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An alarming presence of methicillin-resistant *Staphylococcus aureus* in a major hospital in the Henan province, China: A five-year observation

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ABSTRACT

Background: Health care-associated infection is a major cause of morbidity and mortality. Methicillin resistant *Staphylococcus aureus* (MRSA) is one of the main causes of bloodstream infections, pneumonia and surgical site infections in hospitals.

Methodology: Bodily fluids and skin swab samples from in-patients from a major hospital in Henan province were collected between 2013 and 2017. Samples were then cultured, identified and subjected to drug susceptibility testing on a BD Phoenix™ 100.

Results: A 5-year observation of the presence of MRSA in this hospital revealed a high incidence of MRSA, compared to other staphylococci species isolated from in-hospital patients in 2013 (74.4%). Implementation of hygiene measures and the introduced usage of vancomycin in therapy curbed the number of isolated MRSA to 44.4% in 2017.

Conclusion: Early identification of MRSA is essential for further therapeutic treatment and the control of rapid expansion of this pathogen.

Key words: Antibiotic resistance, henan, hospital, methicillin-resistant *Staphylococcus aureus,* staphylococci

INTRODUCTION

An alarmingly high and increasing prevalence of antibiotic-resistant bacteria, particularly staphylococci bacteria, in hospitals, communities, and the environment globally poses a serious threat to public health. *Staphylococcus aureus* (*S. aureus*) infections have become increasing common in hospitals and communities which can cause skin infections, pneumonia, food poisoning, toxic shock syndrome, and bacteremia. *S. aureus* isolates found in intensive care units, and blood cultures worldwide were found to be resistant to many antimicrobials,[1] which resulted in a decrease in the effectiveness to treat life-threatening infections using antibiotics. Coagulase-negative staphylococci, such as *S. aureus,* are opportunistic pathogens which have emerged as a major cause of nosocomial infections often associated with the use of medical devices.[2] Importantly, the presence of hospital-acquired methicillin-resistant *S. aureus* (MRSA) poses a serious problem in the health-care setting. An Asian Network for Surveillance of Resistant Pathogens study reported a high prevalence of drug-resistant staphylococci, particularly MRSA, in several hospitals in the Asian region, including China.[3] The presence of MRSA in hospitals in the central region of China has been reported.[4,5] There has been no documented study investigating, in detail, the presence of multidrug-resistant staphylococci, let alone MRSA, for in-hospital patients inside a major hospital in the Henan province of Central China.

MATERIALS AND METHODS

This study was undertaken and was carried out from January 2013 to December 2017 and approved by the Hospital Ethics Committee that waived the need for informed consent. Bacteria were isolated from hospital patient bodily fluids and sites including, peripheral blood, phlegm, urine, ear surface swabs, and deep tissue biopsy samples through the hospitals' standard operating procedures for patients. Patient samples were taken irrespective of their age, sex, and medical condition. These samples were routinely collected from patients who had a suspected infection during their stay in the hospital. Samples were cultured directly onto blood agar plates (Antu, China) and incubated over 3–4 days at 35°C. Bacterial colonies were isolated from blood agar plates and prepared in BD Phoenix™ AST broth (BD, Franklin Lakes, NJ) before placing inoculum in a BD Phoenix™ NID panel (BD, Franklin Lakes, NJ). Samples were then analyzed on a BD Phoenix™ 100 (BD, Franklin Lakes, NJ) automated identification and susceptibility testing system for staphylococci identification and antimicrobial susceptibility and minimum inhibitory concentration (MIC) testing as per manufacturers' protocol. Staphylococci sensitivity were tested against 24 antimicrobials including, vancomycin, linezolid, quinupristin, oxacillin, amoxicillin, ampicillin, erythromycin, ciprofloxacin, clindamycin, rifampicin, chloramphenicol, gentamicin, tetracycline, levofloxacin, azithromycin, trimethoprim/sulfamethoxazole, doxycycline, teicoplanin, tobramycin, cefoxitin, and moxifloxacin.

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Table 1: Number of isolated staphylococci species and percentage MRSA detected from in-hospital patients at a major hospital in the Henan province

Staphylococci species	Period (year)				2017
	2013	2014	2015	2016	
S. aureus	321	141	133	127	65
S. epidermidis	28	14	16	18	22
S. lugdunensis	-	1	1	2	
S. haemolyticus	15	10	10	7	11
S. saprophyticus	-	5	1	4	
S. warneri	-			1	
S. capitis	-		2		
S. caprae	-				1
S. chromogenes			1	1	
S. felis		1		1	
S. hyicus				1	1
S. gallinarum				1	
S. hominis			3		
S. intermedius			1	1	1
S. lentus			1	1	
S. schleiferi				1	
S. sciuri		1			
Total staphylococci isolated	364	173	169	166	101
No. of MRSA/no. total *S. aureus* isolates (%)	239/321 (74.4%)	81/141 (57.4%)	85/133 (63.9%)	67/127 (52.8%)	45/101 (44.4%)

S. aureus: Staphylococcus aureus, S. epidermidis: Staphylococcus epidermidis, S. lugdunensis: Staphylococcus lugdunensis, S. haemolyticus: Staphylococcus haemolyticus, S. saprophyticus: Staphylococcus saprophyticus, S. warneri: Staphylococcus warneri, S. capitis: Staphylococcus capitis, S. caprae: Staphylococcus caprae, S. chromogenes: Staphylococcus chromogenes, S. felis: Staphylococcus felis, S. hyicus: Staphylococcus hyicus, S. gallinarum: Staphylococcus gallinarum, S. hominis: Staphylococcus hominis, S. intermedius: Staphylococcus intermedius, S. lentus: Staphylococcus lentus, S. schleiferi: Staphylococcus schleiferi, S. sciuri: Staphylococcus sciuri, MRSA: Methicillin resistant *Staphylococcus aureus*

The presence of MRSA was further confirmed using a Kirby–Bauer disk diffusion method by determining the MIC to oxacillin (CLSI, >2 μg/ml) and ciprofloxacin (CLSI, >8 μg/ml).

