

Surgical antiseptic practices and use of surgical gloves as a potential risk factors to intraoperative contamination

Antissepsia cirúrgica e utilização de luvas cirúrgicas como potenciais fatores de risco para contaminação transoperatória

Antisepsia quirúrgica y el uso de guantes quirúrgicos como potenciales factores de riesgo para contaminación durante la cirugía

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ABSTRACT

Objective: This study aimed to investigate the practice of surgical hand antiseptic and integrity of sterile gloves after use by the surgical team in a teaching hospital in the city of Belo Horizonte, Southeastern Brazil. **Methods:** A cross-sectional study was conducted involving the gynecology service in April 2013. Data were collected through observation of surgical hand antiseptic and test to evaluate surgical glove perforation after use. A descriptive statistical analysis was performed. **Results:** Only 16% of surgeons accomplished the technique and time recommended for the practice of surgical hand antiseptic. Regarding gloves, there were 11.1% of perforations, 31.8% of which were noticed. **Conclusions:** The results presented reveal that failures in these procedures occur routinely, being able to interfere with patients and healthcare workers' safety, prompting reflection on the theme in different health institutions.

Keywords: Hand Disinfection; Gloves, Surgical; Surgery.

RESUMO

Objetivo: Objetivou-se investigar a prática da antissepsia cirúrgica das mãos e a integridade das luvas estéreis após seu uso pela equipe cirúrgica de um hospital universitário de Belo Horizonte. **Métodos:** Realizou-se um estudo transversal envolvendo o serviço de ginecologia, em abril de 2013. Os dados foram coletados por meio da observação da prática da antissepsia cirúrgica das mãos e teste para avaliação de perfuração das luvas após seu uso. Foi realizada uma análise estatística descritiva. **Resultados:** Somente 16% dos cirurgiões cumpriram com a técnica e tempo recomendados para a prática antissepsia cirúrgica das mãos. Para as luvas registrou-se 11,1% de perfurações e 31,8% foram percebidas. **Conclusão:** Evidenciou-se no presente trabalho que falhas nesses procedimentos ocorrem rotineiramente, sendo capazes de interferir na segurança do paciente e do profissional, incitando a reflexão acerca da temática em diferentes instituições de saúde.

Palavras-chave: Desinfecção das Mãos; Luvas Cirúrgicas; Cirurgia.

RESUMEN

Objetivo: Investigar la práctica de la antisepsia quirúrgica de las manos y la integridad de los guantes estériles después de su utilización por el equipo quirúrgico de un hospital universitario de Belo Horizonte. **Métodos:** Estudio transversal realizado con el servicio de ginecología en abril de 2013. Los datos fueron recolectados mediante la observación de la práctica de la antisepsia quirúrgica de las manos y pruebas para la evaluación de perforación de los guantes después del uso. Se realizó un análisis estadístico descriptivo. **Resultados:** Sólo 16% de los cirujanos han cumplido con la técnica y el tiempo recomendados para la antisepsia quirúrgica de las manos. Para los guantes, el 11,1% tuvieron perforaciones y el 31,8% fueron percibidos. **Conclusión:** Las fallas en estos procedimientos se producen rutinariamente, pudiendo interferir en la seguridad del paciente y del profesional, culminando en la reflexión acerca del tema en diferentes instituciones de salud.

Palabras clave: Desinfección de las Manos; Guantes Quirúrgicos; Cirugía.

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INTRODUCTION

Surgical site infections (SSI) are the most frequent complications in patients undergoing surgeries, corresponding to 38% of all infections in this population¹. The occurrence of SSI depends on factors associated with patients and the team, although mainly on the possibility of surgical wound contamination during the surgical procedure. During the intraoperative period, it is essential to prevent surgical wound contamination, capable of causing SSI as microorganisms will be directly in contact with the open cavity being manipulated².

Although the SSI is multifactorial, the surgical team has a key role in the prevention of factors associated with the surgical procedure during the pre- and intraoperative periods. Surgical hand antisepsis and the use of sterile surgical gloves should be emphasized as measures capable of directly interfering with SSI pathogenesis, in the sense that they contribute to the reduction/elimination of microorganism contamination of surgical wounds, the sine qua non for the development of an infection³.

