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Surveillance of microbiological contamination and correct use of protective lead garments

V. La Fauci[1], R. Riso[2], A. Facciolà[2], V. Merlina[2], R. Squeri[1]

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Parole chiave: Indumenti protettivi di piombo, infezioni nosocomiali, sorveglianza

Abstract

Background. *Healthcare associated infections are an important threat of Public Health. Several studies investigated the possible role played by the hospital environment in the transmission of nosocomial pathogens. In addition to the "classic" nosocomial surfaces, some researches focused their attention on "alternative" surfaces. Little is known about the protective lead garments used in operating rooms.*
Study design. This study was conducted in three phases to investigate the microbiological contamination and the normal use of these garments. In the first step, we administered a questionnaire to know the frequency and the type of sanitation. Then, in the second step, we conducted the microbiological samplings and, finally, in the third step, we carried out a surveillance on the use of these garments during the surgical procedures.
Methods. *In the first step, we administered the questionnaire through direct interview. For microbiological sampling we used sterile swabs, the normal growth media and the API Identification System (bioMérieux).*
Results. *The study showed that the garments are sanitized only in 66.7% of the cases with a non-defined frequency. Moreover, a bacterial contamination was found on 88 garments with a positivity of 80.7% and the units with the higher rate of contamination were Urology, Orthopedics, Neuroradiology and Intensive Cardiac Care. Finally, 100% of the surgical team members wore sterile disposable shirts above the protective lead garments while this was never true for the rest of the nursing and anaesthesia team.*
Conclusions. *To prevent the contamination of these garments, it is important to develop appropriate sanitation procedures and to store them in special cabinets also subjected to sanitation. Finally, it is necessary to focus on the correct use of the protective lead garments.*

Introduction

Healthcare associated infections are one of the major public health problems as they are an important cause of morbidity and mortality among hospitalized patients. Every year, in fact, more than 2 million patients suffer from healthcare-associated infections that cause about 90,000 deaths and health costs that are estimated to be over 5 billion dollars (1). According to the Italian Federation of the Order of Physicians, in Italy in 2008-2010 there were 2,269,045 healthcare associated infections, for a total of 22,691 deaths and a cost ranging between 4.8 and 11.1 billion euro (2).

Regarding the transmission of infections in hospitals, there are many studies about

[1] *Department of Biomedical and Dental Sciences and Morphofunctional Imaging, University of Messina, Messina, Italy*
[2] *Postgraduate Medical School in Hygiene and Preventive Medicine, University of Messina, Messina, Italy*

the role of inanimate surfaces, considered a probable source of nosocomial pathogens (3-5). These surfaces also play an important role in cross-transmission through the hands of healthcare workers (6, 7).

The contamination of the surfaces depends on several factors, including the ability of the pathogens to remain viable in the environment and, above all, the frequency with which the surfaces are re-contaminated after disinfection. Some studies, in fact, have shown that some microorganisms, such as *Acinetobacter spp*, *Clostridium difficile*, *Staphylococcus aureus* and vancomycin-resistant *Enterococcus spp* (VRE) have the ability to remain viable on dry surfaces for days, weeks or even months (8-10). In particular, Colbeck demonstrated that *S. aureus* remains virulent and, therefore, able to cause infection even after 10 days on dry surfaces (9) and it has been proved that strains of multiresistant *S aureus* (MRSA) remain viable for up to a maximum of 14 days on "Formica" surfaces and up to 6 to 9 weeks on cotton materials (10).

In recent years, many types of inanimate surfaces have been studied about the possible transmission of healthcare associated infections (3, 10-17). Few studies, however, have investigated the role of protective lead garments in the transmission of pathogens (18, 19). These garments are often used in the operating room when making intraoperative radiographs, especially in orthopedic surgery. While working, they are in direct contact with the skin of healthcare workers and can also become dirty with blood and body fluids of the patient. Therefore, it is a good practice that the members of the surgical team use sterile overalls on these protective devices in order to avoid contact with patients and the contaminated operating room surfaces. However, also the use of disposable gowns can leave some areas of such garments exposed (e.g., thyroid shields or wrap-around skirts) which, therefore, are often in contact with the operative field.

Objective

The purpose of this research was to examine the use and maintenance of the protective lead garments in the operating room by assessing, in particular, their microbiological contamination and their practical use by healthcare workers during surgical procedures.

