American Journal of Infection Control 42 (2014) 1093-6

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major article

Evaluation of surgical glove integrity during surgery in a Brazilian teaching hospital

Adriana Cristina de Oliveira PhD [a,*], Camila Sarmento Gama MSc [b]

[a] School of Nursing, Universidade Federal de Minas Gerais, Center for Studies and Research in Infection-Related Health Care/CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico - "National Counsel of Technological and Scientific Development"), Belo Horizonte, Minas Gerais, Brazil
[b] Universidade Federal de Minas Gerais, Center for Studies and Research in Infection-Related Health Care/CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico - "National Counsel of Technological and Scientific Development"), Belo Horizonte, Minas Gerais, Brazil

Key Words:
Surgical wound infection
Gloves, protective
Patient safety

Background: A cross-sectional study was conducted in a large university hospital in Belo Horizonte, Minas Gerais, Brazil to evaluate surgical glove integrity after use during surgery.
Methods: This 6-month study was conducted by a gastroenterological, cardiovascular, and pediatric surgical team consisting of surgeons (main surgeon and first and second assistants), medical students, and scrub nurses. The gloves used during surgery were examined postsurgery for microperforations using the watertight test as described in European Norm EN 455-1.
Results: A total of 116 medical professionals conducted the 100 surgeries monitored. Of the 1090 gloves analyzed, 131 (12%) had a perforation detected postsurgery, 39 of which (37.5%) were recognized by users at the time of occurrence. The highest incidence of perforations occurred among surgeons ($P = .033$) in the index finger, followed by the thumb of the nondominant hand; in outer gloves (76.9%) when double-gloving was used ($P = .014$); in open surgery ($P = .019$); and in surgeries lasting $\geq$150 minutes ($P < .05$).
Conclusion: These findings reaffirm the importance of double-gloving, using a perforation indicator system, and changing gloves in surgeries of $\geq$150 minutes duration, especially in procedures involving open incisions.

Surgical site infections (SSI) is the most frequent complication among surgical patients, accounting for 38% of infections in this population.[1] The risk of SSI depends on factors related to the patient, surgical team, and surgical intervention, but ultimately related to the possibility of surgical wound contamination during surgery. In transoperatory procedures, a patient's risk of developing an SSI is elevated by the earlier introduction of microorganisms into the open and manipulated cavity, and further increased by a higher volume of microorganisms, especially if the patient's immune system is already weakened.[1]

Although SSIs are often considered to have a multifactorial etiology, the surgical team has a critical role in reducing surgery-related risks during the preoperative and intraoperative phases. Factors of which surgical teams must be aware include, but are not limited to, proper preparation and donning of attire, proper preparation of the operative area of the patient's skin, proper preparation of the surgical team's hands (ie, surgical hand antisepsis), number of persons in the operating room, and transit and excessive talk of professionals during surgery.[2]

The importance of proper washing and preparation of the surgeon's hands has been previously highlighted in studies showing colonization of hands by potentially pathogenic microorganisms associated with infectious outbreaks in surgical patients.[3] This demonstrates the need for effective surgical hand antisepsis and the use of sterile gloves to prevent direct contact with the manipulated cavity.

The use of surgical gloves is an essential measure to prevent SSIs, providing a physical barrier to microorganisms present on the hands of health care workers (HCWs), in the environment, and on patients.[4] Surgical gloves are complementary to and of equal importance as surgical hand antisepsis; however, their use does not guarantee total security for the patient or the surgical team, owing to the common occurrence of microperforations or tears. Users

* Address correspondence to Adriana Cristina de Oliveira, PhD, Universidade Federal de Minas Gerais, Departamento de Enfermagem Básica, Av. Professor Alfredo Balena, 190 Santa Efigênia, 30.130-100 Belo Horizonte, Minas Gerais, Brazil.
E-mail addresses: adrianacoliveira@gmail.com, acoliveira@ufmg.br (A.C. de Oliveira).
This research was supported by the Pró-Reitoria de Pesquisa of Universidade Federal de Minas Gerais.
Conflict of interest: None to report.

http://dx.doi.org/10.1016/j.ajic.2014.06.021

often fail to perceive these microperforations or tears, and procedures continue uninterrupted, exposing both the patient and HCW to infection-causing microorganisms.[5] Consequently, the present study was conducted to evaluate postsurgery sterile glove integrity in gastroenterological, cardiovascular, and pediatric surgical teams at a university hospital in Belo Horizonte, Brazil.

METHODS

This was a cross-sectional study conducted in a large university hospital of Belo Horizonte between April and September 2013, with participation by gastroenterological, cardiovascular, and pediatric surgical team members. This study was approved by the Federal University of Minas Gerais Research Ethics Committee (ETIC 11416512.1.0000.5149).

All members of the team, including surgeons, assistants, medical students, and scrub nurses (when present), were eligible for the study, regardless of sex or age. Data collection was performed in the morning and afternoon in accordance with routine surgical scheduling.

