ORIGINAL ARTICLE

Correlation between a Compliance of Using Double-Gloving Bundle during Endotracheal Intubation and the Surgical Site Infection

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Background: Surgical site infections (SSI) represent severe postoperative adverse events. Contamination of operating room (OR) environment with oral bacteria and bloodborne pathogens poses an additional risk of infection. Studies have demonstrated that anesthesia providers' use of double-gloving care bundle reduce operating room contamination as intubator wears two sets of gloves, sheaths the laryngoscope blade after use with endotracheal tube packaging and removes the outer glove after intubation.

Materials and Methods: The authors conducted a prospective, single-center quality improvement project to increase anesthesia provider compliance with a double-gloving care bundle between January and December 2019. The primary measure was the percentage of anesthesia providers' compliance with the double-gloving care bundle as compared to baseline. The secondary measure was the correlation between compliance with the use of the double-gloving bundle and SSIs.

Results: The authors assessed 307 surgeries with 280 that had adequate data for analyses. The initial compliance rate was 38% before the quality improvement initiative. There was no change in the median compliance rate following the initiative. There was no difference in demographic data between the compliance and the non-compliance providers. Three patients (1.07%) developed SSIs, one patient in compliance group and two patients in the non-compliance group. There was no correlation between double-glove care bundle compliance and SSIs.

Conclusion: The present study quality improvement initiative study did not increase anesthesia providers' compliance with the double-gloving care bundle. There was no correlation between compliance and SSIs due to small sample size. However, double-gloving and laryngoscope sheathing by anesthesia providers do improve the standard of care and reduce contamination in the operating room setting. We will continue efforts to increase compliance.

Keywords: Double-gloving; Laryngoscope sheathing; Surgical site infection; Anesthesia provider; Operating room contamination

Received 13 June 2022 | Revised 23 January 2023 | Accepted 1 February 2023

J Med Assoc Thai 2023;106(3):258-64

Website: http://www.jmatonline.com

Surgical site infections (SSI) are the most common and costly type of hospital-acquired infection[1]. In fact, 20% of hospital-acquired infections can be attributed to SSIs. This severe postoperative adverse event leads to increased morbidity and mortality and prolong hospital length of stay. SSI has been associated with a 3% to 5% mortality rate and 75% of these deaths were directly attributed to infection[2,3]. SSIs have also been shown to increase the average hospital length of stay by 7 to 10 days[2,4]. It has been estimated that in the U.S., SSIs have an annual cost of 3.3 billion USD and are responsible for 1 million additional inpatient days.

The American College of Surgeons Guidelines for the Prevention, Detection, and Management of SSI reported that contamination of oral bacteria and bloodborne pathogens within the operating room (OR) environment increase the risk of SSI[5]. Soiled hands carry pathogenic bacteria and viruses that can be transmitted from provider to patient, increasing the risk for SSI[6]. Inadequate hand hygiene and contaminated anesthesia workstations have also been shown to increase the risk of nosocomial infection[7]. Inadequate OR decontamination causing spreading of bacterial contamination in surgical patient accounted for 30-day postoperative infections[5,8].

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How to cite this article:

Kanavitoon S, Mcsoley J, Ngamprasertwong P. Correlation between a Compliance of Using Double-Gloving Bundle during Endotracheal Intubation and the Surgical Site Infection. J Med Assoc Thai 2023;106:258-64.

DOI: 10.35755/jmedassocthai.2023.03.13804

The reported risk was 4% of health care-associated infections (HCAI) after exposure to intraoperative gram-negative bacteria, which cause surgical site infection, central line associated infection, and primary blood stream infections[5,8-12].

In an effort to reduce these risks and improve patient safety, recent clinical practice guidelines have highlighted the importance of hand hygiene and gloving techniques[13,14]. The American Society of Anesthesiologists (ASA) recently published guidance regarding double-gloving during airway management[15]. Simulated OR studies have demonstrated a significant reduction in contamination of the OR environment if anesthesia providers wore two sets of disposable gloves and remove the outer glove after intubation[16]. This technique decreased contamination of the OR environment from the anesthesia set-up, which included the circuit/face mask, breathing bag, anesthesia machine, medication cards, intravenous (IV) stopcock, and IV fluid bag[17]. A used, unsheathed laryngoscope blade and handle could also contaminate the OR environment. The harbored bacteria and viruses that existed on these instruments could lead to cross-contamination between patients[16,18]. Therefore, sheathing the laryngoscope blade after use can reduce OR contamination[16].

Between January 2019 and December 2019, a quality improvement (QI) project for the anesthesia care team at Cincinnati Children's Hospital Medical Center (CCHMC) was conducted to increase adherence to a double-gloving care bundle during the intubation period in an effort to decrease postoperative SSIs. The authors observed the compliance rate and studied the correlation between the use of the double-glove care bundle and decreased SSIs.