Methods

The study was conducted from 1 October 2015 to 31 March 2016 in 7 surgical operating units (Orthopedics, Neurosurgery, Urology, Thoracic Surgery, Vascular Surgery, General Surgery and Otolaryngology), a Diagnostic Imaging Unit (Neuroradiology) and an Intensive Care Unit (ICU) of Cardiology of the "G. Martino" University Hospital of Messina, Italy.

The research included three stages. To start, we made a list of the operating units in which the protective lead garments were used; then, we administered a short questionnaire through direct interview to the Coordinators of the Operating Rooms (OR) in order to know the methods used for the sanitation of such garments and their frequency. In the second stage, we classified the garments by number and type and, then, samples for microbiological examination were collected. In detail, pre-moistened swabs were used to collect samples from all the identified protective lead garments (over-the-shoulder vests, wrap-around skirts, and thyroid shields), in chosen areas of 10 x 10 cm^2. We sampled both surfaces (inside and outside) of each garment, along the midline. The swabs were taken to the laboratory immediately; they were cultured in a brain-heart infusion broth and incubated at 37° for 24-48 h. Positive samples were prepared for further cultures on different growth media: Mannitol salt agar (Oxoid) to isolate Staphylococci, MacConkey agar (bioMérieux) to isolate Gram-

negative bacteria and Enterococcosel-agar (bioMérieux) to isolate faecal Enterococci. The isolated microorganisms were then identified through the API Identification System (bioMérieux): API STAPH for *Staphylococcus spp*, API 20 NE for non-*Enterobacteriacea* Gram negative and API 20 E for *Enterobacteriacea*. Finally, in the third stage, we conducted an observational survey to verify the behaviours of the surgical staff in the operating room concerning the use of such garments. In particular, we enquired a total of 70 surgical operations (10 for each Operating Unit), each for a period of ~ 45 minutes.

Results

The results of the questionnaire administered in the first phase of the research have shown that the garments are sanitised only in 66.7% of the cases with a non-defined frequency and, in most cases, a 3% sodium hypochlorite solution is used as disinfectant; ethanol and peroxymonosulphate are used with lesser frequency. Once sanitized, the garments are placed in a vertical coat rack and/or in special cabinets. The garments are personally owned only in 33.3% of the cases; in the remaining cases, they are shared by the various members of the operating team. Finally, in 83.3% of the cases, a disposable lab coat is worn over the lead garment.

In the second phase of the research, we examined 19 thyroid shields, 45 over-the-shoulder vests and 45 wrap-around skirts for a total of 109 garments; for each of them, a sample was collected both from the inside and the outside, for a total of 218 samples. Bacterial contamination was found on 88 garments with a percentage of 80.7% positivity. The percentages of positivity for each garment are shown in Fig. 1. In particular, concerning the strains, we isolated *S. aureus*, Coagulase-Negative *Staphylococci* (CONS), *Steptococcus faecalis*, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*. No yeasts and/or moulds were detected. Sometimes, various microorganisms were found on each garment simultaneously. The number

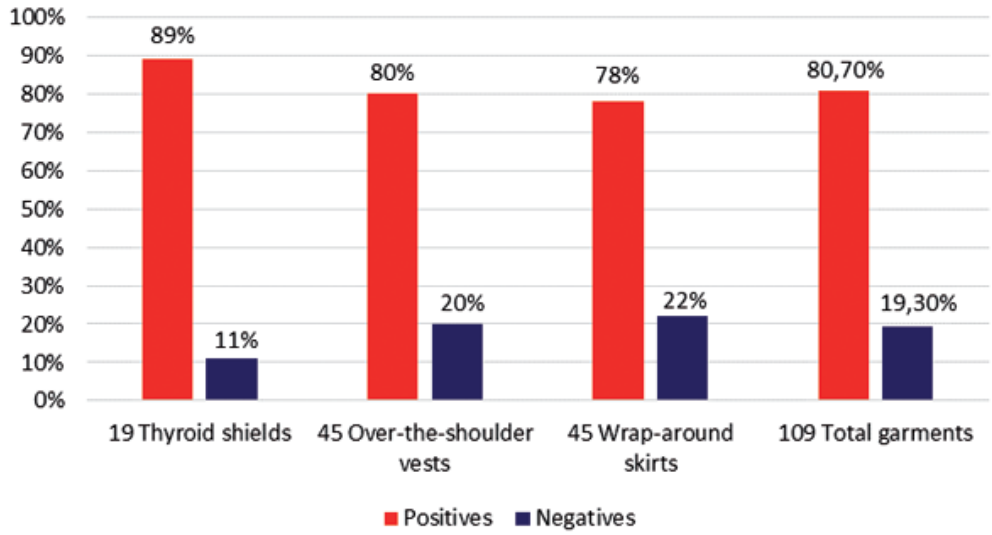

Figure 1 - Percentage of positive lead garments

Table 1 - Percentage of contaminated lead garments according to the microorganisms isolated

