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Antibacterial Susceptibility Profile of *Staphylococcus aureus* in a Private Hospital, India

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ABSTRACT

Staphylococcus aureus has been recognised as a major human pathogen and rates of methicillin resistant strains (MRSA) exceeds 20% worldwide. High MRSA proportions imply increased risk for patients. The present study focuses on the trends of antibacterial susceptibility and resistance among clinically isolated *Staphylococcus aureus* in a private hospital. Susceptibility and resistance data of *Staphylococcus aureus* were collected and analysed from the hospital's microbiology department over a period of three years (calendar year 2012, 2013 and 2014) prospectively. The prevalence of Methicillin-Resistant *staphylococcus aureus* has increased substantially from 22% in 2012 to more than 50% in 2014. The susceptibility of isolates of SA to ampicillin and penicillin remains at a very low level, showing a high degree of resistance. Susceptibility of SA has decreased substantially to oxacillin, ciprofloxacin and cotrimoxazole while the profile remains almost horizontal for erythromycin and clindamycin. The bacteria remain susceptible to high degree to vancomycin, linezolid, teicoplanin, daptomycin, tetracycline, tigecycline, and rifampicin.

INTRODUCTION

Staphylococcus aureus has been recognised as a major human pathogen since 1880s when it was identified as the major cause of wound suppuration[1]. World Health Organization (WHO) lists *S. aureus* as one of the three agents of greatest concern associated with both hospital and community acquired infections. Methicillin-Resistant *S. aureus* (MRSA) rates exceed 20% in all WHO regions and are above 80% in some regions[2]. *S. aureus* resistant to methicillin was reported soon after the introduction of methicillin in 1960[3].

Methicillin-Resistant *Staphylococcus aureus* (MRSA) is now a common pathogen responsible for skin, soft tissue infections, severe bloodstream infections and pneumonia. It is also the most common cause of post-operative wound infections[4]. Antibiotic resistant MRSA are increasing in prevalence worldwide resulting in infections that are difficult and expensive to treat[5]. High MRSA proportions imply increased risk for patients and a need for second – line more toxic drug treatment.

MRSA is endemic in India and the incidences of MRSA are reported to be varying from 25% in western part of the country to 50% in southern part[6-7]. Community-acquired MRSA is also increasingly reported in India[8].

Due to emergence of resistance in many organisms, bacterial susceptibility testing is extremely useful in determining the antimicrobial agents that could potentially be used for the patient's infection. Bacteria that are categorised as 'susceptible' to a given antibiotic will most likely to be eradicated during treatment of infection using standard doses of the antibiotic. Organisms that are 'resistant' to an antibiotic, a poor clinical response is expected even if maximal doses are utilized[9].

The present study focuses on the trends of antibacterial susceptibility and resistance among clinically isolated *Staphylococcus aureus.* The data of which may be helpful in rational prescribing.

MATERIALS AND METHODS

Susceptibility and resistance data of *Staphylococcus aureus* were collected from the hospital's microbiology department over a period of three years (calendar year 2012, 2013 and 2014) prospectively in a designed data collection form. The data collected include patient's source (ward or ICU), specimen of the isolate, antibacterial susceptibility and resistance profile.

S. aureus was identified from the sample on the basis of colony and microscopic morphology. The antibacterial susceptibility testing was performed by Vitek-2 automated system and manually confirmed with Disc – Diffusion Method (Kirby-Bauer) [10], by using Oxacillin (1 mcg), Cefoxitin (30 mcg) and Methicillin (5 mcg) for MRSA. In addition, ampicillin, penicillin, gentamycin, ciprofloxacin, moxifloxacin, levofloxacin, erythromycin, clindamycin, vancomycin, linezolid, teicoplanin, daptomycin, tetracycline, tigecycline, rifampicin and cotrimoxazole were tested. The antibacterial agents were obtained from BIO-RAD. The culture media used were Blood Agar, Coagulase Mannitol Agar Base and Hi Chrome MeReSa Agar base obtained from Hi media. The inoculum was prepared at turbidity equivalent to 0.52 to 0.65 McFarland turbidity gradients in Saline for Vitek 2 and in Peptone water for disc diffusion methods. *S. aureus* ATCC 29213 was used for positive control.

