Original Paper

ANTIMICROBIAL SUSCEPTIBILITY PATTERNS OF β-LACTAMASE PRODUCING STAPHYLOCOCCUS AUREUS

Kawsar NM [1], Mondal MEA[2], Khan NK[3], Jubaida N[4], Chowdhury JP[5], Khan L[6]

Abstract

The prevalence of β-lactamase producing *Staphylococcus aureus* infections and their antimicrobial susceptibility pattern are reported in this study. Fifty Staphylococci isolates obtained from different clinical specimens were studied. Among 50 isolates, 42 (84%) were *S. aureus*. Out of total 42 strains of *S. aureus* 36 (85.7%) were found to be β-lactamase producer. Two (4.8%) strains were found to be methicillin resistant *S. aureus* (MRSA). The present study shows that highest antimicrobial resistance of β-lactamase producing *S. aureus* were against penicillin and ampicillin (100%) followed by trimethoprim/sulphamethoxazole (36.1%), erythromycin and gentamicin (22.2%), cephalexin and ciprofloxacin (19.4%), ceftriaxone (11.1%). Multi-drug resistant *S. aureus* was 26.2% (11 of 42 isolates). To reduce the prevalence of multi-drug resistant *S. aureus*, regular surveillance of hospital associated infections, monitoring of antimicrobial sensitivity pattern and formulation of definite antibiotic policy may be helpful.

Key Words

***Staphylococcus aureus*, β-lactamase, Antimicrobial resistance.**

Introduction

S. aureus is an important pathogen in human infections and is implicated in a wide variety of infections, from mild skin infections to more serious and invasive infections, including septicaemia, pneumonia, endocarditis, deep-seated abscesses and toxicoses including food poisoning and toxic shock syndrome[1,2]. The discovery of antimicrobial agents has been a critical element of the therapeutic armamentarium of modern medicine, but the treatment of infections caused by *S. aureus* is still a challenge for clinicians[3,4]. The term MRSA refers to Methicillin resistant *S. aureus*. Methicillin resistance is widespread and most methicillin resistant strains are also multiply resistant[5]. MRSA strains were initially described in 1961 and have emerged, in the last decade, as one of the most important nosocomial pathogens[6]. The risk factors, which contribute to MRSA, are excessive antibiotic usage, prolonged hospitalization specially in intensive care units and intravascular catheterization[7]. Most strains of MRSA exhibit resistance to both quinolones and aminoglycosides[8].

β-lactamase (also known as penicillinase) is an enzyme that cleaves the β-lactam ring and inactivates the antibiotic. Therefore, empiric therapy for suspected staphylococcal infections should always include a β-lactamase stable antibiotic. To overcome bacterial resistance, some drugs combine a β-lactam antibiotic and a β-lactamase inhibitor, thus creating a stable, new compound with good activity against Staphylococci[9]. The ability to characterize *S. aureus* and monitor antimicrobial susceptibility patterns is important for clinicians selecting empiric antimicrobial therapy, rational formulation of public health care policies, and providing useful information on the global surveillance of this pathogen. This study is designed to find out the antimicrobial susceptibility patterns of β-lactamase producing *S. aureus* isolates obtained from various clinical samples.

Materials and Methods

This study was carried out at the department of Microbiology, Armed Forces Institute of Pathology, Dhaka Cantonment from January to March 2006. Fifty Staphylococci isolates obtained from different clinical specimens were studied for β-lactamase production and antimicrobial sensitivity pattern. Identification of the organism was based on growth in blood agar media, colonial morphology, Gram stain and positive results for catalase, coagulase and β-lactamase. Coagulase positive Staphylococci were considered as *S. aureus*. β-lactamase production was assessed by chromogenic cephalosporin method[10].

