Al-Zahra Hospital in 2016, were used in order to compare the effects of three gloves donning techniques (open-, closed-gloving and open staff- assisted) on the contamination of operating room personnel's gloves and sterile gown. They were divided into three groups (in each group, n=32). Frequency distributions of participants' demographic characteristics were listed in table 1-1. It is noteworthy that all the studied personnel were female. According to **(table 1)**, no significant differences were observed between the groups in demographic characteristics of age, work experience, education and type of employment (p-value> 0.05).

Averagely, in open-gloving group, 2.31±0.138 persons were scrubbed and 2.06±0.118 and 2.16±0.120 persons were scrubbed in closed-gloving and open staff-assisted groups, respectively. No significant difference was observed between the groups in average number of persons scrubbed during surgery (p-value = 0.292 > 0.05). It can be said that averagely, 2 persons were scrubbed during surgery.

Table 1. Frequency distributions of demographic characteristics of operating room personnel of each group who scrubbed during surgery

		Technique			Total	P-value
		Open	Close	Open with Scrub		
Age(Year)	20-30	11	12	7	30	
		36.7%	40.0%	23.3%	100.0%	
	30-40	16	14	13	43	0.243
		37.2%	32.6%	30.2%	100.0%	
	40-50	5	6	12	23	
		21.7%	26.1%	52.2%	100.0%	
Total		32	32	32	96	
		33.3%	33.3%	33.3%	100.0%	
Work Experience (Year)	5-10	15	13	13	41	
		36.6%	31.7%	31.7%	100.0%	
	10-15	5	12	8	25	0.336
		20.0%	48.0%	32.0%	100.0%	
	15-20	12	7	11	30	
		40.0%	23.3%	36.7%	100.0%	
Total		32	32	32	96	
		33.3%	33.3%	33.3%	100.0%	
Education	Associate Degree	15	8	18	41	
		36.6%	19.5%	43.9%	100.0%	
	Bachelor Degree	17	23	14	54	0.085
		31.5%	42.6%	25.9%	100.0%	
	Master Degree	0	1	0	1	
		0.0%	100.0%	0.0%	100.0%	
Total		32	32	32	96	
		33.3%	33.3%	33.3%	100.0%	
		33.3%	33.3%	33.3%	100.0%	

The results showed that there were significant differences between the groups in average total distance of contamination of gloves (p-value < 0.05). According to the results of Post Hoc test (P-value), in open-gloving technique, average total distance of contamination was greater compared to the closed-gloving and open staff-assisted(p-value < 0.05) (open-gloving technique: 157.34±64.15 VS closed-gloving technique: 58.02±34.34 and open staff-assisted: 86.22±45.48). Also, average total distance of contamination in closed-gloving technique was significantly less compared to open staff-assisted (p-value < 0.05) (closed-gloving technique: 58.02±34.34 VS open staff-assisted: 86.22±45.48) (Figure 1).

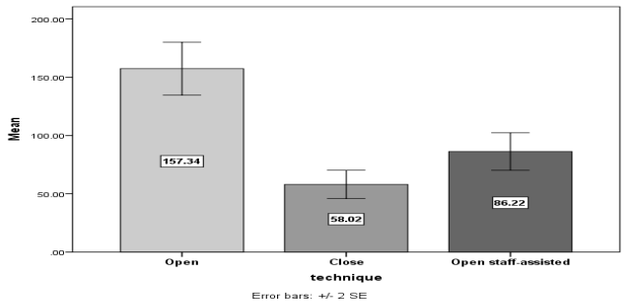


Figure 1. The total average distance of contamination of gloves in the three studied techniques

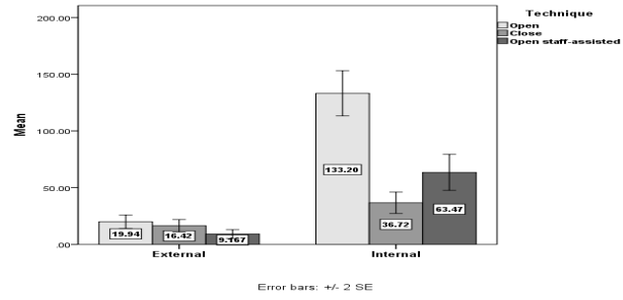


Figure 3. The average distance of contamination of the beginning and end of cuff in terms of internal and external parts of cuff in the three studied techniques