RESULTS

Specimen wise distribution of *Staphylococcus aureus* is given in Table – 1. Prevalence of *Staphylococcus aureus* among the positive cultures is found to be 14%, 15% and 9% in 2012, 2013 and 2014 respectively.

Specimen wise distribution of *Staphylococcus aureus* (Table - 1)

Specimen		2012		2013		2014	
		Total Number of samples with positive culture	Number of SA	Total Number of samples with positive culture	Number of SA	Total Number of samples with positive culture	Number of SA
Urine	Ward	1247	34	1332	30	336	------
	ICU	190	--------	249	------	105	1
Pus/EENT Swabs/Stool/BF	Ward	614	245	574	247	237	58
	ICU	117	10	110	33	45	6
Respiratory	Ward	224	23	301	32	106	7
	ICU	300	37	420	50	205	21
Blood	Ward	301	72	238	77	90	9
	ICU	191	27	175	38	77	5
Total no. of SA		448		507		107	

The prevalence of Methicillin-Resistant *Staphylococcus aureus* has increased substantially from 22% in 2012 to more than 50% in 2014 is given in Table-2. This is a cause of serious concern as the treatment would be more difficult requiring more expensive antibiotics.

Distribution of *S. aureus* and MRSA (Table -2)

	2012		2013		2014	
	Total SA	MRSA (%)	Total SA	MRSA (%)	Total SA	MRSA (%)
Ward	374	26	386	18	74	37.8
ICU	74	18	111	31	33	63.6
Total	448	22	507	24.5	107	50.7

The susceptibility profile (in terms of % of isolates) of *Staphylococcus aureus* over three year period is given in Table – 3. The susceptibility of isolates of SA to ampicillin and penicillin remains at very low level, showing a high degree of resistance. Susceptibility of SA has decreased substantially to oxacillin, ciprofloxacin and cotrimoxazole while the profile remains almost horizontal for erythromycin and clindamycin. The bacteria remain susceptible to high degree to vancomycin, linezolid, teicoplanin, daptomycin, tetracycline, tigecycline, and rifampicin. Susceptibility towards individual antibiotic is given in the figure which is self-explanatory.

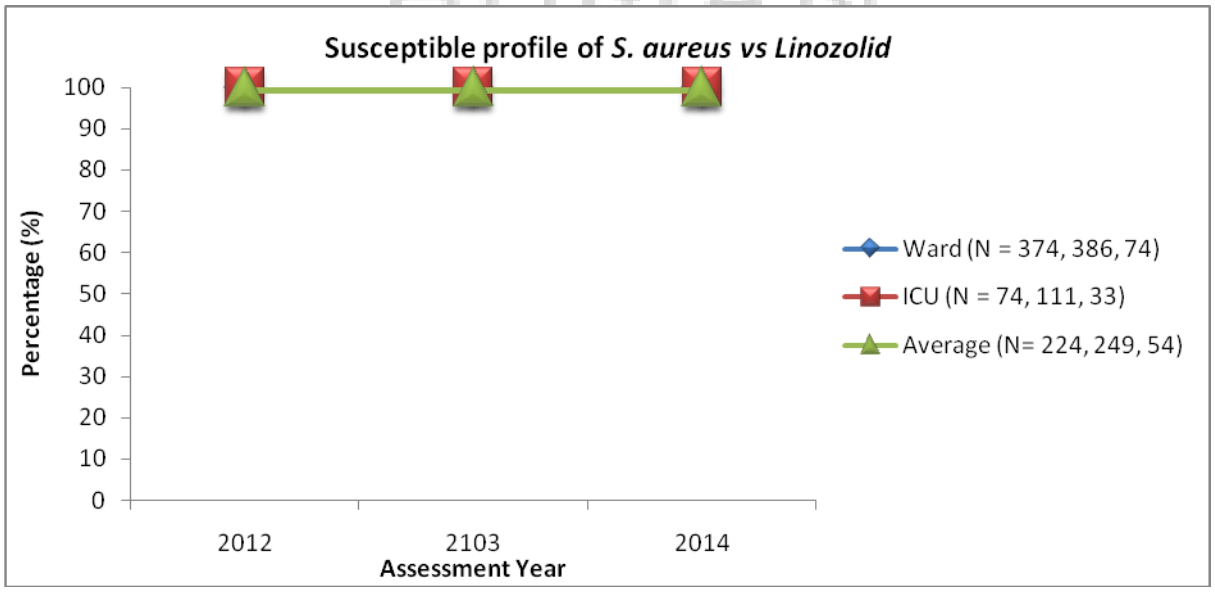
Susceptible profile (in %) of *S. aureus* (Table – 3)

