

Contamination of tourniquets for peripheral intravenous puncture

Contaminação de torniquetes para punção intravenosa periférica

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Abstract

Objectives: To identify the presence of contamination on tourniquets for peripheral intravenous puncture and to characterize the profile of the *Staphylococcus* spp. and the isolated yeasts.

Methods: Cross-sectional study in which 18 tourniquets for peripheral intravenous puncture in use at a hospital were analyzed. The tourniquets were immersed in BHI broth for 24h and cultivated in selective media for isolation and identification of *Staphylococcus* spp. and yeasts. The disk-diffusion method was employed to analyze the susceptibility profile of the *Staphylococcus* spp. to the antimicrobial agents.

Results: The growth of some microorganism was identified on 13 (72.2%) tourniquets: 11 (52.4%) coagulase-negative *Staphylococcus*, two (9.5%) *Staphylococcus aureus*, four (19%) *Rodothorula mucilaginosa*, three (14.3%) *Candida albicans*. 61.5% of the *Staphylococcus* spp. were oxacillin-resistant. The team professionals did not mention protocols for cleaning, disinfection or controlled replacement of these materials at the institution.

Conclusion: The contamination of tourniquets by pathogenic microorganisms was identified, with a resistance profile to the antibiotics that are frequently used in hospitals.

Resumo

Objetivos: Identificar a presença de contaminação em torniquetes para punção intravenosa periférica e caracterizar o perfil dos *Staphylococcus* spp. e leveduras isolados.

Métodos: Estudo transversal que inseriu análise de 18 torniquetes para punção intravenosa periférica em uso no hospital. Os torniquetes foram imersos em caldo BHI por 24h e cultivados em meios seletivos para isolamento e identificação de *Staphylococcus* spp. e leveduras. O método disco-difusão foi empregado para analisar o perfil de suscetibilidade dos *Staphylococcus* spp. aos antimicrobianos.

Resultados: Treze (72,2%) torniquetes apresentaram crescimento de algum micro-organismo sendo 11 (52,4%) *Staphylococcus* coagulase-negativo, dois (9,5%) *Staphylococcus aureus*, quatro (19%) *Rodothorula mucilaginosa*, três (14,3%) *Candida albicans*. 61,5% dos *Staphylococcus* spp. apresentaram resistência a oxacilina. Os profissionais da equipe não relataram protocolos para limpeza, desinfecção ou substituição controlada destes materiais na instituição.

Conclusão: Foi identificada a contaminação de torniquetes por micro-organismos patogênicos com perfil de resistência aos antibióticos muito utilizados em instituições hospitalares.

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Introduction

Healthcare-Associated Infections (HAIs) represent a great problem for the safety and quality of life of health service users. In addition, their impact can result in death, extended hospitalization, disabilities, a great financial burden for the health institutions and a high cost for patients and their families.

⁽¹⁾The mortality rates related to the HAIs vary with the topography, baseline disease, etiology, among others. It is estimated that there are great variations in the lethality coefficients, between 9.0 and 58.0%, with high rates of bloodstream infections, reaching 40.0%.⁽²⁾

Bloodstream infections (BSI) figure among the infections most commonly associated with health-care. It is estimated that about 60% of nosocomial bacterial infections are associated with some intravascular device. The catheter-related BSI include cases in which the same microorganism isolated in the culture of the device segment is identified in the bloodstream, without another apparent source for the presence of the bacteria.⁽³⁾

Bloodstream infections, mainly when catheter-related, figure among the most frequent health-care-associated infections and have been related with high mortality rates, extended hospitalization and higher financial burden.⁽⁴⁾ The pathogens most commonly reported in BSI include coagulase-negative *Staphylococcus*, *Staphylococcus aureus*, enterococci and *Candida* spp. Infections by resistant microorganisms are also highlighted, such as methicillin-resistant *Staphylococcus aureus* and *Candida* spp. resistant to fluconazole, resulting in higher mortality rates and extended hospitalization to treat these infections.⁽³⁾

Candida species have emerged as important pathogens, associated with almost 80.0% of all nosocomial fungal infections and with high mortality rates.⁽⁵⁾ Although *Candida albicans* is the most isolated yeast in BSI, other species, such as *Candida parapsilosis*, have emerged as causes of BSI in hospitalized, weakened patients and particularly in low-weight newborn infants.^(5,6)

To prevent BSI, taking care of the installation and maintenance of the vascular access is essential.