Materials and Methods

The present study was a prospective, single-center QI project, approved by the Cincinnati Children's Hospital by Institutional Review Board (192/2020). This QI project had no direct contact with patients or families and was considered non-human subjects research, therefore informed consent was waived Institutional Review Board classified. The study adhered to the Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0) Guideline[19-25]. The Data were collected from electronic medical records (©EPIC Systems Corporation, Verona, WI), de-identified and treated as confidential.

Setting

CCHMC is a 692-bed acute care pediatric center.

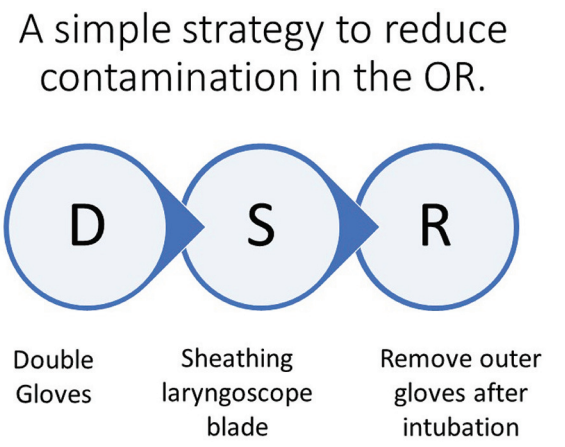

Figure 1. CCHMC double-glove care bundle.

QI intervention

The present project used the Model for Improvement methodology developed by the Associates in Process Improvement[26]. The present project was conducted between January 2019 and December 2019. Multiple Plan-Do-Study-Act (PDSA) cycles were implemented, including education, visual reminders, mini-workshops, and workflow improvement studies. Reminders of these techniques via presentations were done by the QI team describing, emphasizing, and advocating the double-glove care bundle during the department's monthly quality improvement conferences, which occurred every four to eight weeks (Figure 1).

Measures

Primary measure: Percent adherence to the double-gloving care bundle during the intubation period compared to baseline. Compliance of anesthesia providers, including anesthesiologists and Certified Registered Nurse Anesthetists (CRNA) at intubation, were randomly collected every week by two anesthesia technicians. There was a target of ten observations per week, randomly chosen from different operating rooms involving different surgical case types. The double-gloving care bundle included wearing two pairs of disposable gloves, sheathing the laryngoscope blade after use, and removing the outer gloves after intubation. All three criteria were required to be categorized as compliance. The goal of the weekly compliance was set at 90% according to the key performance indicator (KPI) of the quality improvement project.

Secondary measure: Correlation between double-gloving care bundle compliance and SSIs. The electronic medical records (©EPIC, Verona,

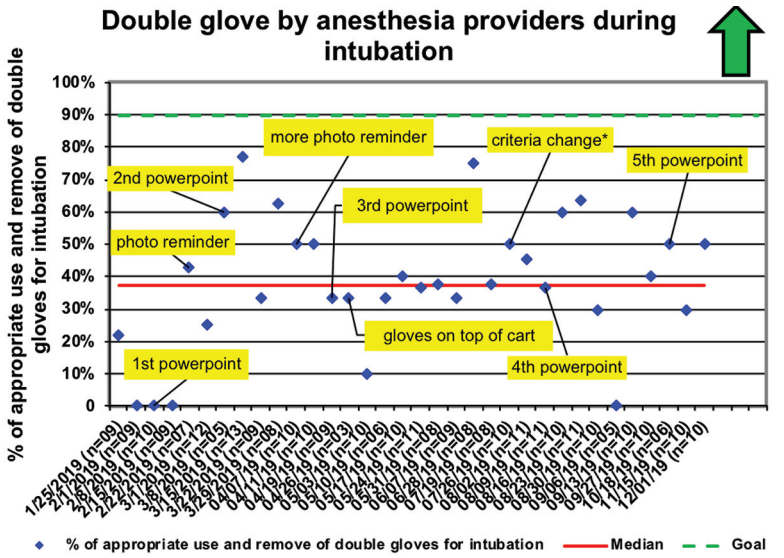

Figure 2. Weekly compliance of double-glove care bundle.

WI) were reviewed for all cases included in the analyses of double-glove care bundle compliance. SSIs were identified during chart review based on the Centers for Disease Control and Prevention (CDC)'s National Healthcare Safety Network (NHSN) definition[27]. The authors used the NHSN surveillance periods for SSIs (30-days and 90-days after surgery)[27]. Demographic data, type of surgery, and surgical site infection after the procedure were collected. Intraoperative protective measures against SSI, defined as SSI bundle, were considered and recorded. Institutions' SSI bundle included ensuring a FiO_2 greater than 0.6, body temperature higher than 35.5°C, antibiotic administered within 30 minutes before surgical incision along with adherence to all other appropriated anti-septic techniques. All anesthetic records were then reviewed for compliance. To be considered compliance, all SSI bundle criteria needed to meet.

