

# UNDETECTED PERFORATIONS OF SURGICAL GLOVES DURING EMERGENCY PROCEDURES

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Study conducted at Irmandade da Santa Casa de Misericórdia de São Paulo

## ABSTRACT

**OBJECTIVES.** To evaluate the incidence of glove perforation during emergency surgical procedures and care at the Emergency Service of the Department of Surgery in the School of Medical Sciences of Santa Casa de São Paulo, for a period of two months.

**METHODS.** A total of 2613 gloves were analyzed, of which 252 gloves were used in 42 surgical procedures and 2361 were used during emergency care at the emergency room. Gloves were tested by the water leak method.

**RESULTS.** Punctures were detected in 41 gloves (16.3%) used in surgical procedures, and the largest percentage occurred in traumatic emergencies (33%). The perforation rate in gloves used during emergency care in the emergency room was 7.3%.

**CONCLUSION.** We concluded that the glove perforation rate was high, more frequent in traumatic emergencies, and that the surgeon is the most vulnerable member of the surgical team in the operative field.

**KEYWORDS:** Surgical gloves. Accident proneness. Accident prevention.

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## Introduction

The risk of contamination caused by occupational accidents among health care workers is a topic of great interest, particularly among emergency service personnel, who are constantly exposed to blood, body fluids, cutting and perforating materials.<sup>1,2,3,4</sup>

Infections by hepatitis B and C viruses and human immunodeficiency virus transmitted through contaminated blood have been observed among health care workers after accidental exposure to the biological material, by means of percutaneous injuries and/or contact between mucous membrane or nonintact skin with infected blood.

As of the 1980s, with the appearance of the AIDS epidemics, the Centers for Disease Control and Prevention (CDC) created the Universal/Standard Precautions, defined in 1987 as a set of rules to prevent the exposure of health care workers to pathogens transmitted by blood, given that it is not always possible to identify which patients represent risk, especially during emergency care.<sup>5,6</sup>

In Brazil, the National Health Surveillance Agency (Agência Nacional de Vigilância Sanitária, ANVISA), through RDC Resolution 5, of February 18, 2008, established minimum identity and quality criteria for national and imported gloves available in the national market.<sup>7</sup>

Among precaution measures, the use of mask, eye shield, apron, impermeable boots, and two pairs of gloves (double gloving) seems to contribute significantly to reduce the contamination rate, particularly by hepatitis B.

Although gloves represent the main barrier between the surgeon and the patient, glove perforation is a common event and can reach the rate of 78%, especially during emergency, plastic, gynecologic, and orthopedic surgeries, which implies an increase in the risk of exposure.<sup>8-10</sup>

The systematic use of two gloves significantly reduces the risk of blood exposure. However, in emergency settings, particularly in our field, a certain negligence is observed in relation to these principles, justified by the tumultuous environment and especially by the lack of appropriate normatization.

Therefore, the objective of this study was to evaluate the incidence of glove perforation during emergency surgical procedures and care in our Service.

## Methods

This study was approved by the Research Ethics Committee of Irmandade de Santa Casa de Misericórdia de São Paulo (ISCMSP), under protocol no. 378/06.

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From May to July 2007, surgical gloves used by the medical team during emergency surgical procedures and care at the Emergency Service of the School of Medical Sciences of Santa Casa de São Paulo were assessed prospectively.

Two types of gloves were analyzed, separated in two groups:

Group I: Sterile latex gloves used in traumatic and nontraumatic emergency surgical procedures.

Group II: Nonsterile latex ambidextrous gloves used during initial care of trauma patients in the emergency room.

Samples were obtained from sequential procedures at the end of the surgery or emergency care. Gloves whose perforations were detected intraoperatively were excluded from the study.

The gloves in group I, obtained after each surgical procedure, were placed in labeled and numbered plastic bags, in which the type of procedure performed and the wearer's position (surgeon, first assistant, second assistant) were recorded.

In order to detect the presence of perforations, the method of insufflation with water was used (water leak test), followed by manual compression on the wrist of the glove for two minutes, as recommended by Pieper et al.<sup>11</sup>

When perforations were identified, their location in the gloves, as well as the type of procedure and the position of the surgeon in the operative field were recorded.

For gloves in Group II, which were tested using the same method, only the perforation location (which finger) was recorded.

Statistical analysis was performed using the chi-square method, and the significance level was set at  $p < 0.05$ .

## RESULTS

Group I: A total of 252 gloves were tested, used in 42 surgical procedures, as follows: 9 cases of traumatic emergencies, and 33 of nontraumatic emergencies. Fifty four gloves were used in traumatic emergencies and 198 gloves in the surgical treatment of non-traumatic conditions.