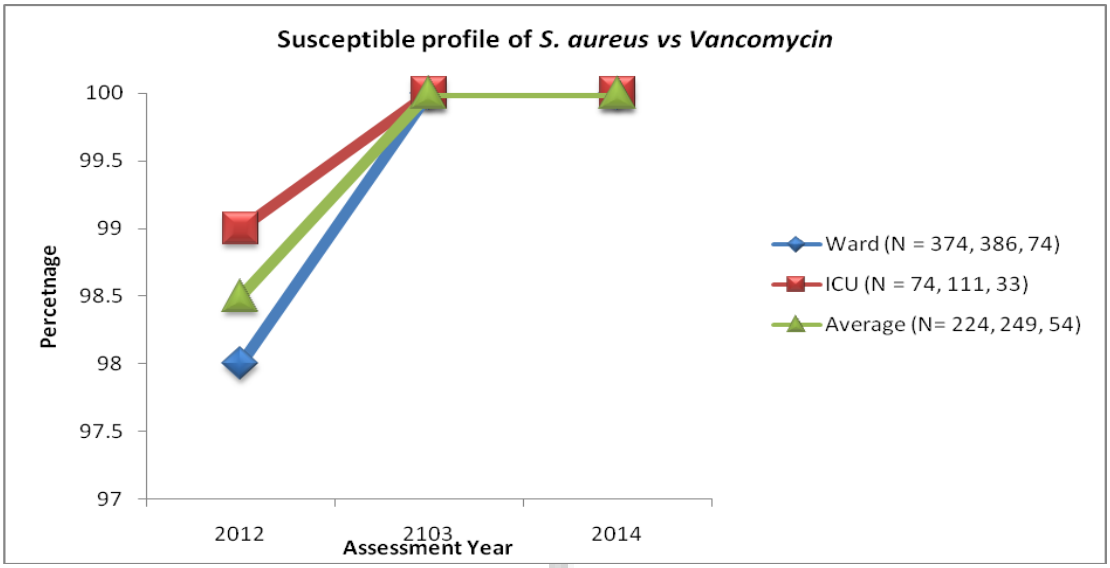
Year / Antibacterial	2012			2013			2014		
	Ward (N = 374)	ICU (N = 74)	Average	Ward (N = 386)	ICU (N =111)	Average	Ward (N=74)	ICU (N = 33)	Average
Ampicillin	15	5	10	21	4	12.5	11	3	7
Penicillin	14	3	8.5	21	4	12.5	11	3	7
Oxacillin	74	82	78	62	42	52	61	36	48.5
Gentamycin	55	63	59	64	52	58	72	69	70.5
Ciprofloxacin	28	38	33	29	29	29	22	18	20
Moxifloxacin	74	65		---------	---------	--------	---------	------	-------
Levofloxacin	----------	---------		------	---------	--------	24	18	21
Erythromycin	60	60	60	55	48	51.5	54	57	50.5
Clindamycin	86	68	77	72	65	68.5	69	75	72
Vancomycin	98	99	98.5	100	100	100	100	100	100
Linezolid	100	100	100	100	100	100	100	100	100
Teicoplanin	----------	---------	--------	100	100	100	99	97	98
Daptomycin	----------	---------	--------	--------	---------	--------	94	90	92
Tetracycline	----------	--------	-----	--------	--------	--------	93	97	95
Tigecycline	----------	---------	---------	---------	---------	-------	94	97	95.5
Rifampicin	---------	--------	--------	--------	---------	---------	96	97	96.5
Cotrimoxazole	48	67	57.5	19	10	14.5	3	0	1.5