⁽³⁾ One of the devices used to install the peripheral venous access is the tourniquet, a collective device for which no specific decontamination recommendations are available. Studies appoint the need to reconsider care with tourniquets that are used indiscriminately among the patients without proper decontamination, which can be considered a risk factor for peripheral venous access infection.^(7,8)

As tourniquets are collective devices that are essential to install a peripheral venous access and in view of the lack of specific recommendations for their decontamination, the potential risk of these devices needs to be assessed as a dissemination source of pathogens that are epidemiologically important for HAIs, which is the contribution expected from this study. This study was aimed at identifying the presence of contamination on tourniquets for peripheral intravenous puncture and at characterizing the profile of the *Staphylococcus* spp. and yeasts isolated.

Methods

A descriptive and cross-sectional study was undertaken at a maternal-infant referral hospital in the state of Goiás (Brazil). The data were collected during one week in August 2012. All hospital sectors that use tourniquets for peripheral intravenous puncture in their care procedures were selected as data collection units, as well as the professional responsible for these devices in the respective sectors.

After receiving the participants' consent, an interview was held with the help of a previously assessed structured script, involving 12 health professionals responsible for peripheral intravenous puncture tourniquets at each hospital unit. The script was aimed at collecting information on the decontamination, storage, use and replacement processes of these articles at the institution.

Next, all tourniquets being used were collected for microbiological analysis, totaling 18 tourniquets from the pediatric and maternal Emergency Care sector, maternal Intensive Care Unit, Surgical Center, Maternity, Gynecology/Obstetric Clinic and Clinical Analysis Laboratory. The tourniquets were

individually stored in sterilized recipients and transported at room temperature to the laboratory of the Institute for Tropical Pathology and Public Health of Universidade Federal de Goiás (IPTSP/UFG) for microbiological analysis. The professional received a new tourniquet to replace the device collected for the research.

At the laboratory, the tourniquets were immersed in individual flasks of BHI (Brain Heart Infusion) broth and incubated at 35°C for up to 48h. At the same time, a new tourniquet was also cultivated as negative control, under the same conditions as the devices collected that were used at the hospital. Samples with microbial growth were seeded in salted agar mannitol and tryptic soy agar with 4% of NaCl and 6 µg/mL of oxacillin (TSA oxa) for isolation and identification of *Staphylococcus* spp. Next, they were incubated at 35° C for up to 48h. TSA oxa medium was used to screen for the isolation of oxacillin-resistant strains. The standard strain *S. aureus* ATCC® 25923 was used for quality control of the tests done.

After the macro and microscopic analysis of the colonies grown in the selected media, biochemical standard identification tests were done: mannitol fermentation test, catalase, coagulase and DNase detection tests. The isolated *Staphylococcus* spp. were assessed to identify the susceptibility profile to 12 antimicrobial agents, using the disk-diffusion method. Microorganisms showing oxacillin and/or cefoxitin resistance (marker of resistance to oxacillin) on the antibiogram were submitted to the *E-test*, using oxacillin strips to detect the minimum inhibitory concentration and confirm the resistance to oxacillin.

Samples with microbial growth in BHI broth were also seeded in 5.0 mL of inclined *Sabouraud Dextrose* agar with 0.1mg.mL⁻¹ of cloramphenicol, kept at room temperature for 15 days to investigate the growth of fungal colonies. The yeast colonies that developed in *Sabouraud Dextrose* agar at room temperature after the 15 days were identified by means of physiological tests (formation of germ tube) and biochemical characteristics, including the assimilation of carbon and nitrogen sources (auxanogram), carbohydrate fermentation tests (zymo-

gram) and micromorphology in corn meal agar with *Tween* 80. A standard strain was applied as quality control for the identification tests (*Candida albicans* ATCC® 10231).

As the outcome variable, the study showed the contamination of the tourniquets by microorganisms of epidemiological importance (*Staphylococcus* spp. and yeasts) for HAIs. The data were analyzed using descriptive statistics with simple frequency of the categorized variables, presented as percentages.

The development of the study complied with Brazilian and international ethical standards for research involving human beings.

Results

All health professionals (n=12) participated in the interview who were responsible for the 18 peripheral intravenous puncture tourniquets used at the hospital. Concerning the interviewees' educational background: six (50.0%) were baccalaureate nurses, two (16.7%) nursing technicians and four (33.3%) laboratory technicians.

It was observed that 83.3% of the tourniquets were used collectively by more than one professional at the same hospital service for the purpose of peripheral intravenous puncture of any patient. All responsible service professionals confirmed that there was no standard protocol for the decontamination of these tourniquets at the institution. This resulted in a range of routines among the services, predominantly using 70% alcohol, which eight (66.7%) subjects mentioned, while one of the participants (8.3%) mentioned not using any decontamination measure of these devices. In addition, the non-standardized use of 70% alcohol is highlighted, mentioning: before and after the reuse of the tourniquets (02/ 16.7%), only after the use (02/ 16.7%), once per period (01/ 8.3%) and once per day (03/ 25.0%).