Statistical analysis

Descriptive statistics were summarized with frequencies and percentages for categorical data with a median for continuous data. The weekly compliance rate was reported as a percentage correlated with the intervention from the PDSA cycle. Outliers were identified and checked for accuracy. Chi-square test of association was used to compare compliance of the double-glove care bundle and the incidence of SSI after the implementation of the bundle. Results were considered significant with p-value less than 0.05. All statistical analyses were conducted with PASW Statistics, version 18.0 (SPSS Inc., Chicago, IL, USA).

Results

There were 307 observations during the double-glove care bundle QI project between January and December 2019. SSIs could not be identified in three cases due to lost follow-up. Twenty-four did not have enough data for analyses and were excluded. Two hundred eighty observations were analyzed. A baseline compliance rate of 38% was determined before the start of the QI initiative in January of 2019. After implementation of the present study QI initiative, anesthesia providers in 117 cases (41.8%) complied with the double-glove care bundle, while anesthesia providers in 163 cases (58.2%) had an incomplete double-glove care bundle compliance. There was no change in median compliance rate of 38% after different educational initiatives, which included visual reminders, mini-workshops, and changes in the workflow (Figure 2). Weekly compliance observations failed to reach the present study goal of 90% adherence.

Patient demographics included in the second measurement analysis are shown in Table 1. There was no difference between groups in demographic data including age, gender, body mass index, ASA classification, choice of anesthesia, type of operation, and compliance to SSI bundle for FiO_2 greater than 0.6, body temperature greater than 35.5°C, and antibiotic administered within 30 minutes of surgical incision[4,28], or compliance with the double-glove care

Table 1. Demographic data

Patient characteristics	Provider compliance with double-glove care bundle		p-value
	Compliant (n=117)	Non-compliant (n=163)	
Age (years); median (IQR)	6.1 (3.1, 14.3)	6.4 (1.7, 13.7)	0.759
Sex; n (%)			0.332
Male	58 (38.9)	91 (61.1)	
Female	59 (45.0)	72 (55.0)	
Weight (kg); median (IQR)	23.0 (14.0, 52.9)	20.4 (10.7, 54.1)	0.426
ASA classification; n (%)			0.112
1	19 (59.4)	13 (40.6)	
2	35 (44.9)	43 (55.1)	
3	2 (1.5)	134 (98.5)	
4	12 (35.3)	22 (64.7)	
Choice of anesthesia; n (%)			0.838
GA	105 (41.5)	148 (58.5)	
GA combine RA	12 (44.4)	15 (55.6)	
Operative region; n (%)			0.151
Head and neck	49 (44.5)	61 (55.5)	
Chest	19 (28.8)	47 (71.2)	
Abdomen	23 (46.9)	26 (53.1)	
Extremity	8 (50.0)	8 (50.0)	
Spine	3 (21.4)	11 (78.6)	
Groin	4 (80.0)	1 (20.0)	
Bronchus	4 (66.7)	2 (33.3)	
Genitourinary	3 (100.0)	0 (0.0)	
More than one region	4 (36.4)	7 (63.6)	
Compliance with SSI bundle*; n (%)	82 (56.6)	63 (43.4)	0.628

IQR=interquartile range; ASA=American Society of Anesthesiologists; GA=general anesthetic; RA=regional anesthesia; SSI=surgical site infection

* SSI bundle, FiO_2 >0.6, body temperature >35.5°C, antibiotic administered within 30 minutes at incision

bundle (Table 1).

SSI incidence results are shown in Table 2. SSI was identified in three patients (1.07%). Of these three patients, one patient (33.3%) was in the double-glove care bundle compliance group and two (66.7%) were in the non-compliance group. However, no correlation existed between the double-glove care bundle compliance group and SSI (p=1) (Table 2).

Table 2. Relationship between double-glove care bundle adherence and SSI

Patient characteristic	Provider compliance with double-glove care bundle; n (%)		p-value
	Compliant (n=117)	Non-compliant (n=163)	
SSI			1.00
Yes	1 (33.3)	2 (66.7)	
No	116 (41.9)	161 (58.1)	

SSI=surgical site infection

Discussion

Anesthesia providers perform tasks that have the potential for contamination of the OR environment. Intubation is one of the procedures that can contribute to contamination. Clinical guidelines from the ASA and the American Association of Nurse Anesthetists recommend the double-gloving method when managing a patient's airway to decrease the risk of contamination of the anesthesia workstation and hence, SSIs may be reduced[15,29]. Sheathing the laryngoscope blade after use during intubation can also reduce OR contamination[16]. Therefore, the authors' institution implemented a double-glove care bundle that required anesthesia providers to wear two pairs of disposable gloves during intubation, remove the outer gloves after intubation and sheathing of the laryngoscope blade after intubation. However, adherence to this protocol was lower than the authors would like. The baseline compliance with the double-glove care bundle was 38%. Therefore, the authors conducted a QI project for the CCHMC anesthesia care team to increase adherence to the double-gloving

care bundle during the intubation period to decrease postoperative SSIs.