Antibiotic susceptibility testing was performed using the disc diffusion method. The antibiotics (OXOID limited, England) included penicillin (10 units), ampicillin (10 μg), erythromycin (15μg), trimethoprim/ sulphamethoxazole (25 μg), ciprofloxacin (5 μg), cephalexin (30 μg), ceftriaxone (30 μg), chloramphenicol (30 μg), vancomycin (30 μg), clindamycin (2 μg). *S. aureus* ATCC 25923 was used as a standard control

1.Major Narjis Maliha Kawsar, MBBS, DCP, FCPS (Microbiology), Asst Prof of Microbiology,AFMC. 2.Brigadier General Md Eunus Ali Mondal MBBS, FCPS (Microbiology), Prof & Head, Dept of Microbiology, AFMC, 3.Dr Nizamul Karim Khan, MBBS, DEM, Asst Prof of Endocrinology, Mymensingh Medical College. 4.Maj Nishat Jubaida, MBBS, DCP, FCPS (Microbiology), Pathologist, BANMED-5, UNMIL. 5.Major Jamal Pasha Chowdhury, MBBS, MCPS, DCP, FCPS (Microbiology), Graded Specialist in Pathology, 51 Field Ambulance, Jalalabad Cantonment, Sylhet. 6.Maj Lutfunnahar Khan, MBBS, MCPS, DCP, Asst Prof of Pathology,AFMC.

strain. The isolates were considered sensitive, intermediately resistant and resistant based on the National Committee for Clinical Laboratory Standards (NCCLS; now The Clinical and Laboratory Standards Institute [CLSI] guidelines[11]. Multi-drug resistance was defined as resistance to penicillin along with at least 3 classes of antibiotics[12].

Results

Maximum 18 (36%) isolates of *S. aureus* were from sample of pus followed by 9 (18%) from urine. Coagulase positivity pattern of Staphylococci species from different clinical specimens is shown in the Table - I. Out of 50 isolates of Staphylococci 42 (84%) were *S. aureus*.

Table - I: Coagulase positivity pattern of Staphylococci species from different clinical specimens

Clinical specimens	Number of specimens	Coagulase positive	Coagulase negative
Pus	18(36)	18	0
Wound swab	4(06)	2	2
Urine	9(18)	9	0
Conjunctival swab	3(6)	3	0
Umbilical swab	8(16)	5	3
Nasal swab	3(6)	1	2
Throat swab	1(2)	1	0
Pleural fluid	1(2)	1	0
Semen	1(2)	1	0
Prostatic secretion	2(4)	1	1
Total	50(100)	42(84)	8(16)

Figures in the parentheses indicate percentage

All the *S. aureus* isolates were studied for β-lactamase production and sensitivity pattern against various antibiotics. Among 42 *S. aureus* isolates, 36 (85.7%) were β-lactamase producer (Table-II).

The antimicrobial susceptibility pattern of *S. aureus* is shown in the Table - III. Hundred percent isolates of *S. aureus* were sensitive to vancomycin and clindamycin and 90.5% to ceftriaxone. Only 9.5% strains were sensitive to penicillin and ampicillin.

Of the 42 *S. aureus* isolates, 02 (5%) were found to be MRSA. The MRSA isolates were resistant to penicillin, ampicillin, cephalosporin, ceftriaxone, gentamicin, erythromycin, trimethoprim/sulphamethoxazole and ciprofloxacin; but susceptible to vancomycin and clindamycin. All of the isolates of β-lactamase producing *S. aureus* were resistant to penicillin and ampicillin, 36.1% isolates were resistant to trimethoprim/ sulphamethoxazole, 22.2% to gentamicin and erythromycin, 19.4% to ciprofloxacin and cephalexin, 11.1% to ceftriaxone and 5.6% to methicillin. However

Table - II: Distribution of b-lactamase producing *S. aureus* from different clinical specimens (n = 42)

Specimens	Number of specimens	β lactamase positive	β lactamase negative
Pus*	18	16(44.4)	2(33.3)
Wound swab	2	1(2.8)	1(16.7)
Urine	9	9(25.0)	0
Conjunctival swab	3	2(5.6)	1(16.7)
Umbilical swab*	5	5(13.9)	0
Nasal swab	1	1(2.8)	0
Throat swab	1	0	1(16.7)
Pleural fluid	1	0	1(16.7)
Semen	1	1(2.8)	0
Prostatic secretion	1	1(2.8)	1
Total	42 (100)	36 (85.7)	6 (14.3)

Figures in the parentheses indicate percentage
*One isolate of each was MRSA

Table - III: Antimicrobial susceptibility pattern of *S. aureus* (n = 42)