Concerning the microbiological analysis, no microbial growth was found on the tourniquet used as a negative control. Out of 18 tourniquets collected that were used at the hospital, 13 (72.2%) showed the growth of some of the microorganisms inves-

tigated. Ten (55.6%) displayed growth of *Staphylococcus* spp. and seven (38.9%) of yeasts, while four (22.2%) showed the concomitant growth of two microorganisms. Twenty-one microorganisms were isolated, being 13 *Staphylococcus* spp. and eight yeast-forming fungi, as described in table 1.

Table 1. Prevalence of microorganisms isolated and identified on peripheral puncture tourniquets

Microorganisms isolated	n(%)
Coagulase-negative <i>Staphylococcus</i>	11(52.4)
<i>Staphylococcus aureus</i>	02(9.5)
<i>Rodothorula mucilaginosa</i>	04(19.0)
<i>Candida albicans</i>	03(14.3)
<i>Candida parapsilosis</i>	01(4.8)

In this research, the susceptibility profile of the *Staphylococcus* spp. to 13 antibacterial agents was assessed, highlighting the resistance of these microorganisms to penicillin (100.0%), erythromycin (46.2%), ciprofloxacin (38.5%) and gentamycin (38.5%), presented in table 2.

Table 2. Antimicrobial susceptibility profile of *Staphylococcus* spp. isolated from tourniquets

Antibacterial agents	Isolated n(13)			Total R (%)
	S	I	R	
Oxacillin	05	NA	08	61.5
Penicillin	00	NA	13	100.0
Mupirocin	10	NA	03	23.1
Ciprofloxacin	07	01	05	38.5
Cloramphenicol	11	00	02	15.4
Rifampicin	13	00	00	0.0
Gentamycin	08	00	05	38.5
Tetracycline	12	01	00	0.0
Trimethoprim-sulfamethoxazole	09	00	04	30.8
Clindamycin	09	01	03	23.1
Erythromycin	06	01	06	46.2
Linezolid	12	NA	01	7.7
Quinupristine-dalfopristine	13	00	00	0.0

S - sensitivity; I - intermediary resistance; R - resistant; NA - not assessed

Out of 13 microorganisms isolated, eight (61.5%) *Staphylococcus* spp. were resistant to oxacillin/cefoxitin using the disc-diffusion method (screening). All eight microorganisms isolated were identified as coagulase-negative *Staphylococcus* (CoNS) and showed resistance to oxacillin, confirmed by the *E*-test*. The minimum inhibitory concentration of oxacillin detected in the *E*-test* ranged between 0.75µg/mL and > 256µg/mL.

Discussion

In this study, the nursing team stood out as the primary responsible for the peripheral intravenous puncture tourniquets used at the hospital (66.7%). Historically, nursing is the team most frequently accountable for the planning, administration and supervision of intravenous therapies, and therefore carries a great responsibility for the prophylaxis and control of bloodstream-related infections. Although this seems to be a simple activity, it demands specific care and the strict observation of preventive measures to guarantee patient safety.⁽⁹⁾

The absence of the sanitary standardization of effective measures for the decontamination of peripheral intravenous puncture tourniquets may have contributed to the different ways in which the health professionals handled this device. Alcohol at 70% was the most used product (66.7%). It is known that alcohol preparations are effective for intermediary disinfection, inactivating the vegetative forms of bacteria, enveloped viruses, mycobacteria and fungi.⁽¹⁰⁾ The indiscriminate use of 70% alcohol with an excessive burden of organic matter is not successful to eliminate microorganisms from any surface, as the organic matter turns into a mechanical barrier that impedes or reduces the action of the alcohol on the microorganisms.^(10,11)

In the practical use of the tourniquets, the absence of any proven effective and safe measure to decontaminate these devices is observed, which have contact with different microorganisms on the patients' skin, the health professionals' hands and the surfaces where they are stored. Studies are needed to find not only clinical, but also technical and operational evidence on how to guarantee the decontamination of the tourniquets, besides the cost-benefit relation of reuse. At the hospital where the study was carried out, it was observed that various services used "fingers" from disposable gloves as a tourniquet for punctures in infants, an alternative improvised for a single-use device, which can be more costly in relation to a disposable device proposed specifically for this purpose. These are suppositions that also lack further research.