In this sense, the hands of surgical team professionals have an important role. It has been proved that they are colonized by potentially pathogenic microorganisms associated with the occurrence of infectious outbreaks in surgical patients^{4,5}. This shows the need to perform surgical hand antisepsis effectively and to use sterile gloves that prevent direct contact of hands with the manipulated cavity, thus protecting patients and professionals.

Surgical antisepsis or preoperative hand preparation aims to eliminate the transient microbiota and reduce the resident one, in addition to inhibiting the growth of microorganisms in the surgical team's gloved hands during surgery. This is performed during the preoperative period through hand hygiene with antiseptic substances that have broad and persistent antimicrobial properties. Additionally, the efficacy depends on the selection of the antiseptic agent, application method and duration of process⁶.

The practice of surgical hand antisepsis is strongly recommended by associations/societies and organizations such as the World Health Organization (WHO)⁶, Association of Perioperative Registered Nurses (AORN)⁴, Centers for Disease Control and Prevention (CDC)¹, Brazilian Ministry of Health and *Agência Nacional de Vigilância Sanitária* (ANVISA - Brazilian Health Surveillance Agency)⁷. However, despite its relevance, studies have shown insufficient adherence of surgeons whether in terms of time spent on this procedure or technique used for such⁸.

Apart from surgical hand antisepsis, the use of sterile surgical gloves is also an essential measure to prevent SSI by creating a physical barrier against microorganisms found in the hands of health care workers, in the environment and in patients^{6,8}.

Sterile gloves are used to complement surgical hand antisepsis and they are both equally indispensable. However, their use does not guarantee total safety for professionals and patients, as (micro) perforations/tears were a common occurrence, preventing them from achieving their purposes⁹. These defects often pass unnoticed by health care workers and the procedure is performed uninterrupted, exposing patients to potentially infectious microorganisms¹⁰.

In view of what has been described, the present study aimed to investigate the practice of surgical hand antisepsis and integrity of sterile gloves after their use among surgical team members of the gynecology service of a university hospital located in the city of Belo Horizonte, Southeastern Brazil.

Literature Review

Surgical hand antisepsis is usually part of a routine procedure performed by the surgical team and adherence is actually not a problem, differently from hand hygiene. Thus, the literature shows extensive publications on hand hygiene techniques and adherence, whereas there are few studies on hand antisepsis aspects⁸, none of which were Brazilian.

Hand antisepsis depends on meeting requirements such as adequate antiseptic selection, not wearing jewelry, nail care, subungual area cleaning and hand washing^{4,7,9,11}.

Preoperative preparation of the surgical team's hands must begin with timing. Although this is a recommended stage, there is little consensus on the ideal time for effectiveness of the antiseptic agent. Studies demonstrate that brushing for two minutes during surgical hand antisepsis is as effective as ten minutes in terms of reduction of bacterial count¹. Thus, the CDC instructs that this time should be at least two minutes and at most five minutes¹, the AORN recommends from three to five minutes according to the product manufacturer's instructions¹² and ANVISA recommends the first antisepsis moment of the day should be performed for three to five minutes and the subsequent ones for two to three minutes⁷.

With regard to the technique, it should include brushing all fingers, including all sides and interdigital spaces, and the palm and back of the hands for two minutes. Next, each arm should be brushed on all sides from the fist to the elbow for one minute, keeping the hand elevated, higher than the elbow and away from one's body at all times, enabling the water to flow towards the elbow and avoiding recontamination of the hands as this water can carry microorganisms^{4,6,9}. The entire process must be repeated with the opposite hand and forearm. In case a certain body part that has already been brushed touches any object, piece of equipment or structure apart from the brush/sponge impregnated with antiseptic, the contaminated area must be brushed again for one minute. After brushing both hands and arms, rinsing must be performed with reliable water, letting

this water flow in one direction exclusively, from the fingertips to the elbow, and moving one's arm forwards or backwards is not recommended at this stage^{4,6,9}.

In all movements during this process, care must be taken not to splash water on the surgical scrubs. Finally, taps must be turned off without disinfected body parts touching contaminated areas. Hands and forearms must not be shaken, instead, they must be dried using a sterile towel and aseptic technique before surgical scrubs can be worn. Drying must be performed from the fingertips to the elbow, pressing different parts of the towel against one's body, rather than rubbing it^{4,6,9}.

