Injury, Int. J. Care Injured 46 S8 (2015) S77–S80

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Colonization by methicillin resistant staphylococci of nares and skin in healthcare workers: a pilot study in spinal surgeries

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KEYWORDS

healthcare professionals
spinal surgeries
staphylococcal colonization
methicillin resistant staphylococci

ABSTRACT

Introduction: *Staphylococcus aureus* and coagulase-negative staphylococci (CoNS) colonization among healthcare workers (HCWs) may have implications in development of infections and in spreading of resistance. This study aimed to determine the rate of methicillin-resistant staphylococci carriage in HCWs of spinal surgeries in an Italian Orthopaedic Institute.
Materials and methods: Samples from nares, axillae and hands were inoculated onto appropriate media in order to perform colony counts of methicillin-susceptible and resistant *S. aureus* and CoNS.
Results: Prevalence of *S. aureus* and CNS was 42.3% and 98%, respectively. Methicillin-resistance was rather infrequent in *S. aureus* (13.5%) while it was detected in most of CoNS (90.4%). Methicillin resistant *S. aureus* were prevalently isolated from nares while axillae showed the highest methicillin-resistant CoNS colonization rates.
Conclusions: A relatively high rate of methicillin resistant staphylococci was found among HCWs in spinal surgeries wards, thus evidencing the need for careful prevention measures and for periodic evaluation of spread among HCWs.

Introduction

Surgical site infections (SSIs) can be a devastating problem of spinal surgery because of the risk of spread of infection to the central nervous system, which can lead to complications such as chronic pain, deformity, paralysis, and even death.

Staphylococcus aureus is a major cause of infections in patients undergoing spinal surgery [1]: its virulence and ability to acquire resistance to antimicrobial agents result in a serious worldwide problem for hospitals and health professionals [2]. Treatment of infection caused by *S. aureus* has become more problematic, since the occurrence of methicillin resistance involves resistance to all β-lactams and to other antibiotics, which significantly limits the treatment choice [3].

In Italy a high level of MRSA infections has been reported according to the European Antimicrobial Resistance Surveillance Network (EARS-Net), being MRSA isolated from about 35% of invasive infections [4].

Anterior nares, hands, axillae and intestine are the major reservoir of *S. aureus* [5].

Nasal carriage of *S. aureus* appears to play a key role in the epidemiology and pathogenesis of infections. Approximately 20% of individuals carries at least one type of *S. aureus* strain; while a large proportion of the population (60%) harbors *S. aureus* intermittently, and the strains change with varying frequency. Finally, a minority of people (20%) almost never carry *S. aureus* [6]. MRSA colonization among healthcare workers (HCWs) has at least 3 important implications. First, HCWs may become infected by their own MRSA carriage strains; second, they could serve as a route of cross-transmission to patients; and finally, they may introduce the pathogen into their communities [7]. Acquisition of MRSA frequently brings about asymptomatic colonization; however it may be associated with infection resulting in significant morbidity and mortality, particularly in vulnerable patients [8], such as those of spinal surgeries.

MRSA is found endemically in many hospitals: the severity of resulting diseases and high costs of health care justify an investment in prevention and control guidelines [2].

Over the last few years, also coagulase-negative staphylococci (CoNS) are becoming important as causative agents of hospital-acquired bacteraemia and surgical site infections [9]. Furthermore, CoNS are nosocomial pathogens often associated with multiple antimicrobial-resistance mechanisms including, in particular, methicillin resistance [10].

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Several studies have evidenced that HCWs are more frequently colonized from methicillin resistant staphylococci if compared with persons not having contact with hospital environments [11,12].

Hospitalized patients may acquire methicillin resistant staphylococci by HCWs through transiently colonized hands or from contaminated environmental surfaces. Traditionally hand hygiene is one of the most effective measures to limit dissemination of methicillin resistant staphylococci and, more generally, of pathogens. Unfortunately, the importance of this simple practice is often underestimated and compliance by HCWs may be scarce.

Therefore, aim of the study was to determine the rate of MRSA and methicillin-resistant coagulase negative staphylococci (MRCoNS) carriage in HCWs of two spinal units of an Italian reference center for Orthopaedics with 350 beds and an average of 1700 spinal procedures a year.

Methods

The study was carried out at the IRCCS Galeazzi Orthopaedic Institute of Milan, Italy from 30 October 2012 to 30 June 2013 on a total of 52 HCWs working in two different spinal units of the hospital. In particular, 41 nurses and 11 medical doctors (orthopaedic surgeons), all volunteers, participated in the study.

Nasal, axillary and skin swab collection

Six samples were collected from each HCW: one from each nostril, hand and axilla. Sterile cotton swabs (Heinz Herenz, Hamburg, Germany) were used for sample collection. Samples were obtained by rotating the swabs gently on nares of the study participants and swabbing an area of approximately 2 cm^2 of the palm of the hands and of the axillae. Then each swab was inserted into a sterile test tube containing 1 mL of sterile normal saline and immediately transported to the laboratory.