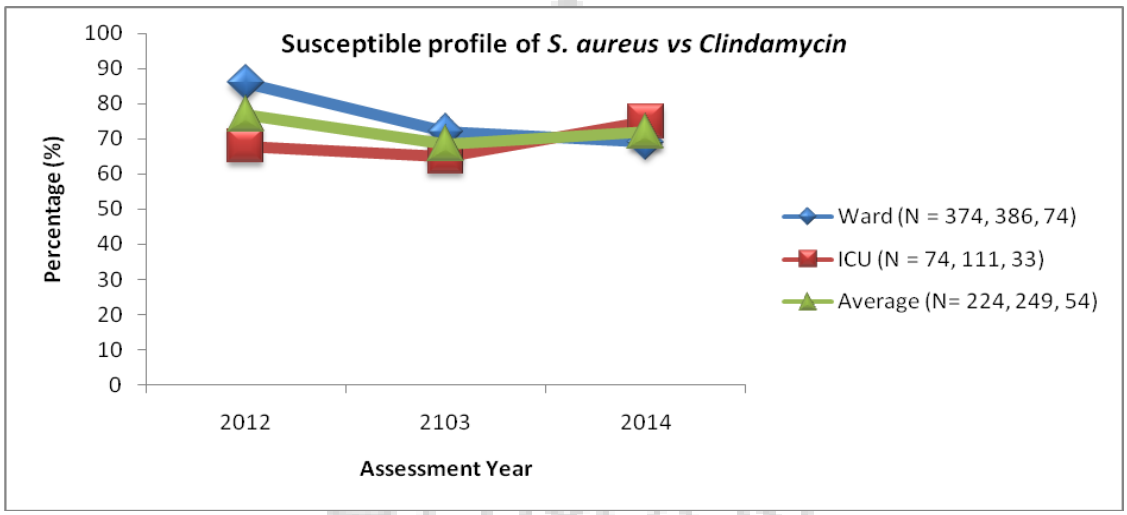
DISCUSSION

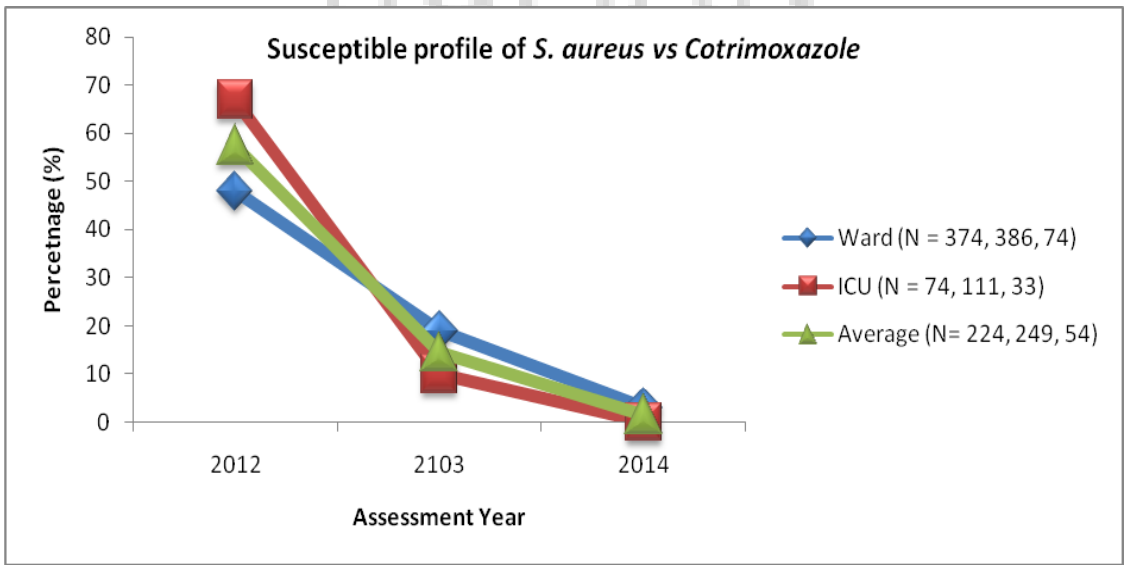
Staphylococcus aureus is known to cause skin, soft tissue, bone and bloodstream infections besides the most common cause of post-operative wound infections. In the beginning, bacteria were sensitive to penicillin but the resistance to penicillin started emerging in 1940s. The resistance was mediated by the production of beta-lactamase enzyme that inactivates the drugs like penicillin, ampicillin and amoxicillin. Consequently, beta-lactamase stable drugs like methicillin and cloxacillin were introduced to treat infections of *Staphylococcus aureus* but the strains of *Staphylococcus aureus* have acquired a novel gene (mecA) that made these antibacterials ineffective. Such strains are known as Methicillin-Resistant *Staphylococcus aureus* (MRSA). Though MRSA was initially the problems of hospital-acquired infections, now even they are isolated in communities.