Garments	Samples	*Staphilococcus aureus*	CONS	*Enterococcus faecalis*	*Pseudomonas aeruginosa*	*Klebsiella pneumoniae*	Yeasts and moulds	%Tot of positivity
Thyroid shields	19 inside	42% (8)	21% (4)	15,8% (3)	5,3% (1)	0	0	84,2% (16)
	19 outside	42% (8)	15,8% (3)	5,3% (1)	10,5% (2)	10,5% (2)	0	84,2% (16)
Over-the-shoulder vests	45 inside	22,2% (10)	4,4% (2)	4,4% (2)	0	0	0	31,1% (14)
	45 outside	15,5% (7)	8,8% (4)	2,2% (1)	4,4% (2)	0	0	31,1% (14)
Wrap-around skirts	45 inside	13,3% (6)	13,3% (6)	2,2% (1)	2,2% (1)	0	0	31,1% (14)
	45 outside	17,7% (8)	4,4% (2)	2,2% (1)	4,4% (2)	0	0	28,8% (13)
Tot	218	21,5% (47)	9,6% (21)	4% (9)	3,6% (8)	0,9% (2)	0	

and the percentage of isolation of each microorganism is shown in Tab. 1.

The results showed a higher positivity rate in the units of Urology, Orthopedics, Neuroradiology and Intensive Cardiac Care, while lower positivity rates were observed in the remaining units (Fig. 2), and no contamination was observed in Neurosurgery.

Finally, the survey conducted in the third phase, observing the behaviour of the operators during surgery, showed that 100% of the surgical team members wore sterile disposable overalls above the protective lead garments, while this was never true for the memebers of the nursing and anaesthesia teams.

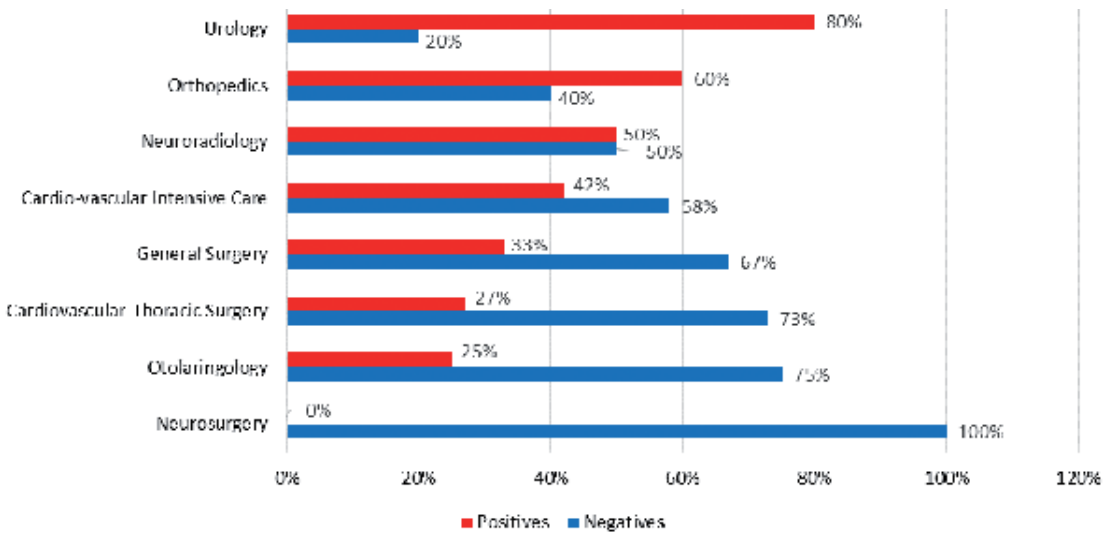

Figure 2 - Contamination rates of lead garnments in different operating rooms

Discussion and conclusions

The hospital environment can play a significant role in the transmission of nosocomial pathogens (11). Many studies have been conducted on the possible role of hospital surfaces. However, little is known about the potential role played by the protective lead garments used by healthcare workers during surgery. In fact, as these garments come into contact with healthcare providers, patients and/or other potential vehicles, they can become contaminated and represent a possible vehicle for the transmission of potential pathogens that can cause healthcare associated infections. They can also contaminate, by cross-contamination, other inanimate surfaces or the hands of the operators.