Also, the results showed that there were significant differences between the three groups in contamination between the beginning and end of the cuff (p-value = 0.003 <0.05) so that average contamination in the closed-gloving technique was less than two other techniques (p-value <0.05) (open-gloving technique: 153.14±61.36 VS closed-gloving technique: 53.14±33.57 and open-gloving with assistance of scrub staff technique: 53.14±33.57). Average contamination in open staff-assisted-was significantly less compared to open-gloving technique (p-value=0.024 < 0.05) (open-gloving technique: 80.61±45.77 VS open staff-assisted technique: 153.14±61.36) (Figure 2).There were significant differences between the three groups in average contamination between the internal and external parts of the cuff (p-value <0.05) so that according to the results of Post Hoc test (*P-value), in the internal part of glove cuff, average contamination between the beginning and end of cuff in the open-gloving technique was significantly greater than two other techniques (p-value <0.05) (open-gloving technique: 133.20±56.07 VS closed-gloving technique: 36.72±26.62 and open staff-assisted technique: 70.81±43.09). Also, average contamination in open staff-assisted was significantly greater compared to closed-gloving technique (p-value < 0.05) (closed-gloving technique: 36.72±26.62 VS open staff-assisted technique: 70.81±43.09). About external part of cuff, there was significant difference only between open-gloving and open staff- assisted and it was less in open-gloving technique (p-value < 0.05) (open-gloving technique: 19.94±16.67 VS open staff-assisted technique: 9.80±10.85((Figure 3).

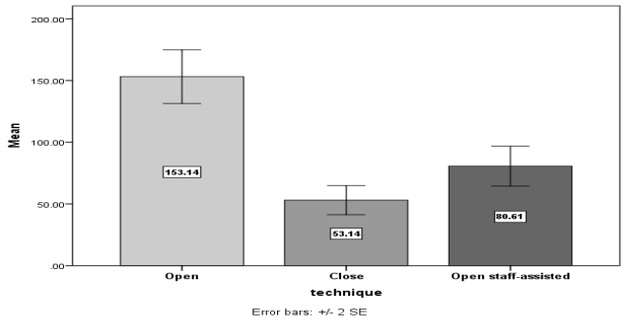


Figure 2. The total average contamination of the beginning and end of cuff in the three studied techniques

It was observed that there were significant differences between the three groups in the contamination rate in zone 1 of the gown (p-value <0.05) so that according to the results of Post Hoc test (P-value), average contamination rate (glitterbug powder) in zone 1 in closed-gloving techniques was significantly less than two other techniques (p-value <0.05) (open-gloving technique: 115.81±60.74 VS closed-gloving technique: 51.98±62.24 and open staff-assisted technique: 99.09±53.9) (Figure 4).

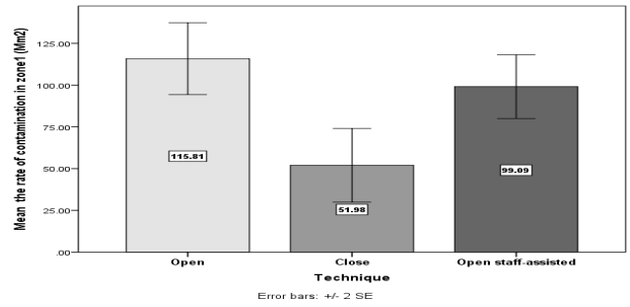


Figure 4. The average of contamination rate in zone 1 in the three studied techniques

It was observed that there were significant differences between the three groups in the contamination rate in zone 2 of the gown (p-value <0.05) so that according to the results of Post Hoc test (P-value), average contamination rate (glitterbug powder) in zone 2 in open staff- assisted was significantly less compared to open-gloving technique (p-value <0.05) (open-gloving technique: 69.28±46.02 VS closed-gloving technique: 54.31±69.23 and open staff-assisted technique: 33.39±21.41) (Figure 5).

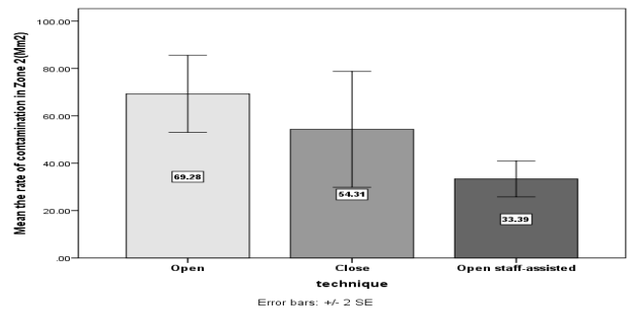


Figure 5. Bar chart of average contamination rate in zone 2 in the three studied techniques

It was observed that there were significant differences between the three groups in the contamination rate in zone 3 of the gown (p-value <0.05) so that according to the results of Post Hoc test (P-value), average contamination rate (glitterbug powder) in zone 3 in open staff- assisted was significantly less compared to two other techniques (p-value <0.05) (open-gloving technique: 28.42±23.93 VS closed-gloving technique: 12.09±16.95 and open staff-assisted technique: 4.55±9.11). Also, in closed-govening techniques, it was less compared to open-gloving technique (p-value <0.05) (open-gloving technique: 28.42±23.93 VS closed-gloving technique: 12.09±16.95) (Figure 6).