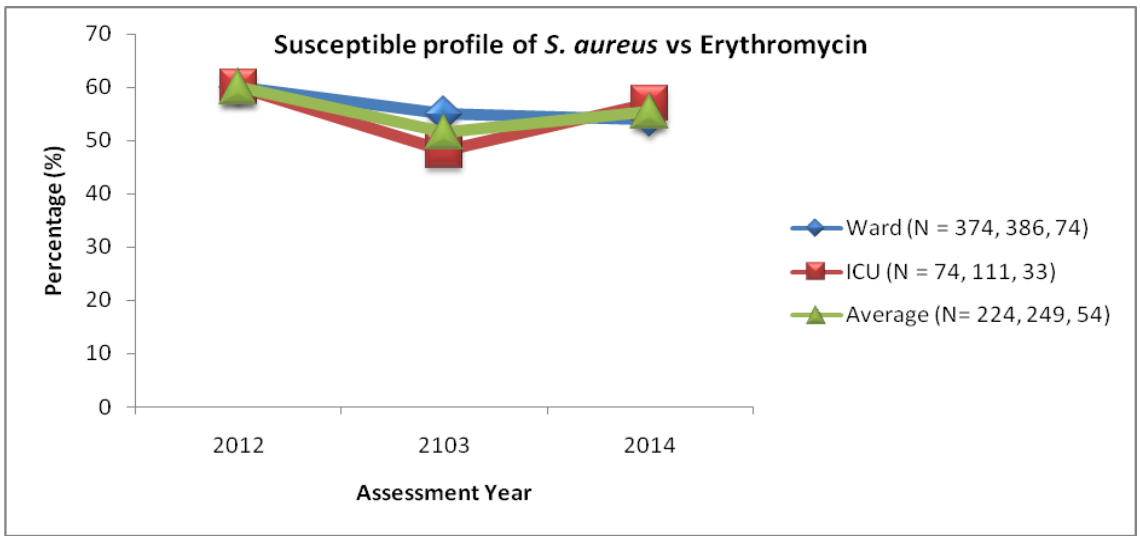
Three years data show the increasing incidences of MRSA confirming more than 50% *Staphylococcus aureus* isolates are MRSA. The similar trend was reported earlier[6]. Though oxacillin was effective in about 78% of isolates in 2012, its effectiveness has come down to less than 50% precisely to 48.5% in 2014. The isolate *Staphylococcus aureus* remains susceptible at high level to vancomycin and linezolid. But both of them are expensive and associated with many adverse effects. The susceptibility of the isolates of *Staphylococcus aureus* towards ciprofloxacin is low: varied from 33% at 2012 to 20% at 2014 while erythromycin and clindamycin are found to be effective against more than 60% isolates.