The questionnaire revealed a lack of attention to hygienic standards and to the disinfection of these garments, because there are no hospital policies that establish timing and frequency of their routine sanitation or offer products suitable for this purpose. In addition, a high number of samples tested positive for microorganisms known to cause hospital infections and the rate of colonization was similar in the three types of garments analysed. We found a major positivity in the Surgical Units of Urology and Orthopedics and this result is in line with international epidemiological data on healthcare associated infections that show a higher frequency of surgical site infections in these departments (19). The high positive findings in our study contrasts with the results of a previous study conducted by Grogan et al (17), in which the positivity rate was 2.7%. In their study, however, a sanitation procedure of the garments was routinely carried out and this could be the reason for this discrepancy. They also found, mostly, microorganisms belonging to the normal skin flora, while our research highlighted also pathogenic and potentially dangerous strains.

To prevent contamination of these garments, it is important to develop appropriate sanitation procedures and store them in special cabinets also subjected to sanitation. Finally, it is necessary to focus on the correct use of the protective lead garments. According to the national guidelines published in 2009 by the Italian Ministry of Labour, Health and Social Policies (20) on safety in the operating room, the members of the entire surgical team, before surgery, should wear disposable sterile gowns, a mask covering the mouth and nose, a cap/hat to cover hair and beard, and sterile gloves after washing hands. However, in our observational survey, only the members of the surgical team used sterile disposable gowns above the lead garments. Therefore, it is necessary to continue to train, supervise and audit the operating room staff, in particular the nursing and anaesthesia teams.

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Riassunto

Sorveglianza su contaminazione microbiologica e corretto uso degli indumenti protettici di piombo

Introduzione. Le infezioni nosocomiali sono un'importante minaccia in sanità pubblica. Diversi studi hanno evidenziato il ruolo svolto dall'ambiente ospedaliero come possibile fonte di trasmissione di agenti patogeni nosocomiali. Oltre alle superfici ospedaliere "classiche", alcune ricerche hanno concentrato la loro attenzione su superfici "alternative". Poco si sa, invece, circa il ruolo giocato dagli indumenti protettivi di piombo.

Disegno dello studio. Questo studio è stato condotto in tre fasi con l'obiettivo di indagare sullo stato della contaminazione microbiologica e il corretto uso di questi indumenti. Nella prima fase, abbiamo somministrato un questionario per conoscere la frequenza e il tipo di prodotti utilizati per la sanificazione dei suddetti capi.

Nella seconda fase, abbiamo eseguito i campionamenti microbiologici e, infine, nella terza, abbiamo effettuato un controllo sul corretto uso degli indumenti protettivi di piombo durante le procedure chirurgiche.

Metodi. Nella prima fase, abbiamo somministrato il questionario attraverso un'intervista diretta. Per il campionamento microbiologico abbiamo utilizzato tamponi sterili e i comuni terreni di coltura, mentre l'identificazione microbiologica è avvenuta mediante il sistema API (bioMérieux).

Risultati. Lo studio ha mostrato che i capi erano sanificati solo nel 66,7% dei casi con una frequenza non definita. Inoltre, una contaminazione batterica è stata trovata su 88 capi con una percentuale dell' 80,7% di positività e le unità operative con il più alto tasso di contaminazione sono risultate Urologia, Ortopedia, Neuroradiologia e Unità di Terapia Intensiva Cardiologica. Infine, il 100% dei membri del team chirurgico indossava il camice sterile monouso sopra gli indumenti protettivi, mentre ciò non è mai avvenuto per il resto del team infermieristico e anestesiologico.

Conclusioni. Per evitare la contaminazione di questi capi, è importante sviluppare adeguate procedure di sanificazione e una corretta sistemazione di questi in armadi dedicati anch'essi sottoposti a sanificazione. Infine, è necessario formare il personale sanitario sul corretto uso degli indumenti protettivi di piombo.

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Corresponding author: Prof. Vincenza La Fauci, Department of Biomedical Sciences and Dental and Functional Images, A.O.U. Policlinico "G. Martino", Torre Biologica 1 Piano, Via Consolare Valeria, 98125 Messina, Italy
e-mail: vlafauci@unime.it.