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SURVEILLANCE OF METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS (MRSA) AT A GENERAL HOSPITAL IN SAUDI ARABIA

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ABSTRACT

Background: MRSA colonization and infection are widespread worldwide causing significant morbidity and economic impact. MRSA is hard due to their resistance to commonly used antibiotics. Prevention is only hope if patients to be targeted are known. We present results of surveillance to identify at-risks patients and units in a Saudi Arabia hospital in Jeddah. The aim is to detect the range of MRSA spread through hospital wards and units, between the patients their genders and sites and to use the results to recommend effective infection control systems to prevent hospital acquired infections in hospital settings. **Methods:** The subjects consisted of 597 in-patients from different wards between January 2010 and January 2011. A total of 2074 swabs from multi-sites were collected and tested with the BDGO BD GeneOhm using both PCR and conventional chromogenic culture. Smart Cycler® II software was used for amplifying, detecting and interpreting the results. **Results:** There are statistically significant ($p<0.001$) overall MRSA infection prevalence of 25.2%. Units' prevalence ranges from 4.8% (Medical rehabilitation) to 80% (coronary unit). There is statistically significant effects of Age ($p = .04$) and sex ($p=0.05$) on MRSA infection. Two of the swab sites are statistically significant (Nasal swab ($p<0.01$) and Perineum ($p<0.001$). **Conclusions:** From the findings of this study, we conclude that hospital surveillance of MRSA can help to identify not only at-risk patients but can also indicate which units to target activities of control of infection for effective results.

KEYWORDS: MRSA, colonization, infections, spread, nosocomial, hospital settings.

BACKGROUND

Occurrence of antibiotic resistance in microorganisms and their spread is threatening patients care worldwide such examples include MRSA. It appeared in the early 1960s nosocomial pathogen[1] and is defined as any member of Staphylococcus aureus strain found to show resistivity to a number of antibiotics known as beta-lactams, which include the penicillin and the cephalosporins[2] Methicillin-resistance occurs as a result of the mecA gene which encodes a penicillin-binding protein (PBP2A) with decreased affinity for ß-lactam antibiotics and which forms part of the mobile genetic element.[3]

Most incidences of MRSA were found in periodic epidemics initially and by 1970s, wider outbreaks were reported in hospitals from many countries including the USA, Europe, Japan and Australia.[4] Frequently, MRSA is responsible for infections of membranes and soft tissue, respiratory tract, bones and joints, surgical wounds urinary tract and bloodstream.

These contagious are not as easy to deal with due to their resistance to commonly used antibiotics.[5] MRSA is a major pathogen causing bacteremia, pneumonia and skin and soft-tissue infections that result in significant morbidity, mortality and prolonged hospitalization.[6] It has now reached epidemic levels worldwide, including in USA health care.[7] Approximately 25% to 30% of the population is colonized with S. aureus and 0.2% to 7% with MRSA; consequently, health-care facilities not only infected patients, but also colonized patients, represent the most important reservoir.

Nasal MRSA colonisation can serve as a source for transmission and is also considered a risk factor for subsequent infection.[8] Mass media have been attracted to reporting infections of MRSA for a while now. For instance, in 2005, the USA press described MRSA as the "super bug", on the basis that it killed more people than did AIDS.[9]

Nasal colonization with MRSA serves as the most common reservoir for nosocomial transmission and is the

major risk factor for subsequent infection.[10] The increase MRSA occurrence is a major cause of morbidity and mortality in hospitals during the last decade.[11] Knowledge of its occurrence in any environment is very essential due to its public health importance and the threat poses by MRSA infection.[12]

It is not easy to assess the degrees and kinds of MRSA from existing studies because studies are usually carried out during outbreaks which are not the same in endemic situation.[13] Surveillance remains important part of managing, controlling, and total reducing or eradicating MRSA but there is need for greater attention than what is given at the present.