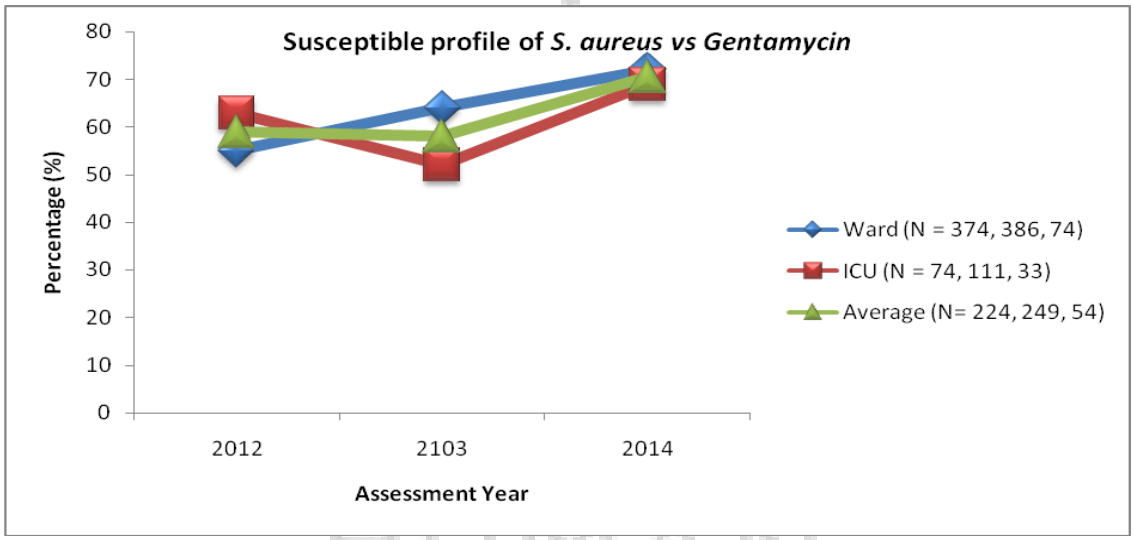


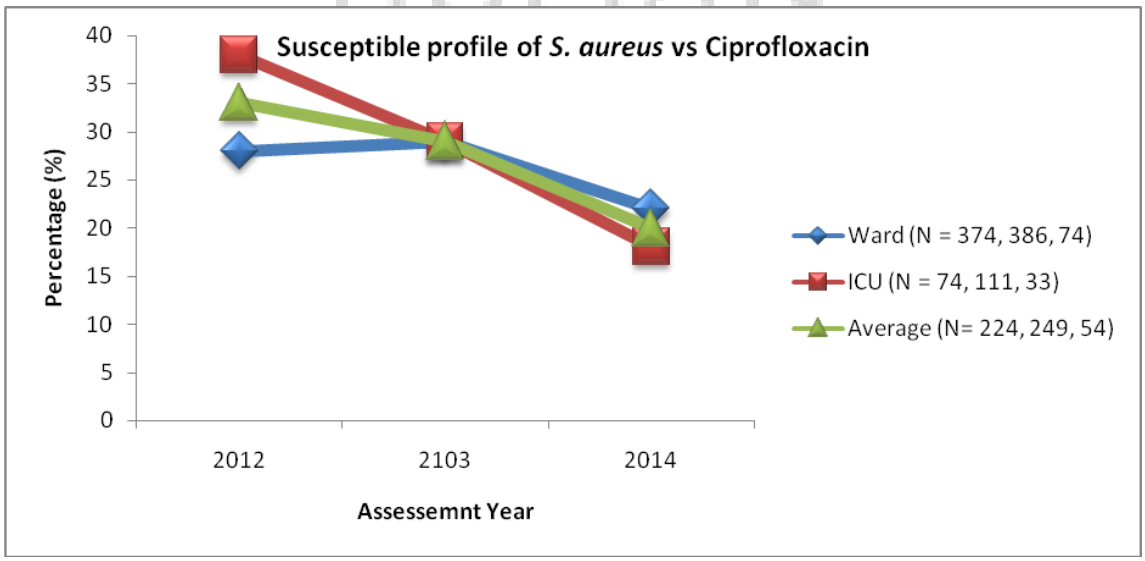

Susceptible profile of S. aureus vs Vancomycin
Percetnage
100
99.5
99
98.5
98
97.5
97
2012
2103
2014
Assessment Year
Ward (N = 374, 386, 74)
ICU (N = 74, 111, 33)
Average (N= 224, 249, 54)