Perforations were observed in 41 gloves (16.3%). Of these, 18 gloves (33%) were being used in traumatic emergencies, and 23 (12%) in nontraumatic emergencies, with a statistically significant difference ( $p < 0.001$ ).

Out of the total of 41 perforated gloves, 26 were used by surgeons (31%), 10 by first assistants (12%), and 5 (6%) by second assistants, with statistically significant differences (Table 1).

In traumatic emergencies, perforation was detected in 11 gloves used by surgeons (61%), in 5 used by first assistants (27.7%), and in 2 used by second assistants (11%) (Table 2).

**Table 1. Distribution of perforated gloves according to wearer's position during the surgical procedure**

	Perforated	Not perforated	Total
<b>Surgeon</b>	26 (31%)	58 (69%)	84 (100%)
<b>First assistant</b>	10 (12%)	74 (88%)	84 (100%)
<b>Second assistant</b>	5 (6%)	79 (94%)	84 (100%)

$P < 0.001$

**Table 2. Distribution of perforated gloves in traumatic emergencies according to wearer's position during the surgical procedure**

	Perforated	Not perforated	Total
<b>Surgeon</b>	11 (61%)	7 (39%)	18 (100%)
<b>First assistant</b>	5 (27.7%)	13 (72.3%)	18 (100%)
<b>Second assistant</b>	2 (11%)	16 (89%)	18 (100%)

$P = 0.005$

In nontraumatic emergencies, 15 perforations were found in the gloves used by surgeons (22.7%), 5 in the gloves used by first assistants (7.6%), and 3 in the gloves used by second assistants (4.5%) (Table 3).

**Table 3. Distribution of perforated gloves in nontraumatic emergencies, according to wearer's position**

	Perforated	Not perforated	Total
<b>Surgeon</b>	15 (22.7%)	51 (77.3%)	66 (100%)
<b>First assistant</b>	5 (7.6%)	61 (92.4%)	66 (100%)
<b>Second assistant</b>	3 (4.5%)	63 (95.5%)	66 (100%)

$P = 0.002$

Considering only gloves used by surgeons, 11 perforations were detected in association with traumatic emergencies and 15 with nontraumatic emergencies. In this case, no statistically significant difference was observed ( $p < 0.005$ ).

Group II:

A total of 2361 gloves were tested, used in 2571 emergency care services; perforation occurred in 174 gloves (7.4%).

Twenty two perforations occurred in the first finger (12.5%), 56 (32%) in the second finger, 32 (18.5%) in the third finger, 23 (13%) in the fourth finger, 19 (11%) in the fifth, and 22 (13%) on the dorsum of the hand.

## DISCUSSION

In the analysis of initial care performed in the emergency room, failures in the normalization and implementation of isolation measures with regard to the contact between blood and secretions were frequently observed.

Overall, the medical team does not make use of adequate surgical equipment, wearing only aprons and one pair of gloves.

There are several publications showing the efficacy of double gloving in lowering the risk of contact with blood and secretions: perforations have been found to occur more frequently only in the outer glove.<sup>12-15</sup>

In general, the use of gloves is a topic explored in the literature usually in relation to hand hygiene, and references to the subject

can be found in a vast and varied range of documents, such as guidelines for infection control among health care workers, guidelines for hand hygiene in health care settings, and instructions about occupational health and safety.<sup>16,17</sup>

The Brazilian norm NR 32, focused on occupational safety and health at health care institutions, points out that the use of gloves does not replace the hand washing process, which should be done before and after contact with the patient. Disposable or non-disposable personal protective equipment should be offered at work in sufficient number, guaranteeing immediate access or replacement whenever necessary.<sup>18</sup>

Synthetic gloves or gloves made of a mixture of natural and synthetic rubber should be previously assessed with regard to the safety they offer when used in contact with the human skin and should be free from contaminants.

Products made of natural latex should be submitted to processes aimed at reducing the amount of proteins, so as to avoid allergic reactions.

Products for surgical as well as nonsurgical use should contain the expression "reprocessing forbidden" in their labels.

Manufacturers and import establishments are obliged to comply with good manufacturing practices, guaranteeing compliance with the certification requirements of the Brazilian Compliance Evaluation System (Sistema Brasileiro de Avaliação da Conformidade, SBAC), coordinated by the Brazilian Institute of Metrology, Standardization and Industrial Quality (Instituto Nacional de Metrologia, Normalização e Qualidade Industrial, INMETRO), performing physical (dimensions), mechanical, and hermetic tests.<sup>19</sup>

There are several methods available to assess glove integrity, such as the use of electronic devices, pressure-air insufflation, surgeon hand examination to detect the presence of blood and the water insufflation method proposed by Pieper et al., considered as a reliable and low-cost method.<sup>11,20,21</sup>