Among all tourniquets analyzed, 07 (38.9%) showed the growth of yeast-forming fungi. Eight microorganisms were isolated and identified as *Rhodotorula mucilaginosa* (50.0%), *Candida albicans* (37.5%) and *Candida parapsilosis* (12.5%). Candidiasis is one of the main opportunistic fungal infections in human beings, caused by *Candida* yeasts. Their etiological agent can grow and multiply at high temperatures (37°C) and produce lipases, proteinases, biofilms, allergic manifestations and depression of cell immunity in the host, characteristics that grant these yeasts a high level of pathogenicity.⁽¹²⁾

Rodothorula spp. yeasts are also considered opportunistic microorganisms related to bloodstream infections, whose most common species is *Rodothorula mucilaginosa*. These yeasts were considered as non-pathogenic for years but, in recent decades, their pathogenic potential has increased, especially in immunodepressed patients, often related to the presence of venous catheters, prostheses, grafts, endocarditis, peritonitis and meningitis.^(13,14)

The infections caused by *Candida* spp. and *Rodothorula mucilaginosa* fungi can be related to the presence of venous catheters and have been described as microorganisms that cause bloodstream infections.⁽¹⁴⁾ Tourniquets are essential devices to install peripheral lines, collect blood and apply intravenous therapy, and are mostly manufactured from porous material that facilitates fungal adhesion.

As regards the bacteriological analyses of the tourniquets, 84.6% of the isolated *Staphylococcus* were characterized as CoNS. This group colonizes the skin and mucous tissues of humans and other animals, and was long considered as saprophytes with a reduced capacity to cause human infections. In recent years, however, they have been related to important nosocomial infections, mainly in weakened and elderly patients and low-weight infants.^(15,16)

In addition, some species produce a slime layer of polysaccharides that increases the bacterial adhesion to the different surfaces and is related to the formation of biofilms.^(17,18)

The susceptibility profile of the *Staphylococcus* revealed that, of all isolated strains, 61.5% were oxacillin-resistant. This is an important phenotype, which predicts resistance to the group of beta-lactam antibiotics, including cephalosporins and carbapenem products. Oxacillin resistance is mostly due to the production of penicillin-binding proteins (PBPs) with low levels of affinity with the beta-lactam antibiotics (PBP2a). This protein is coded by the gen *mecA*, which is inserted in a mobile genetic element present in the bacterial chromosome called *SCCmec* (*Staphylococcal* cassette chromosome *mec*).^(19,20)

All oxacillin-resistant *Staphylococci* isolated in this research belong to the group CoNS. This data is in line with recent studies that appoint this group as emerging nosocomial microorganisms resistant to various antimicrobials.⁽¹⁶⁻¹⁸⁾

It is also important to highlight that, among the isolated bacterial agents, penicillin resistance amounted to 100.0%. Some microorganisms (38.5%) were resistant to penicillin through the production of beta-lactamase (penicillinase). This resistance phenotype is expanded to all penicillinase-labile penicillin, such as ampicillin, amoxicillin, piperacillin and ticarcillin. These data strengthen that penicillin resistance is widely disseminated in the hospital context, so that the use of this antibacterial agent in the treatment of staphylococcus infections is no longer recommended.⁽²⁰⁾

Another important fact was the *Staphylococcus*' resistance to other antibacterial agents, such as erythromycin (46.2%), ciprofloxacin (38.5%) and gentamycin (38.5%). Oxacillin-resistant strains, particularly those isolated in hospitals, frequently have genes linked to their chromosome that are resistant to several non beta-lactam antibacterial agents.⁽²¹⁾

Studies have proved the colonization of these devices by pathogenic microorganisms due to the reuse of contaminated tourniquets, inappropriate decontamination practices or the professionals' lack of hand washing.^(7,8)

No cleaning, disinfection or controlled replacement routine of the peripheral intravenous punc-

ture tourniquets was identified at the place of study. These research results demonstrate that peripheral intravenous puncture tourniquets are widely used by the nursing teams and can be contaminated by pathogenic microorganisms that act as fomites in healthcare environments.

Conclusion

The contamination of the tourniquets by pathogenic microorganisms was identified, with a resistance profile to antibiotics that are frequently used in hospitals.

Collaborations

Batista KCO contributed to the construction and execution of the project, analysis and interpretation of the data and elaboration of the article. Tipple AFV contributed to the construction of the project, analysis and interpretation of the data, writing of the article and approval of the final version. Leão-Vasconcelos LSNO and Ribeiro EL contributed to the construction of the project, analysis and interpretation of the data and critical review of the intellectual content of the article. Prado MA contributed to the construction of the project and critical review of the intellectual content of the article.

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