RESULTS AND DISCUSSIONS

The presence of MRSA is common in hospitals in the Asian region (>50%) with a 25–50% prevalence in Chinese hospitals.[6] For the first time, we report the alarming presence of MRSA in a major hospital in the Henan province. A total of 872 staphylococcal isolates belonging to 17 species from in-hospital patient samples were identified [Table 1]. The most common staphylococci species detected was *S. aureus* (>75% of total Staphylococci identified), followed by *Staphylococcus epidermidis* (<10% of total staphylococci identified) [Table 1]. Notably, MRSA was isolated from an alarming 74.4% of *S. aureus* isolates in 2013 [Table 1], higher than the national average. However, the prevalence of MRSA dropped markedly to 44.4% in 2017 when compared to the prevalence in 2013 [Table 1]. A high average MRSA drug-resistant rate to gentamicin (63.66% ± 18.49, standard deviation [SD]), clindamycin (69.04% ± 9.83, SD), ciprofloxacin (57.4% ± 21.32, SD), and tetracycline (55.58% ± 16.84, SD) over the 5-year period was observed [Table 2]. This first hospital-wide study on the epidemiology of MRSA in a major urban hospital in the Henan province revealed a high presence of MRSA in hospital patients. Although data suggest that the prevalence of MRSA has decreased gradually over the 5-year period, the overall average prevalence remains quite high (58.58% ± 11.34, SD) [Table 2]. The remaining staphylococci species identified included *Staphylococcus lugdunensis* (*n* = 4), *Staphylococcus haemolyticus* (*n* = 53), *Staphylococcus saprophyticus* (*n* = 10),

Table 2: Comparison of antimicrobial resistant rates in MRSA isolates over a 5-year period in the Henan province

Period (year)	Resistance rate (%)				
	2013	2014	2015	2016	2017
Gentamicin	79.3	70.1	70.8	66.4	31.7
Ciprofloxacin	78.1	68.6	62.3	56	22.2
Clindamycin	84.3	72.8	66.2	61.6	60.3
Erythromycin	79.2	80.2	70.8	66.4	71.4
Rifampicin	59.5	51.5	56.1	44	17.4
Tetracycline	75.6	61.8	60	50.4	30.1
Trimethoprim/sulfamethoxazole	41.2	20.7	21.5	29.6	20.6
Vancomycin	0	0	0	0	0
Teichoplanin	0	0	0	0	0

MRSA: Methicillin-resistant *Staphylococcus aureus*

Staphylococcus warneri (*n* = 1), *Staphylococcus capitis* (*n* = 2), *Staphylococcus caprae* (*n* = 1), *Staphylococcus chromogenes* (*n* = 2), *Staphylococcus felis* (*n* = 2), *Staphylococcus hyicus* (*n* = 2), *Staphylococcus gallinarum* (*n* = 1), *Staphylococcus hominis* (*n* = 3), *Staphylococcus intermedius* (*n* = 3), *Staphylococcus lentus* (*n* = 2), *Staphylococcus schleiferi* (*n* = 1), and *Staphylococcus sciuri* (*n* = 1). Our findings highlight the complexity of the number of staphylococci species found in the hospital setting, although *S. aureus* was the most common. Vancomycin has been used as the drug of choice in the treatment of established MRSA infections for many years. However, the extensive use of vancomycin to treat MRSA infections over the years has resulted in the emergence vancomycin-intermediate and vancomycin-resistant *S. aureus* strains and is of growing concern worldwide.[7] No vancomycin-

resistant *S. aureus* was detected over the 5-year period despite the fact that vancomycin treatment regime was adopted post-2013 in the hospital, which contributed to the gradual decrease in MRSA over the 5-year period [Table 2]. However, critical measures have to be taken to the hospital to strictly control the usage of vancomycin.

We were unable to determine whether MRSA detected was either hospital-acquired -MRSA or community-acquired-MRSA. MRSA as staphylococcal chromosomal cassette *mec* (SCC*mec*) typing was not done. Located on the SCC*mec* mobile genetic element, methicillin resistance is commonly associated with the carriage of the *mecA* gene, which encodes penicillin-binding protein PBP2a.[8] Therefore, we were unable to determine the spread of MRSA between the hospital and community as well as the potential spread of clones between these environments based on the molecular characteristics of MRSA isolates. Given the widespread endemicity of MRSA infections in this hospital, continuous efforts to understand the changing epidemiology of *S. aureus* infection are necessary for appropriate antimicrobial treatment and effective control of resistance problems. Furthermore, these findings indicate the need for identifying the factors contributing to the high presence of MRSA in this hospital.

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