Wide spread of the approach beyond medical institutions responsible for acute and chronic care to include community and patients' homes was suggested.[14] Guidelines on what to do to reduce the spread of MRSA according to the Society for Healthcare Epidemiology of America and the CDC advocate increased MRSA colonization surveillance as a tool for enhanced activity whenever routine infection control practice fails to lower infection rates.[15],[16]

There are limited choice of antimicrobial drugs for dealing with much complicated cases of MRSA infections which can be life threatening at times and can cause undue long stay of affected patients in the hospital and increased cost of care.[17] Importance of getting infections caused by MRSA reduced was emphasized and surveillance was suggested as the key to success in addition to close collaboration between infection control staff, clinicians, patients and laboratory personnel.[18] Hospital surveillance for MRSA is rarely taken serious especially in the developing countries.

We carried out hospital surveillance for the detection of MRSA from swabs from patients hospitalized in various units of a Jeddah General Hospital, Saudi Arabia using, PCR-based methods. The aims are to detect the range of MRSA spread through hospital wards and units; to detect the range of MRSA spread between the patients, their genders and sites of isolation from them; and to use the results in helping to reshape the systems of controlling the nosocomial in the hospital settings.

METHODS

The study was conducted over a period of 24 months, from January 2010 to January 2012 using 959 in-patients admitted to different wards or in an outpatient attending hospital clinics, at the King Fahad General Hospital (KFGH) Jeddah, Kingdom of Saudi Arabia - a 1,442-bed hospital. All subjects were from age 2 years and above. Written informed consents were obtained from the patients when able and legally appropriate to do so or from their representatives (when too young or too ill). The study went through the Hospital Ethical Committee and permitted to be conducted. Patients were excluded if they were on antibiotics treatments that can compromise MRSA colonisation within one week to sample collection and if sample from nostrils could not be taken for whatever reasons.

A total of 2074 samples were taken and processed. All swabs were collected by the same infection control nurse during the study. Swabs were from: the, nose (both nostrils in one swab) - 511, axilla (both) - 384, hairline - 128, wound site - 208 , I.V. site - 205, tracheostomy site - 80, urine (only in case of an indwelling urinary catheter) - 37, perineum or vagina - 396, groin - 91, throat - 16, ear and other sites – 18. Swabs were collected and obtained directly after meeting eligibility criteria on during admission according to the guidelines of the KFGH policy for MRSA screening for patients with a high risk for MRSA carriage such as patients that were transferred from other hospitals or care homes; patients who have been on admission within the last 2 years; and patients who had a history of MRSA colonization or infection.

Laboratory Procedure

To start with, swabs in liquid Stuart transport medium were used for the PCR and afterwards, swabs were taken for conventional and chromogenic culture. Double swabs were transported in Copan Transystem liquid Stuart (Copan Italia S.P.A., Brescia, Italy). Specimens were transported, handled at room temperature 15-25◦c for 24-48h, or refrigerated at 2-8◦c up to 5 days until processed in order to lyse Staphylococcus aureus cells from swab specimens prior to analysis and tested with the BDGO **BD GeneOhm.** The lysis of bacterial cells in the swab specimens and sample processing were carried out according to the instruction manual in the BDGO BD GeneOhm™MRSA ACP Lysis Kit. The amplification, detection and results interpretation were automatically performed by the SmartCycler® II software. The operation of the SmartCycler® II instrument is based on the proprietary microprocessor-controlled I-CORE® (Intelligent Cooling/Heating Optical Reaction) module.[8]

Statistical Analysis

The analysis was conducted using SPSS 18, with statistical power set at $p< 0.05$. We assessed univariable associations between MRSA infection using linear regression stratified by gender and adjusted for hospital units. The multiple regressions are used to characterize any relationship between several independent or predictor (the hospital unit groups' variables and gender) and a dependent or criterion variable (the MRSA results – positive or negatives) in the patients admitted and tested in the hospital units. We compared the categorical variables with chi-squared test or the Fisher's exact test.

RESULTS AND DISCUSSION

Results

Demographic characteristics, swab sites and MRSA results

Table l presents the gender and units of admissions. Percentages of Male subjects and female subjects are

67.7 and 32.3 respectively. Also, more males are admitted to all units except urology (25.4 and 74.6% for males and females respectively) and Intensive Care Unit (ICU) where the patients are 100% females. MRSA results positive or negatives are presented (see Table II). The highest MRSA positive – 80% (24/30) is from coronary (private) unit followed by Special Ward (SW) with 62.5% (5/8) while the lowest MRSA infected unit is the Medical Rehab – 4.5% (6/133). Overall, there are 25.2% and 74.8% positive and negative results respectively and the difference is statistically significant (x^2 = 129.608, df = 12, p<0.001). Swab sites by results and the percentages are presented (see table III). The highest is from perineum (34.8%) followed by nasal (both nostrils) (33.9%) while the least positive results are from tracheostomy (3.9%).