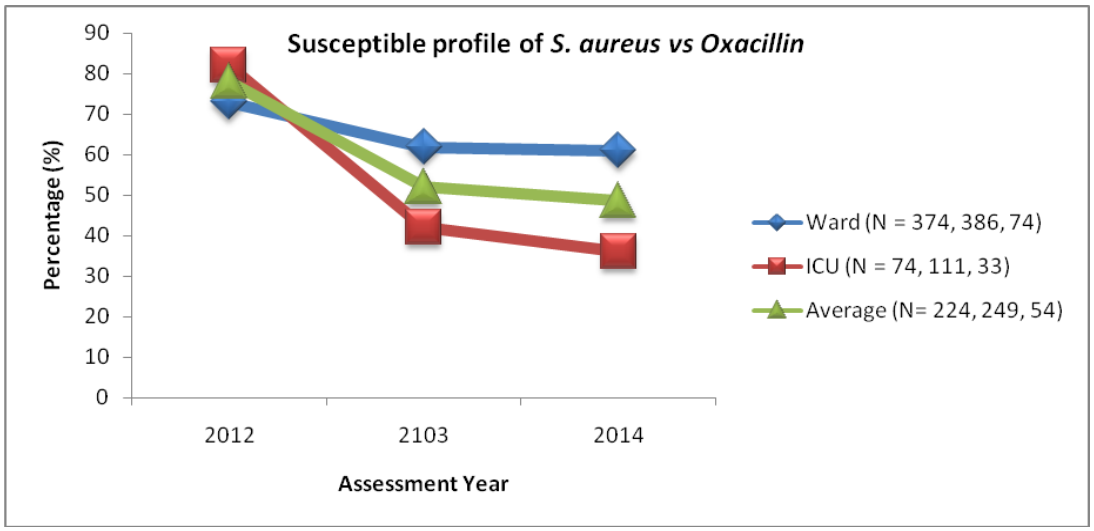

Susceptible profile of S. aureus vs Clindamycin
Percentage (%)
100
90
80
70
60
50
40
30
20
10
0
2012
2103
2014
Assessment Year
Ward (N = 374, 386, 74)
ICU (N = 74, 111, 33)
Average (N= 224, 249, 54)

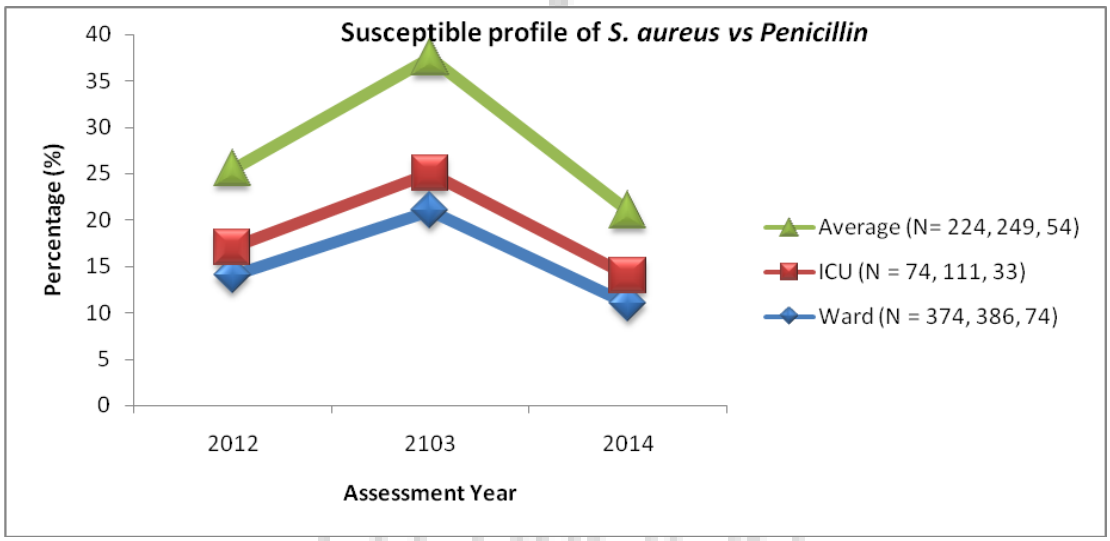

Susceptible profile of S. aureus vs Cotrimoxazole
Percetnage (%)
80
70
60
50
40
30
20
10
0
2012
2103
2014
Assessment Year
Ward (N = 374, 386, 74)
ICU (N = 74, 111, 33)
Average (N= 224, 249, 54)