Aiming to complement the practice of surgical hand antisepsis, sterile surgical gloves are used as they act as barriers against microorganisms, although not being capable of eliminating them. On the contrary, they create a humid environment in the hands that promotes the proliferation of microorganisms and which is particularly higher when surgical hand antisepsis is not performed. Therefore, in case of glove perforation, transference of such pathogens through holes, however microscopic, can occur more easily, thus increasing the risk of contamination of the surgical site, which can lead to SSI.

For this reason, the use of gloves does not replace the practice of preoperative hand preparation⁶.

In this sense, surgical hand antisepsis and the use of sterile surgical gloves should be emphasized as extremely important preventive measures capable of interfering with SSI pathogenesis. Such measures must be adequately performed to guarantee their effectiveness and, consequently, patients' safety.

METHODS

A cross-sectional study with a quantitative approach was performed at a large university hospital in the city of Belo Horizonte, Southeastern Brazil, including the gynecology service team members in elective surgeries performed in April 2013.

Surgeons, preceptors, residents and surgical technologists were eligible when participating in the team, regardless of sex and age group.

Data collection was performed in the morning and afternoon, according to the routine of surgical schedule the prioritized specialty, and data collection was divided into two stages.

During stage 1, a researcher observed the practice of surgical hand antisepsis by team members, who was not introduced to the professionals under observation. Thus, these professionals were blind to it, aiming to prevent change in behavior when someone knows they are being observed, known as the Hawthorne effect.

During stage 2, in the operating room, before the beginning of the procedure, a researcher different from the one who performed in stage 1 obtained consent from the surgical team to evaluate the integrity of gloves used during the surgical procedure, the need to exchange them and perception of perforations. After the

team agreed to and signed an Informed Consent Form, they were asked to respond to an instrument that included the following information: professional category, dominant hand for surgical activity and type of glove wearing adopted: single, i.e. one glove per hand, or double, two gloves per hand. The gloves used were evaluated through the test described by the European norm EN 455-1¹³ to detect (micro)perforations, performed by filling each glove collected with 1L of water, observing it and manually pressing each glove finger and interdigital spaces to assess the presence of holes.

At the end of the collection, surgical team members were approached again, aiming to provide more details to the study in terms of the observational part and justification for it to be performed without biases. At this moment, agreement from participants observed was requested and it was clarified that, in case they did not agree with the observation made from their behavior, such analysis would be excluded from the study. Upon their agreement, another informed consent form was shown, in accordance with the ethical principles adopted for the present study from Resolution 466/12 of the Brazilian Health Council. This research project was approved by the Research Ethics Committee of the Federal University of Minas Gerais under official opinion ETIC 11416512.1.0000.5149.

After this stage, the data obtained were typed and analyzed in a descriptive way with the help of the Statistical Package for the Social Sciences (SPSS[®]) software, version 20.0.

RESULTS

A total of 30 individuals from surgical teams of the gynecology service of a university hospital in the city of Belo Horizonte, Southeastern Brazil, were approached in April 2013. Of these, 19 (63.3%) were females, 27 (90.0%) had graduated in medicine, one (3.3%) was a medical student and two (6.7%) were nursing technicians. Mean age was 33.1 years, ranging from 24 to 58 years.

Of all participants, eight (26.7%) were gynecology preceptors and 19 (63.3%) were residents. Of all 19 residents, six (31.6%) were in the 1st year of residency, six (31.6%) in the 2nd year, three (15.8%) in the 3rd year, three (15.8%) in the 4th year and one (5.2%) in the 5th year.

A total of 20 elective gynecological surgeries were observed, of which 14 (70.0%) were performed in the afternoon and six (30.0%) in the morning.

A total 50 observations of surgical hand antisepsis performed by the surgical team were made during the period of study. The following aspects were approached: wearing jewelry, using a brush impregnated with antiseptic, rubbing an antiseptic agent on skin (hands, fists, forearms and elbows), keeping hands above elbow level during the entire procedure, repeating the technique on the opposite arm, fully rinsing in running water and in a single direction from the hands to the elbows, turning off the tap without contamination, shaking arms vigorously to eliminate excess water, and adequate time.