During the present project, multiple interventions were implemented to try and increase compliance. Movement of the anesthesia gloves to a more visual location on top of the anesthesia cart was implemented to create a visual reminder, with hopes of increasing compliance. The authors also adjusted the workflow surrounding the act of intubation by moving the tray for the contaminated laryngoscope to the side of the staff performing the intubation, while also having an additional provider assist with intubation to allow time for the intubator to remove their contaminated gloves. The compliance rates transiently improved immediately following education sessions and reminders, but this improvement was not sustained. Unfortunately, after the authors' initiative, compliance was 41.8% and the median compliance was unchanged, with a weekly compliance rate of 0% to 75%. The present study target compliance rate of 90% was not reached at any time during the project.

The preset study QI project and the analyses had significant limitations. These included the small number of SSIs seen during the project period and the Hawthorne effect. The incidence of SSI in the present study was very low (1.07%) as compared to the previous research, which demonstrated an SSI rate of 5% following an inpatient surgical procedure[3]. Due to the small sample size, the authors could not demonstrate a correlation between compliance of the double-gloving bundle at intubation and an increase in SSI. Many patient care factors can affect the outcome of SSI as a controlled SSI bundle in the present study. Considering that an SSI is a rare complication with late-onset and no immediate result to the provider, perception of change might not produce the visible outcome.

Increasing awareness of the use of the double-glove care bundle for SSI prevention is complex. While the authors' institution has a history of sustained metrics after successful improvement projects, the authors' transient improvements could be partially attributed to the Hawthorne effect whereby practitioners modify their behavior because they are aware they are being studied. Increasing awareness of the use of the double-glove care bundle for SSI prevention is complex. The complete double-glove care bundle requires multiple steps such as wearing two sets of gloves, removing outer gloves after intubation, and sheathing the laryngoscope blade immediately after use.

Resistance to change is common among anesthesia providers. Educational sessions, workshops, and visual reminders did not induce lasting change, especially in light of a high degree of disbelief due to lack of immediate results. SSIs are rare and requires a significant amount of time to develop. Therefore, there is no direct visual perception associated with those who adhere to the double-glove care bundle and those who do not. Some anesthesia providers were unfamiliar with those steps. More experienced providers may have developed other practices to prevent contamination and may be resistant to changing their practice to include the double-glove care bundle. OR workflow organization, checklists, resources, and team-based training perhaps could further engage operating personnel in the efficacy and sustainability of the double-glove care bundle[30-32]. Larger-scale QI projects with more strategies to increase compliance, extended observation, and larger populations should be conducted in the future in efforts to continue to increase compliance.

Conclusion

The present QI initiative study did not increase anesthesia provider compliance with the double-glove care bundle. There was no correlation between compliance and SSIs. Even though no direct benefit was demonstrated with the present study, the benefit of the implementation of the procedures outlined on the double-glove care bundle remains important and is supported by multiple clinical practice guidelines.

What is already known on this topic?

The double glove wearing and the sheathing laryngoscope blade after intubation is recommended for prevention of the operating room contamination. The compliance to these suggestions is astonishing low. Even in the tertiary care hospital, the baseline compliance is low. It should improve after the implementation of a well-developed quality improvement project. The attempts to increase the compliance to the double glove and sheathing the laryngoscope blade after use will decrease the operating room contamination, consequently, reduce the incidence of the surgical site infection. Finally, this quality improvement project aims to improve the standard of care.

What this study adds?

Implementation a new technique or practice bundle to improve the standard of care is hard.

Resistance to change is common among health care personnel including anesthesiologist or anesthetists. Changing of practice need both system, checklist, and protocol to support to achieve the goal of the quality improvement and sustainability.

Acknowledgment

- The authors would like to acknowledge Maria Karalis and Maria Kremer, Anesthesia technicians, CCHMC, for assisting with data collection.
- The authors thank Maria Ashton MS, RPH, MBA for providing writing assistance, editing, and proofreading.
- The authors gratefully acknowledge the CCHMC anesthesia providers participating in this study.

Authors' contributions

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analyses, writing, or revision of the manuscript.

Funding disclosure

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest

All authors declare no personal or professional conflicts of interest and no financial support from the companies that produce or distribute the drugs, devices, or materials described in this report.

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