Table IV presents the results of logistic regression to test the age, gender and swab sites with MRSA infection. The regression was a rather fairly fit (R^2_{adj} = 5%), but the overall relationship was significant (x^2= 68.901, p < 0.001) for MRSA positive results. Age and sex have negative effects on MRSA positive infection results. Tracheostomy has the highest probability of MRSA positive result. Swab 2 (axillary both) and swab 5 (IV site) are significant (p<0.01 and p<0.001) respectively. It shows that detecting MRSA was not as common in swab 2 and swab 5 than it is in swab 6 (Tracheostomy). So, swab from tracheostomy has the highest probability of been infected with MRSA than other swab sites, the effect is significant (p=0.000).

Table I: Patients units by gender

Units			sex		Total
			male	female	
unit	Burn Unit	Count	13	6	19
		% within unit	68.4%	31.6%	100.0%
	Intensive Care Unit	Count	52	37	89
		% within unit	58.4%	41.6%	100.0%
	Cardiac Surgery	Count	11	3	14
		% within unit	78.6%	21.4%	100.0%
	General Surgery	Count	104	32	136
		% within unit	76.5%	23.5%	100.0%
	Orthopaedic	Count	105	44	149
		% within unit	70.5%	29.5%	100.0%
	Internal Med	Count	90	40	130
		% within unit	69.2%	30.8%	100.0%
	Urology	Count	16	47	63
		% within unit	25.4%	74.6%	100.0%
	Special Ward	Count	8	0	8
		% within unit	100.0%	0.0%	100.0%
	Neurology	Count	24	24	48
		% within unit	50.0%	50.0%	100.0%
	SICU	Count	95	45	140
		% within unit	67.9%	32.1%	100.0%
	Coronary (private)	Count	30	0	30
		% within unit	100.0%	0.0%	100.0%
	Med Rehab Centre	Count	101	32	133
		% within unit	75.9%	24.1%	100.0%
		Count	649	310	959
Total		% within unit	67.7%	32.3%	100.0%

Table II: Units of patients by MRSA results

			result		Total
			positive	negative	
unit	Burn Unit	Count	4	15	19
		% within unit	21.1%	78.9%	100.0%
	Intensive Care Unit	Count	10	79	89
		% within unit	11.2%	88.8%	100.0%
	Cardiac Surgery	Count	2	12	14
		% within unit	14.3%	85.7%	100.0%
	General Surgery	Count	28	108	136
		% within unit	20.6%	79.4%	100.0%

	Orthopaedic	Count	43	106	149
		% within unit	28.9%	71.1%	100.0%
	Internal Med	Count	59	71	130
		% within unit	45.4%	54.6%	100.0%
	Urology	Count	18	45	63
		% within unit	28.6%	71.4%	100.0%
	Special Ward	Count	5	3	8
		% within unit	62.5%	37.5%	100.0%
	Neurology	Count	16	32	48
		% within unit	33.3%	66.7%	100.0%
	SICU	Count	27	113	140
		% within unit	19.3%	80.7%	100.0%
	Coronary (private)	Count	24	6	30
		% within unit	80.0%	20.0%	100.0%
	Med Rehab Centre	Count	6	127	133
		% within unit	4.5%	95.5%	100.0%
	Total	Count	242	717	959
		% within unit	25.2%	74.8%	100.0%

Table III: Swab sites and results

			result		Total	Chi Square	P-value
			positive	negative			
swab	Nasal both nostrils	Count	114	287	401		
		% within result	33.9%	26.7%	28.4%		
	Axillary both	Count	27	205	232		
		% within result	8.0%	19.1%	16.4%		
	Wound side	Count	49	134	183		
		% within result	14.6%	12.5%	13.0%		
	Perineum	Count	117	269	386	55.20	0.000
		% within result	34.8%	25.0%	27.3%		
	IV site	Count	16	155	171		
		% within result	4.8%	14.4%	12.1%		
	Tracheostomy site	Count	13	26	39		
		% within result	3.9%	2.4%	2.8%		
Total		Count	336	1076	1412		
		% within result	100.0%	100.0%	100.0%		