Table 1. Characteristics of the practice of surgical hand antisepsis in terms of time and technique. City of Belo Horizonte, Southeastern Brazil, 2013

Variable	N (50)	(%)
Wearing jewelry		
Yes	0	0
No	50	100
Using a brush impregnated with antiseptic		
Yes	49	98
No	1	2
Rubbing an antiseptic agent on skin from the hands to the elbows		
Yes	48	96
No	2	2
Keeping hands above elbow level		
Yes	27	54
No	23	46
Repeating the technique on the opposite arm		
Yes	50	100
No	0	0
Fully rinsing in running water		
Yes	37	74
No	0	0
Partially (an amount of soap remained)	13	26
Rinsing in a single direction from the hands to the elbows		
Yes	25	50
No	25	50
Turning off the tap without contamination		
Yes	50	100
No	0	0
Shaking arms vigorously to eliminate excess water		
Yes	1	2
No	49	98

Of all 50 observations, only eight (16%) met the time and technique requirements (Table 1).

Antisepsis time was calculated and considered as adequate in 20 (40%) out of the 50 observations made. Additionally, 18 (36%) of them showed an adequate time of three minutes or more, in accordance with the recommendation for those performing this procedure for the first surgery of the day (Table 2).

Hand drying after surgical hand antisepsis was performed with a sterile compress in 48 (96%) observations. However, only 12 (24%) moved it from the fingertips to the elbows and 31 (62%) did not use different sides of the compress on distinct disinfected areas.

Glove perforation occurred in 13 surgeries (65.0%) observed. The gloves used were made of natural latex from the same registered trademark. A total of 198 gloves were analyzed, of which 22 (11.1%) had perforations detected by tests after the end of surgery. Perforated gloves were used by 12 (40.0%) participants and five of them had gloves perforated more than once in different surgeries. Of all perforations detected, seven (31.8%) were identified by users.

Regarding users of perforated gloves, 17 (77.3%) were residents, five (22.7%) were preceptors, 16 (72.7%) were surgeons and six (27.3%) were assistant physicians. In terms of the dominant hand, 26 (86.7%) were right-handed, three (10.0%) were left-handed and one (3.3%) ambidextrous.

Table 2. Time spent on surgical hand antisepsis for the first surgery of the day. City of Belo Horizonte, Southeastern Brazil, 2013

Antisepsis time*	First surgery		Total
	Yes	No	
0 to 59 seconds	2	1	3
60 to 119 seconds	12	1	13
120 to 179 seconds	14	2	16
180 to 239 seconds	13	0	13
240 to 299 seconds	5	0	5
Total	46	4	50

* In accordance with ANVISA's recommendations, from three to five minutes was considered to be adequate for the first surgery, and from two to three minutes for the subsequent ones.

The length of time of surgery when the highest number of glove perforations occurred was from 90 to 119 minutes (40.9%). Gloves worn on the left hand were the ones most frequently perforated, as shown on Table 3.

With regard to anatomical location, thumbs were most frequently affected by perforations (25%), followed by the index finger and dorsal aspect of hand (20.8% each) (Figure 1).

Of all perforations detected, 15 (68.2%) were female users, nine (41.0%) occurred in the dominant hand, 12 (54.5%) in the non-dominant hand and one (4.5%) in an ambidextrous user. It should be emphasized that three (13.6%) gloves were perforated when they were put on, but they were not replaced when this happened; instead, another glove was worn over it, resulting in double glove wearing.

The type of glove wearing used at the moment the glove was perforated was single in 68.4% and double in 31.6% of occurrences. Among those who used double glove wearing, 66.7% had only the outer glove perforated and 33.3% had both inner and outer gloves perforated at the same location.

DISCUSSION

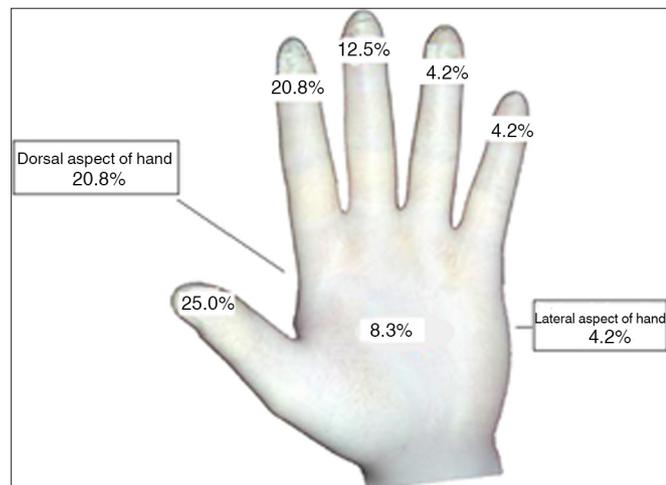
Regarding surgical hand antisepsis, findings from the present study are in agreement with other studies⁸, showing the surgical team's insufficient adherence (16%) to length of time and technique to perform this procedure.