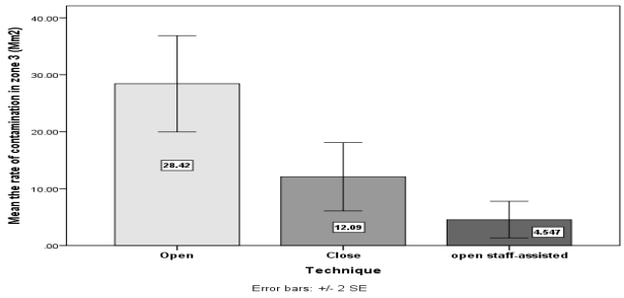


Figure 6. The average of contamination rate in zone 3 in the three studied techniques

It was observed that there were significant differences between the three groups in the contamination rate in zone 4 of the gown (p-value <0.05) so that according to the results of Post Hoc test (*P-value), average contamination rate (glitterbug powder) in zone 3 in open-gloving was significantly greater compared to two other techniques (p-value <0.05) (open-gloving technique: 8.41±11.04 VS closed-gloving technique: 2.75±4.96 and open staff-assisted technique: 2.00±4.83) (Figure 7).

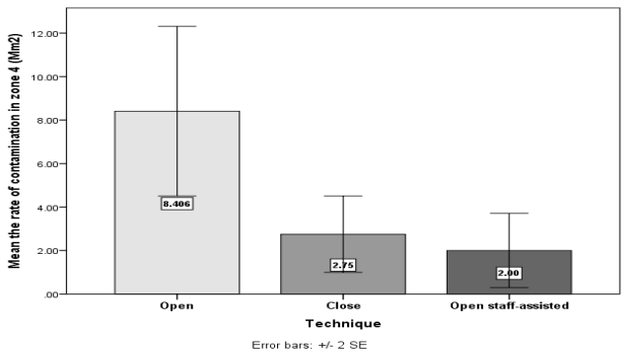


Figure 7. The average of contamination rate in zone 4 in the three studied techniques

It was observed that there were significant differences between the three groups in the total contamination rate in zones 1 to 4 (p-value <0.05) so that according to the results of Post Hoc test (P-value), average total contamination rate (glitterbug powder) in open-gloving technique was significantly greater compared to two other techniques (p-value <0.05) (Table 2).

Table 2. Average total contamination in the four zones in the three studied techniques

	Technique	N	Mean	Std. Error	P-value
Contamination in Total Zone	Open	32	221.92	18.40	0.001*
	Close	32	121.14	23.55	
	Open staff-assisted	32	139.03	12.85	
	Total	96	160.70	11.64	

Discussion

The present study aimed to compare the effects of three gloves donning techniques on the contamination of operating room personnel's sterile gloves and gown. Despite efforts to reduce bacterial contamination, such as the use of ultra-clean air and good ventilation systems, there is a need to seek other solutions. Transmission of microorganism through the hands can be considered as an important factor. Since hospital personnel's hands are considered as the most important way of transmission of pathogens such as methicillin-resistant Staphylococcus aureus and spore bacteria such as Clostridium and the bacteria tend to remain on the hands as much as possible even after scrubbing, a standard gloving technique should be selected to reduce the transmission of contamination to surgical field and surgical wounds [16].

The present study showed that gloving techniques are not similar and the rate of contamination indirectly transmitted from operating room personnel's hand skin to the gloves and gown and consequently surgical wound can be different.

The results of the present study showed that there were significant differences between the three studied groups in terms of average total distance of contamination (p-value < 0.05) so that according to the results of Post Hoc test (*P-value), in open-gloving technique, average total distance of contamination was greater compared to the closed-gloving and open staff-assisted (p-value < 0.05) (open-gloving technique: 157.34±64.15 VS closed-gloving technique: 58.02±34.34 and open staff-assisted technique: 86.22±45.48). The results of a microbiological study performed by Newsom et al. (1988) (open- and closed gloving techniques in 50 cases) showed that in closed-gloving technique, less contamination was transmitted compared to open-gloving technique (2 cases vs. 13 cases). This result is consistent with the results of the present study. It can be due to that in closed-gloving technique, the scrub staff's hands are kept in gown but in open-gloving technique, the fingers touch the glove cuff and during the return of glove cuff to back (Unintentionally), it can contaminate other parts of the glove and the surgical field.