Antibiotics	Sensitive		Resistence	
	Number of isolates	Percentage	Number of isolates	Percentage
Penicillin	4	9.5	38	90.5
Ampicillin	4	9.5	38	90.5
Cephalexin	35	83.3	7	16.7
Ceftriaxone	38	90.5	4	9.5
Gentamicin	34	81.0	8	19.0
Trimethoprim/ sulphamethoxazole	27	64.3	15	35.7
Ciprofloxcin	35	83.3	7	16.7
Erythromycin	34	81.0	8	19.0
Chloramphenicol *	3	100	0	0
Methicillin	40	95.2	2	4.8
Vancomycin	42	100	0	0
Clindamycin	42	100	0	0

* Chloramphenicol was used only in 03 conjunctival swab isolates

Table - IV: Resistance pattern of *S. aureus* strains to different antimicrobials

Antibiotics	Number of isolates	
	β lactamase producer (n = 36)	β lactamase non producer (n =06)
Penicillin	36 (100)	2 (33.3)
Ampicillin	36 (100)	2 (33.3)
Cephalexin	7 (19.4)	0
Ceftriaxone	4 (11.1)	0
Gentamicin	8 (22.2)	0
Trimethoprim/ sulphamethoxazole	13 (36.1)	2 (33.3)
Ciprofloxcin	7 (19.4)	0
Erythromycin	8 (22.2)	0
Chloramphenicol	0	0
Methicillin	2 (5.6)	0
Vancomycin	0	0
Clindamycin	0	0

Figures in the parentheses indicate percentage

this study found no resistance to vancomycin and clindamycin. All the isolates of β-lactamase non producing *S. aureus* were sensitive to cephalexin, ceftriaxone, gentamicin, ciprofloxacin, erythromycin, methicillin, vancomycin and clindamycin; while 33.3% were resistant to penicillin, ampicillin and trimethoprim/sulphamethoxazole [Table - IV]. Among the *S. aureus* isolates 11 (26.2%) were multi-drug resistant.

Discussion

Antimicrobial resistance among nosocomial pathogens is a significant problem in clinical settings that adds to the cost of medical care and the morbidity and mortality of patients[13]. The adaptation of *S. aureus* to the modern hospital environment has been marked by the acquisition of drug resistance genes soon after antibiotic introduction[14]. β-lactamase production is a very important cause of antimicrobial resistance in bacteria. The present study shows that highest resistance of β-lactamase producing *S. aureus* was against penicillin and ampicillin (100%) followed by trimethoprim/sulfamethoxazole (36.1%). This correlates with an earlier study by Sharma in India[15]. Resistance to trimethoprim/sulphamethoxazole was found to be high 35.7% (36.1% in β-lactamase positive, 33.3% in β-lactamase negative) in the present study. This correlates with the Tahnkiwale's report which showed higher resistance (55.67%) to trimethoprim/sulphamethoxazole[16]. In this study gentamicin resistance was observed in 22.2%. Pulimood had observed only 8% resistance of MRSA to gentamicin[17], while Rajaduraipandi had reported 63.6% resistance[18]. An increase of gentamicin resistance from 0% before 1996 to 80% after 1996 has been reported[19]. Qureshi had repoted a gentamicin resistance of 97.8%[20], which is higher compared to our study. Vancomycin and clindamycin seem to be the only antimicrobial agents which show 100% sensitivity even with multi-drug resistance. This correlates with an earlier study[21]. Kawsar also observed the similar findings[22].

Conclusion

The degree of resistance or sensitivity of β-lactamase producing *S. aureus* towards commonly used antibiotics is recognized to be diverse from region to region. Vancomycin and clindamycin are the only antibiotics found to give uniform sensitivity (100%). When antimicrobials including vancomycin are considered for treatment, choice inevitably requires the need for in vitro susceptibility testing of every isolates. In rare instances, some strains of *S. aureus* hyperproduce β-lactamase, thereby exhibiting a sensitivity pattern similar to MRSA. Further studies with large sample size will help to establish the incidence of β-lactamase producing *S. aureus* and MRSA and their antimicrobial sensitivity pattern.

Continuous surveillance on antimicrobial susceptibility of *S. aureus* is essential for the detection of emerging trends and the development of appropriate therapeutic strategies. The determination of prevalence and antibiotic sensitivity pattern will help the treating clinicians for first line treatment in referral hospitals. Antibiotic choice should be governed by the organism, expect to find in a given situation. Change or continue the antibiotic based on culture results as soon as possible and avoid prolonged empiric therapy. When sensitivities are known, choose the narrowest spectrum agent with the highest efficacy and the lowest toxicity.

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