Before surgery, a researcher requested the consent of each surgical team member to examine glove integrity, to record whether gloves were exchanged for new gloves owing to perceived perforations, and to evaluate these data in relation to the duration of surgical procedure. After obtaining signed informed consent, each surgical team member provided the following information: occupation, role, level as a medical resident, dominant hand for activity, and whether single- or double-gloving was used.

Perforation of used surgical gloves was evaluated postsurgery using the watertight test described in European Norm EN 455-1 by the Comité Européen de Normalisation.[6] This test involved filling each glove with 1 L of water and observing for leaks while manually compressing each glove finger and the spaces between. Each glove was evaluated separately, not as part of a pair. A 50-mm-diameter PVC pipe in the vertical position supported the glove after expansion caused by the water. The glove was attached to the pipe using a ring adjusted to its circumference and positioned at a maximum of 40 mm from the end; this allowed an effective seal without damaging the glove. Once the glove was attached to the pipe, 1 L ± 50 mL of water was added at the opposite (open) end of the pipe, and the glove was visually inspected to detect leakage or dripping, whether as a jet or droplets.

To confirm the integrity or perforation after the first examination, the glove was left hanging, and each finger and the palm were manually compressed, with observation continuing for 2-3 minutes. Leaks within 40 mm around the ring were not considered.

Data were analyzed using the χ^2 test or Fisher's exact test, with the significance level set at $\alpha = 0.05$. SPSS 20.0 (IBM, Armonk, NY) was used for all analyses.

RESULTS

Demographic data and characterization of surgeries

A total of 117 surgical team members were invited to participate in the study; 1 individual declined the invitation, resulting in a total of 116 participants. Of these, 80 (69%) were members of the gastroenterological surgical team, 18 (15.5%) were members of the cardiovascular surgical team, and 18 (15.5%) were members of the pediatric team. The participants were predominately men (n = 71; 61.5%), and had a mean age of 33.9 years (range, 23-77 years).

Participants included 36 (31%) main surgeons, 41 (35.3%) first and second assistants, 27 (23.3%) medical students, 11 (9.5%) scrub nurses, and 1 (0.9%) researcher. Most of the first and second assistants were medical residents. The 41 medical residents included 10 (24.4%) in their first year of residency, 10 (24.4%) in their second year, 8 (19.5%) in their third year, 10 (24.4%) in their fourth year, and 3 (7.3%) in their fifth year.

Table 1
Surgical glove perforation according to time worn, hand, and quantity (n = 131)

Variable	Number	%
Time worn, min		
≤29	13	9.9
30-119	55	42
≥120	63	48.1
Site of perforation		
Single glove of the right hand	41	29.8
Single glove of the left hand	47	35.9
Outer glove of the left hand	19	14.5
Outer glove of the right hand	17	13
Inner glove of the right hand	6*	6
Inner glove of the left hand	1	0.8
Number of perforations per glove		
One	103	78.6
Two	20	15.3
Three	5	3.8
Four	3	2.3

*Only 2 of 6 inner gloves were perforated separately; the others included in this table were perforated simultaneously with outer gloves.

Of the 100 surgeries conducted during the study period, 65 (65%) had a duration of ≤149 minutes and 35 (35%) had a duration of ≥150 minutes, with a minimum duration of 30 minutes and a maximum duration of 419 minutes.

All data were evaluated independent of specialty. Of note, to expand the possibilities for data collection, the specialties were used to define institutional surgical volume.

Glove perforation

Three brands of natural rubber latex (100% cis-polyisoprene) gloves, with no polymeric variability among them, were used. These are classified herein as brand A (966 gloves), with a mean thickness of 0.21 mm; brand B (68 gloves), with a thickness of ≥0.13 mm; and brand C (56 gloves), with a thickness of ≥0.17 mm, for a total of 1090 gloves. None of the tested products was latex-free. Of note, 3 different glove brands were used because of a shortage in brand A, which was temporarily replaced by brands B and C.

As a quality control measure, an a priori evaluation was performed on 20 random pairs (one pair for every 5 surgeries) for each lot and size of the 3 brands to identify potential manufacturing failures. None were noted in any of the brands. Postsurgical analysis of the gloves identified perforations in 131 of 1090 gloves (12%), including 83 perforations (63.4%) by the gastroenterological team, 29 (22.1%) by the cardiovascular team, and 19 (14.5%) by the pediatric team.

Surgical glove perforations occurred in 65 (65%) of the surgeries; of these, 54 (83.1%) occurred during open procedures ($P = .019$), 9 (13.8%) occurred during video laparoscopy, and 2 (3.1%) occurred during mixed open and video laparoscopy.

The duration of surgical glove wear was categorized in 30-minute increments (0-29 minutes, 30-59 minutes, 60-89 minutes, 90-119 minutes, and so on), and the mean duration of surgical procedures monitored was 150 minutes. In this sense, the mean duration of surgery was used as the cutoff point to make the χ^2 test with a significance level of $\alpha = 0.05$, and check the association between quantitative perforation and surgical time. Surgeries lasting ≥150 minutes were significantly associated with glove perforation ($P < .05$).

Of the 131 total perforations detected, 39 (37.5%) were perceived by the user. The perforated gloves were used by 60 participants (51.7%), including 26 first and second assistants (43.3%), 20