Also, it was observed that, there were significant differences between the three groups in the total contamination rate in zones 1 to 4 (p-value <0.05) so that according to the results of Post Hoc test (P-value), average total contamination rate (glitterbug powder) in open-gloving technique was significantly greater compared to two other techniques (p-value <0.05). The results of a study by Newman et al. showed that the rate of contamination in open-gloving method was greater compared to closed-gloving and open gloving with assistance of scrub

staff techniques (8 parts vs. 4parts) and it is consistent with the result of the present study. But in their study, it was noted that in closed-gloving with assistance of scrub staff technique, there was no contamination and contamination rate in it was less compared to closed-gloving technique (0 part vs. 4 part). This result is inconsistent with the result of the present study. It can be due to the use of closed-gloving with assistance of scrub staff technique instead of open-gloving with assistance of scrub staff technique.

Jones et al. reported that closed-gloving with assistance of scrub staff technique is more preferable than open staff-assisted (12) and in the present study, closed-gloving with assistance of scrub staff technique was not studied and there are a little research on it and it is recommended to study on it.

Existence of a few studies on this topic and limited number of samples can be noted as the limitation of present study, leading to caution in generalizing the results.

Conclusion

Since not gloving correctly and standardly can lead to transmission of infection to the patient, increased cost of treatment, complications and increased mortality, it is recommended that the policy and protocol of wearing gloves with open staff-assisted and closed-gloving technique are emphasized in order to reduce contamination more by operating room personnel. Also, more research is needed in this area.

Acknowledgment

The present study was extracted from the thesis approved with No 395552 at the Isfahan University of Medical Sciences. Hereby, I thank all the operating room personnel and authorities of the Al-Zahra Hospital who participated in the present study. Also, I thank the authorities of the Isfahan University of Medical Sciences and department of Assistance Research or funding.

Competing interests

The authors declare that they have no competing interests.

References

1. Ducel G, Fabry J, Nicolle L, Organization WH. Prevention of hospital-acquired infections: a practical guide. 2002.
2. Abdollahi E, Rahmani A, Khodabakhshi B, Behnampour N. Determine the knowledge, attitude and practice of nurses of Golestan University of Medical Sciences in control of nosocomial infections. J Gorgan Uni Med Sci. 2003;5(11):80-6.
3. Lobdell KW, Stamou S, Sanchez JA. Hospital-acquired infections. Surgical Clinics of North America. 2012;92(1):65-77.
4. Nguen Q, Jaımovıch D, Pharmd R, Domachowke J, Tolan R, Stleele R. Hospital-Acquired Infections. Medicine. 2004;171:1-9.
5. Kallen AJ, Mu Y, Bulens S, Reingold A, Petit S, Gershman K, et al. Health care–associated invasive MRSA infections, 2005-2008. Jama. 2010;304(6):641-7.
6. Schabrun S, Chipchase L. Healthcare equipment as a source of nosocomial infection: a systematic review. Journal of Hospital Infection. 2006;63(3):239-45.
7. Ensayef S, Al Shalchi S, Sabbar M. Microbial contamination in the operating theater: a study in a hospital in Baghdad. 2009.
8. Boscart VM, Levchenko AI, Fernie GR. Defining the configuration of a hand hygiene monitoring system. American Journal of Infection Control. 2010;38(7):51822.
9. Magill SS, Hellinger W, Cohen J, Kay R, Bailey C, Boland B, et al. Prevalence of healthcare-associated infections in acute care hospitals in Jacksonville, Florida. Infection Control & Hospital Epidemiology. 2012;33(03):283-91.
10. Awad SS. Adherence to surgical care improvement project measures and post-operative surgical site infections. Surgical infections. 2012;13(4):234-7.
11. Conrad A, Kaier K, Frank U, Dettenkofer M. Are short training sessions on hand hygiene effective in preventing hospital-acquired MRSA? A time-series analysis. American journal of infection control. 2010;38(7):559-61.
12. Jones C, Brooker B, Genon M. Comparison of open and closed staff-assisted glove donning on the nature of surgical glove cuff contamination. ANZ journal of surgery. 2010;80(3):174-7.
13. Hübner NO, Goerdt AM, Mannerow A, Pohrt U, Heidecke CD, Kramer A, et al. The durability of examination gloves used on intensive care units. BMC infectious diseases. 2013;13(1):226.
14. TEAM IC. Standard Infection Control Precautions Literature Review: Personal Protective Equipment (PPE) Gloves. Health Protection Scotland (HPS). 2016.
15. Phillips N. Berry & Kohn's Operating Room Technique. 2013: Twelfth Edition, 267-9.
16. Newman JB, Bullock M, Goyal R. Comparison of glove donning techniques for the likelihood of gown contamination. An infection control study. Acta Orthopaedica Belgica. 2007;73(6):765.
17. Newsom S, Rowland C, Wells F. What is in the surgeon's glove? Journal of Hospital Infection. 1988;11:244-50.

How to cite this article:
Hosseini M, Ghadami A, Hashemi SM. A study of the effects of three gloves donning techniques on the contamination. J Clin Anal Med 2017;8(suppl 4): 458-63.