Aiming to improve such technique and length of time for surgical hand antisepsis and to guarantee its effectiveness, it is essential that the surgical team follow recommendations such as: removing jewelry before beginning the procedure; not using artificial nails; cleaning the subungual area with a nail file/picks

Table 3. Characteristics of perforated gloves by length of use and hand. City of Belo Horizonte, Southeastern Brazil, 2013

Variable	N (22)	%
Length of time of surgery when glove perforation was detected		
0 to 29 minutes	1	4.5
30 to 59 minutes	1	4.5
60 to 89 minutes	2	9.1
90 to 119 minutes	9	40.9
120 to 149 minutes	3	13.7
180 to 209 minutes	4	18.2
300 to 329 minutes	2	9.1
Hand where glove perforation occurred		
Single glove on left hand	6	27.3
Single glove on right hand	5	22.7
Inner and outer gloves on left hand concomitantly*	4	18.1
Outer glove on left hand	3	13.7
Inner glove on right hand ⁺	3	13.7
Outer glove on right hand	1	4.5
Number of perforations per glove		
One perforation	19	86.5
Two or more perforations	3	13.5

* Referring to a pair of gloves that were perforated simultaneously on the same hand of user; ⁺ Gloves were perforated at the time they were put on. Another glove was worn over it (double glove wearing).

Figure 1. Anatomical location of glove perforations.

or appropriate brush under running water; paying attention to the recommended brushing^{1,4,6,11}.

Adherence to brushing time was low (40%). Studies on the time required for the effectiveness of brushing have different methodologies in terms of the antiseptic assessed, application time and outcome measured⁹. Thus, a standard protocol must be established for health institutions to guide their professionals.

In this sense, some guidebooks and manuals on surgical infection prevention based on scientific evidence, as proposed by the AORN⁴, WHO⁶, and ANVISA⁷, contribute to the guidance of institutions by standardizing the length of time of the first brushing from three to five minutes and from two to three minutes for the subsequent ones. This includes the use of antiseptic solution, three milliliters in general, enough to cover hands completely.

Not wearing jewelry during surgical scrub was in agreement with the AORN⁴, CDC¹, National Institute for Health and Clinical Excellence (NICE)¹¹ and WHO⁶ recommendations. This is because studies have shown a greater colonization by microorganisms under the areas covered by such jewelry, hindering the contact of the antiseptic with these areas and consequently contributing to the reduction in the effectiveness of antiseptics. Additionally, the risk of perforations and tears in gloves is higher among jewelry wearers, apart from affecting their handling of patients in cases of emergency and causing glove adherence during the surgical procedure to be more difficult^{1,6}.

The use of disposable sterile brushes with soft bristles impregnated with antiseptic, polyvinylpyrrolidone - iodine/PVP-I, as recommended by ANVISA⁷, was adopted by almost all participants (98%) adequately.

Throughout the years, the practice of using brushes has changed significantly. Up until the 1960s, hard bristles were used for brushing. From then on, studies began to show that this use damaged and scratched the epidermis, facilitating

the spread of microorganisms in these areas and promoting bacterial colonization. Thus, hard-bristled brushes were replaced by disposable soft-bristled brushes in the market, apart from sponges that had the same effect of reducing microbial load in hands than hard-bristled ones. However, subsequently, other studies showed that the use or not of brushes/sponges during surgical hand antisepsis achieved the same result, so that its use was not required^{6,8,9}.

Regarding the use of antiseptics, all of them used PVP-I. Although not recommended by the WHO and not being a part of the reality of the institution studied, certain surgical hand antisepsis techniques are performed with alcohol-based preparations by rubbing these products on professionals' hands and forearms¹².