Culture and identification

Samples were vortexed and 100 µl of suspension were inoculated onto Mannitol Salt Agar (MSA; Bio-Rad Laboratories, Redmond, USA) and MRSA*Select™* (Bio-Rad Laboratories,) to perform colony counts. After 24–48 hrs of incubation at 37°C, colony forming units (cfu) were counted, differentiating between *S. aureus* and CoNS. On MSA, colonies of Gram positive cocci that were mannitol fermenter (golden or cream color) were tested for coagulase production (Coagulase Plasma EDTA, Biolife Srl, Milano, Italia) by suspending colonies in 500 µL of plasma and incubating them for at least 6 hrs. Mannitol and coagulase positive colonies were taken as *S. aureus*. On MRSA*Select™* identification was based on the cleavage of a chromogenic substrate by a specific enzymatic activity of *S. aureus*, leading to a strong pink coloration of the *S. aureus* colonies. Coagulase negative methicillin-resistant staphylococci did not metabolize the chromogenic substrate and appeared as white colonies (possibly light pink), while methicillin-susceptible staphylococci were inhibited. All pink colonies were tested for coagulase production as described above.

Results

S. aureus was recovered in 22 HCWs (42.3%) and, in particular, in the nares of 15 HCWs (28.8%), on the hands of 7 HCWs (13.5%) and on the axillae of 5 HCWs (9.6%). Two HCWs carried *S. aureus* on hands and axillae; 2 on hands and in nares; while only one on axillae and in nares. However, MRSA colonized only 7 HCWs (13.5%): 4 only in nares, 2 on hands and 1 on hands and axillae (**Table 1**).

CoNS prevalence was 98%, in fact all HCWs except one were colonized in at least one of the three sampled districts: in particular 48 (92.3%) showed CoNS in the nares, 41 (78.8%) on the axillae and 25 (48%) on the hands. On the contrary compared to *S. aureus*, almost all (47, i.e. 90.4%) CoNS carriers of the health staff were colonized by methicillin-resistant strains.

Table 1
Prevalence of staphylococci in healthcare workers.

	S. aureus	MRSA	CoNS	MRCoNS
Total	42.3%	13.5%	98%	90.4%
Nares	28.8%	7.7%	92.3%	73.1%
Axillae	9.6%	5.8%	78.8%	42.3%
Hands	13.5%	1.9%	48%	23.1%

MRSA: methicillin resistant S. aureus; CoNS: coagulase negative staphylococci; MRCoNS: methicillin resistant coagulase negative staphylococci.

We counted a total of 46150 cfu/ml (range 0-18140 cfu/ml per HCW) of *S. aureus* and 394560 cfu/ml (range 0-31670 cfu/ml per HCW) of CoNS, among them 6184 (13.4%; range 0-5970 cfu/ml per HCW) were MRSA and 112020 (28.4%; range 0-20000 cfu/ml per HCW) were MRCoNS.

Figure 1 reports the distribution of *S. aureus* and CoNS isolated from nares, hands and axillae with a distinction between methicillin resistant and susceptible staphylococci. In nares 13% of *S. aureus* and 24% of CoNS were methicillin resistant; methicillin resistance was 3% and 30% in S. aureus and CoNS isolated from axillae, and 12% and 50% in S. aureus and CoNS isolated from hands.

As showed in Figure 2, most MRSA were isolated from nares while most of MRCoNS came from axillae.

Discussion

S. aureus is a common cause of both community- and hospital-acquired infections. Despite adequate antibiotic therapy, patients with MRSA infections have a higher mortality risk and are associated to higher healthcare costs than patients with methicillin susceptible *S. aureus* (MSSA) infections [13].

Several studies have been conducted in various hospitals worldwide to evaluate MRSA prevalence in the health staff, because HCWs may represent a source of cross-contamination to patients.

In spinal surgical units of our Institute MRSA prevalence on hands and nares was similar (7.7% and 8%) and comparable to those reported in an American (6.6%) [7] and a Brazilian hospital (4.1%) [2], while on axillae was very low (1.9%). However, we must consider that a limited number of HCWs attended our study, while in the American study [7] attendees were about 200 and in Brazil [2] more than 300.

Even if there are a lot of studies about staphylococcal colonization of HCWs, only few take into account CoNS. An Indian study reported that almost two-thirds (63%) of the surgical unit staff were CoNS carriers, while almost all HCWs participating to our study were colonized by several CoNS [14]. We should not undervalue the high prevalence of MR strains, especially in the case of an orthopaedic institute. In fact, CoNS were originally described as ubiquitous commensals of the healthy human skin and mucosa; nevertheless in recent years, they have emerged as important opportunistic pathogens primarily causing healthcare associated infections in patients with indwelling medical devices [15].

Many studies have focused their attention to nasal colonization. An epidemiological investigation among medical students reported an increase (from 27% to 46%) in nasal *S. aureus* carriage between their third and sixth years of hospital practice, indicating that health care work could be a risk factor for nasal carriage [16]. This is important because MRSA (and also MRCoNS) carriage by health staff could have implications in nosocomial transmission and in the development of infections by such microorganisms [17]. As easily conceivable, between the evaluated anatomic sites, the nasal cavity was the area that presented a higher colonization of *S. aureus*. The prevalence of nasal *S. aureus* colonization