In 2001, Hentz et al. used an electronic device to detect glove leaks in 111 procedures and obtained 278 alarms. Only 16% of these alarms were associated with glove perforations, which, in the majority of cases (89%), were not perceived by the wearer. In 28% of the cases, there was skin contact with the patient blood, and in 43% there were only porosities in the gloves, however sufficient to allow contact with skin. The authors also observed that 13% of the alarms were false positive.<sup>21</sup>

In 1989, Ottis & Cottoni studied the prevalence of perforations in disposable latex gloves during routine dental treatment and showed that, in order to maintain barrier integrity, they should be used for less than two hours.<sup>22</sup>

In a recent study, Punyatanasakchai et al. evaluated 150 sets of double gloves and 150 of single gloves for a seven-month period. The authors observed perforation rates of 4.6% and 18%, respectively, values that reached a statistical difference ( $p < 0.05$ ). There was no statistical difference, however, in the comparison of wearers' positions.<sup>23</sup>

According to the literature, the rate of glove perforation can reach 100%, depending on the procedure analyzed. General surgery, orthopedic and plastic surgery are the areas in which the incidence of perforation is usually higher.<sup>24-26</sup>

The incidence found in the present study is similar to the findings reported by Thomas et al. and reflects a high degree of

blood exposure, although in that study only one pair of gloves (single gloving) were used.<sup>27</sup>

In 2004, Laine et al. pointed out that the risk of perforation can be 13 times higher when using single gloves compared with double gloves. These authors carried out a prospective and randomized study to assess glove perforations in 885 surgical procedures. Gloves were tested immediately after the procedures using the water leak method for two minutes. A total of 2462 gloves were tested, and perforations occurred in 8% of the cases. Perforations were detected during surgery in 28 cases (37%).<sup>28</sup>

It is important to emphasize that perforations do not always occur during surgery; gloves can be punctured or torn while being used. In addition, perforations, which may occur in up to 60% of the cases, is not always detected by the surgeon during the procedure, a fact that is corroborated by Caillot et al., who have pointed out that 96% of barrier breakdowns remain undetected.<sup>20</sup>

In 2005, Florman et al. conducted a double-blind randomized study with simulated surgeries to assess the average time that a surgeon takes to identify punctures. The authors observed that perforation was detected after 42 seconds in 56% of the cases and after 67 seconds in 12%.<sup>29</sup>

Therefore, considering the high number of interventions usually performed by an emergency surgeon, it is possible to suggest that the risk of exposure is high, particularly when double gloves are not used.

The higher incidence of perforations associated with traumatic emergencies in our study is in agreement with the literature, as in this type of surgery, the fast manipulation of surgical instruments, necessary for access to the operative field, may represent an increased risk for accidents, especially for resident physicians, who still lack a high level of technical skills.<sup>30,31</sup>

In traumatic as well as in nontraumatic emergencies, the perforation rate was higher in the gloves used by surgeons, which can be explained by the fact that our study was conducted at a university hospital, where the surgeon is usually a resident physician. Although the supervision of an experienced surgeon is mandatory, he/she will usually be in a first assistant position.

Olsen et al., on the other hand, suggest that surgeon's level of experience and type of surgery should not be considered as determinant factors of accident.<sup>1</sup>

Driever et al. (2001) analyzed 953 gloves used in cardiac surgery and observed punctures in 26% of the gloves used by surgeons, in 22% of the gloves used by first assistants, and in 9% of the gloves used by second assistants. They also evaluated a control group of 50 unused gloves, in which no punctures were detected.<sup>24</sup>

Our study also analyzed perforations taking place during the initial care of trauma patients in the emergency room. In this situation, the surgeon is often still undergoing medical training, and commonly neglects precaution measures due to the eagerness to perform invasive procedures. In relation to perforation location, punctures were detected in the first finger in 27.3% of the gloves, in the index finger in 42%, in the medium finger in 10%, in other fingers in 15%, on the palm in 3.8%, and on the dorsum of the hand in 0.9% of the cases, with a total incidence of 7.4%.

Out of the total of 2571 procedures performed in the emergency room, only 2361 gloves were obtained, which is justified

by the fact that some materials used in the procedures had been disposed of prior to the glove integrity test.

## CONCLUSION

It is important to stress that, during surgical procedures or initial care in the emergency room, cutting and perforating instruments should not be passed hand to hand, but should rather be placed on a table. Also, needles should be cut off before knots are tied, and bandages should be disposed of in appropriate containers. Another important aspect is the mandatory adoption of the protection measures, which include the use of two pairs of gloves.

Undetected perforations of gloves used in emergency procedures occur frequently and expose the medical team to risks of contamination.

Patient severity, represented by the traumatic emergency procedure, implies a higher incidence of glove perforation.

Surgeons are the most vulnerable member of the surgical team in the operative field, independently of the type of procedure (traumatic or nontraumatic).

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