The active substances in these preparations are ethanol, isopropanol and n-propanol, separately or in a combination of two of them. Alcohol's antimicrobial activity is due to its ability to denature proteins, stopping cell functions. Despite the fast antimicrobial action, there is no residual activity when applied to the skin. Adding PVP-I, chlorhexidine, octenidine or triclosan to the alcohol solution can result in residual activity^{6,14}.

Compared to that of traditional products, the efficacy of alcohol preparations has the advantages of fast beginning of action, wide availability, reduction in damage to the skin and low cost^{1,15}. With regard to microbial reduction, they have achieved equal or better results than those of traditional ones, while infection rates were found to be similar¹⁶.

During the entire process of surgical hand antisepsis, participants satisfactorily adhered to repeatedly rubbing it with the opposite arm, turning off the tap without contamination of disinfected area and not moving arms abruptly for the water to flow after rinsing. However, keeping one's hands above elbow level and rinsing them in a single direction, from the fingertips to the elbows, aiming to prevent contamination of the disinfected area with microorganisms from the non-disinfected area, did not show satisfactory adherence, based on guideline recommendations^{4,6}.

It is recommended that hands should be rinsed with clean water to avoid their recontamination, preferably warm water, for antiseptics to act more effectively. In certain cases, although the water comes from a reliable source, tap contamination may occur through *Pseudomonas aeruginosa* and other Gram-negative bacteria. Although there are no cases of outbreaks in surgical centers caused by contaminated taps in the literature, it is recommended that taps should not have aerators when aimed at surgical antisepsis⁶.

Regarding hand drying, although the majority (96%) used a sterile compress and met the recommendations⁶, only 24% performed this by pressing it against the skin from the fingertips to the elbows and 62% did not use both sides of this compress

in different areas, thus allowing microorganisms from more colonized areas to move to less colonized ones.

With regard to perforation rates in sterile surgical gloves, the results of the present study are in agreement with the literature. It is estimated that 18% (with a variation from 5% to 82%) of (micro) perforations/tears occur in gloves during procedures, allowing the transfer of microorganisms¹⁰ and being capable of doubling the risk of SSI⁹.

As observed, these perforations occurred more frequently in the dominant hand, mainly in the thumb, followed by the index finger, differently from the results found where perforations in the index finger were more frequent, followed by the thumb. This characterization of perforations is due to surgeons handling piercing-cutting objects with the dominant hand, causing accidents in the opposite hand¹⁷.

With regard to the role played by health care workers studies have shown a higher number of glove perforations among surgeons, a fact which is in agreement with the present study¹⁸.

The longer duration of surgical procedures is associated with the increase in glove perforation rates¹⁷. The reduction in microbial contamination rates is associated with the increase in the frequency of exchange of surgical gloves. Thus, it is suggested that gloves should be replaced during long surgeries, preferably at every ninety minutes.

In addition to the more frequent exchange of gloves, the use of two gloves in each hand is recommended to maintain their physical integrity, as the outer glove acts like a protective barrier against inner glove perforations^{1-3,6}. Double glove wearing is recommended when there is a high risk of glove perforation, such as orthopedic surgeries with an excessive use of piercing-cutting objects and bone fragments, when the consequences of contamination are disastrous such as prosthetic implants^{2,19}. The protection the outer glove gives to the inner glove was effective in 66.7% of users who followed this recommendation.

In general, few users perceived glove perforation. Thus, aiming to improve the effectiveness of double glove wearing, the use of pairs of gloves of different colors has been recommended, such as bright green inner gloves and white outer gloves, thus increasing the perception of occurrence of perforations by those wearing them²⁰.

CONCLUSION

Inadequate surgical antisepsis that does not meet the recommendations for time and technique and the concomitant accidental and unnoticed occurrence of perforations in sterile surgical gloves can expose the surgical wound to potentially pathogenic microorganisms capable of causing infections.

The present study showed that failures in these procedures occur frequently and they are capable of interfering with patients' safety, promoting reflection on this theme in different health institutions, according to their realities.

Thus, aiming to minimize the occurrence of failures, the implementation of the following measures is suggested: routine training and monitoring of surgical hand antisepsis by surgical team members; the use of double glove wearing to maintain the integrity of inner gloves, thus guaranteeing their effectiveness; and the exchange of gloves at every 90 minutes of use to reduce the chance of professionals using them while perforations are not perceived.

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