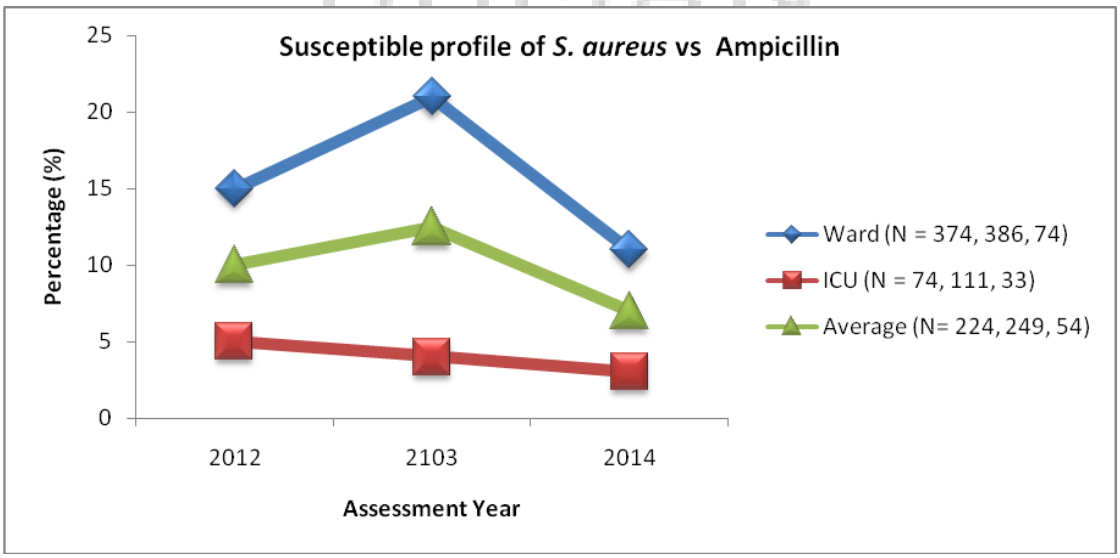

Susceptible profile of S. aureus vs Erythromycin
Percentage (%)
70
60
50
40
30
20
10
0
2012
2103
2014
Assessment Year
Ward (N = 374, 386, 74)
ICU (N = 74, 111, 33)
Average (N= 224, 249, 54)


Susceptible profile of S. aureus vs Gentamycin
Percentage (%)
80
70
60
50
40
30
20
10
0
2012
2103
2014
Assessment Year
Ward (N = 374, 386, 74)
ICU (N = 74, 111, 33)
Average (N= 224, 249, 54)


Susceptible profile of S. aureus vs Ciprofloxacin
Percentage (%)
40
35
30
25
20
15
10
5
0
2012
2103
2014
Assessemnt Year
Ward (N = 374, 386, 74)
ICU (N = 74, 111, 33)
Average (N= 224, 249, 54)


Susceptible profile of S. aureus vs Oxacillin
Percentage (%)
90
80
70
60
50
40
30
20
10
0
2012
2103
2014
Assessment Year
Ward (N = 374, 386, 74)
ICU (N = 74, 111, 33)
Average (N= 224, 249, 54)


Susceptible profile of S. aureus vs Penicillin
Percentage (%)
40
35
30
25
20
15
10
5
0
2012
2103
2014
Assessment Year
Average (N= 224, 249, 54)
ICU (N = 74, 111, 33)
Ward (N = 374, 386, 74)


Susceptible profile of S. aureus vs Ampicillin
Percentage (%)
25
20
15
10
5
0
2012
2103
2014
Assessment Year
Ward (N = 374, 386, 74)
ICU (N = 74, 111, 33)
Average (N= 224, 249, 54)

Though the study was not an active surveillance programme, the susceptibility data obtained through compilation of routine diagnostic activity serves as guide for the hospital and the clinicians to developing policy on empirical therapy in routine medical practice. The pooled data from individual hospitals and diagnostic centres would provide the trend in antimicrobial resistance in that geographical area.

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