Table IV: Associations between positive MRSA with units, swabs, age and gender

Variable		Estimates	Sig.
Step 1[a]	age	-.006	.036
	male	-.280	.046
	swab		.000
	swab(1)	.245	.494
	swab(2)	1.348	.001
	swab(3)	.318	.402
	swab(4)	.161	.654
	swab(5)	1.611	.000
	Constant	1.150	.003

a. Variable(s) entered on step 1: age, sex and swab.
Swabs: 1 = Nasal, 2 = Axillary, 3 = Wound, 4 = Perineum, 5 = IV site.

DISCUSSION

We report in our study the findings from a two year (2010 and 2011) MRSA surveillance carried out in a 1,442-bed General hospital in Jeddah Saudi Arabia. Total samples of 2074 were used for the study from various sites of 959 patients tested for MRSA positives or negatives. Two hundred and forty-two positive patients (25.2% of all cases) were identified. This is similar to results found in South Africa in which MRSA detection ranged from 4% - 74% while 45% prevalence was found overall.[19,12] In Hospitals in Europe, detection of MRSA was found in the range of 1% to 20%.[13] This is in line with another report that nosocomial outbreaks were becoming common in teaching hospitals and endemic in

Canada, USA and UK while community acquired MRSA was noted as major public health concerns.[14]

Also, in our study, the importance of clinical-related swab was shown. Swabs from wound, IV site and tracheostomy form 23.3% of total MRSA colonisation cases isolated. This suggests that in order for MRSA screening to be successful, combinations of clinical swabs should be carried out at the same time with surveillance swabs. Perineum and Nasal form the major positive areas for MRSA colonization with each forming 34.8% and 33.9% positives respectively. It conforms to the earlier results which found that skin especially the anterior nares including the warm moist skinfolds of perineum (also groin), axilla and throat harbor more MRSA.[20] In the study, about 30% of patients carry MRSA and nose is the principal carriage site.[20] Also, results of weekly screening of MRSA in NICU infants found nasal swabs to show greater sensitivity.[21]

In our study, age and sex showed negative effects on MRSA infection meaning that as patient is advanced in age, the more the chances of her /his infectivity with MRSA with males having higher chances of getting infected more often than female. In fact, one year addition in age brings 6% extra probability of infection. As for the sex, male patients are to a greater extent to be infected with MRSA while in the hospital (32%) than female patients. Regarding swab sites, the effect is significant (p=0.000). Similar findings have been documented in Geneva University Health facility. It was found that male sex, age >75 years and being on urinary catheter were among the factors found associated with colonization with MRSA at hospital admission.[22]

We explored if units where patients are admitted have any relationship with higher or lower MRSA infection detection. Coronary (private ward) and special ward (where inmate of the local prison in the city is admitted) have higher MRSA prevalence with 80% and 62.5% positives respectively. This appears to be the common finding with an earlier study on MRSA in which proportion and incidence rate in Hawaii inmate were at a significant increase.[23] In their study which was carried out between years 2000 to 2005, 69% of 753 S. aureus isolated in the inmate were MRSA. It was recommended that use of active surveillance of MRSA should be considered a valuable Public Health tool in the inmate population. This collection of patients on admission should receive targeted MRSA prevention programme. Exploring units with high infection with MRSA agrees with suggestions from research findings that found as the bases for reduction in MRSA infection with a significant decrease of 29% in ICU – acquired MRSA in Germany who had 2 MRSA components of surveillance between 2004 and 2009.[24]

Also, in this study, we used multiple-site screening cultures to detect MRSA colonization found in another study to lead to high screening sensitivity.[25] They found combined swabs from the same patients do detect more MRSA than one swab site. In their study which detected 5.1% MRSA prevalence when only one swab culture was used increased sensitivity and detected 20% MRSA when swab sources included throat and / or peri –anal, nasal, axilla or groin.

CONCLUSIONS

It can be concluded based on our findings that hospital surveillance of MRSA can help to identify not only at-risk patients but can also indicate which units to target infection control justifications if fruitful results are to be achieved. It will lead to a reduction in the transmission of infections which will save resources, reduce morbidity and mortality.

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