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Original Research Article

Incidence of methicillin-resistant *Staphylococcus aureus* (MRSA) infection among patients and hospital staff and impact of preventive measures in reduction of MRSA infection rate: a prospective observational study

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ABSTRACT

Background: Methicillin-resistant *Staphylococcus aureus* (MRSA) is associated with difficult to treat infections and high levels of morbidity. It is importance to assess the effectiveness of surveillance screening programs in prevention of MRSA infection. The objective of the study was to assess the type, pattern and antimicrobial sensitivity of MRSA infection and analyse the effectiveness of preventive measures in reduction of MRSA infection rate from 2014 to 2015.

Methods: 1044 and 996 samples with positive cultures obtained from patients admitted in 2014 and 2015 respectively were screened for MRSA using chrome agar test. Only MRSA positive cultures were included in the study and their sensitivity to antibiotics was tested. Screening of MRSA infection was conducted in patients as well as staff of Rao Nursing home, Pune for early identification of MRSA infection and prevention of transmission. MRSA infection rates in 2014 and 2015 were compared.

Results: Community acquired MRSA (CA-MRSA) was more common when compared to Hospital acquired pneumonia (HA-MRSA). HA-MRSA was more common in patients admitted in isolation units. There was a decrease in number of MRSA positive cultures from 2014 (4.8%) to 2015 (1.3%), proving the effectiveness of screening for MRSA infection amongst patients as well as healthcare workers. Higher hand hygiene rates were observed in 2015 (95.83%), which further contributed to the decrease in incidence of MRSA infection in 2015.

Conclusions: Strict adherence to preventive measures of MRSA such as hand hygiene, monitoring and adherence to the bundles for prevention with judicious use of antibiotics can greatly reduce the incidence of MRSA infection.

Keywords: Methicillin resistant *Staphylococcus aureus* (MRSA), Preventive measures, Hand hygiene, Antimicrobial sensitivity

INTRODUCTION

Methicillin-resistant *Staphylococcus aureus* (MRSA) infection is caused by a bacteria which has developed resistance to majority of the antibiotics used to treat ordinary staphylococcus infections, which can cause severe problems such as bloodstream infections, pneumonia and surgical site infections in a healthcare setting.[1] The commonest mode of infection is by direct contact with an infected wound or from contaminated hands, usually those of healthcare providers. Carriers of MRSA with absence of signs of infection can also spread the bacteria to others and potentially cause an infection.[2] MRSA infections are commonly acquired in hospitals or other health care settings, such as nursing homes and dialysis centers, and are named as health care-associated MRSA (HA-MRSA) which are associated with use of invasive procedures or devices, such as surgeries, intravenous tubing or artificial joints.[3] Whereas, another type of MRSA, community-associated MRSA (CA-MRSA) is observed in wider community among healthy people, starting as a painful skin boil, and spreading by

skin-to-skin contact. At-risk populations include groups such as school population, child care workers and people who live in crowded conditions.[3]

Compromised immune system is the primary risk factor for MRSA infection in an in-patient setting.[4] Apart from it, other population at high risk include infants, the elderly, the chronically ill, burn survivors, organ transplants recipients, cancer patients receiving chemotherapy agents, steroid users, diabetic patients, intravenous drug users, and those with AIDS are the population at high risk of acquiring MRSA infection. Risk factors for HA-MRSA infection include: prolonged length of stay in hospital, high exposure to antibiotics, and exposure to people infected with MRSA.[4] A previous study has shown that African-American patients and patients with increased lengths of hospital stay are at increased risk of developing MRSA infection, and that female patients had a decreased risk.[5] In the outpatient or community setting, risk factors for CA-MRSA infection include exposure to an individual with MRSA, usually skin-to-skin contact, and exposure to environments favourable to crowding or a lack of cleanliness.[4] Hand hygiene has always been the key factor for prevention of infection and limiting the spread of multi-drug resistant organisms (MDROs) as well as susceptible pathogens. Recent studies have reported higher rates of compliance (up to 77%) with hand hygiene as compared to less than 40% on average (ranging from 30-60% depending on healthcare worker type and unit) in older studies.[6] However; additional work in this area is needed. Treatment options for MRSA are limited and less effective than options available for susceptible *S. aureus* infections and result in higher morbidity and mortality. However, active screening for MRSA and decolonization in ICU settings is associated with a decrease in MRSA infections, mortality and medical cost as seen in a study.[7]

Hence, this study was conducted to assess the effectiveness of preventive measures like hand hygiene and screening of MRSA in patients as well as healthcare workers in reducing the incidence of MRSA.

METHODS

After obtaining Independent Ethics Committee approval and taking written informed consent of patients and healthcare workers of Rao Nursing Home, Pune, 1044 samples with positive cultures from patients admitted in 2014 and 996 samples with positive cultures from patients admitted in 2015 were screened for MRSA using chrome agar test. The swabs for culture were collected from nose and groin and plated on the chrome agar plate to check for color change, after which they were tested in the Microbiology department at Rao Nursing Home using (Mannitol sugar and coagulase test). All cases where swab was positive for MRSA nasal/ groins were considered as positive for MRSA and were included in the study. All other strains such as Methicillin sensitive *Staphylococcus aureus* (MSSA) were excluded. The data was analyzed under the following headings: i) Comparison of percentage positivity of samples of MRSA of 2014 and 2015, ii) type of sample in which positive culture sensitivity was recorded, iii) distribution pattern of MRSA positive cases in hospital during 2014 and 2015, iv) comparison of HAMRSA cases against CAMRSA, v) antibiotic sensitivity pattern of 2014 cases versus 2015 cases, vi) device utilization rates relationship with MRSA infection, vii) hand hygiene rates and their relation to MRSA, and viii) screening of healthcare workers for MRSA. All cases of laboratory confirmed MRSA were analyzed for 2015 against the data of 2014. Screening of staff for MRSA was carried out as part of patient and staff safety programme of staff working in critical care areas. Data was analyzed using descriptive statistics like number and percentages.

RESULTS

Table 1: Comparison-percentage positivity of samples of MRSA of 2014 and 2015.

Sample Details	2014	2015
Total No. of microbiology samples	6234	8013
Total no of positive cultures	1044	996
Total no. of MRSA positive cultures	50	13
% of positive cases of MRSA of total positive cases	4.8%	1.3%
In patients day	27933	23683
MRSA Infection incidence rate	0.17	0.054

Table 2: Type of sample in which positive c/s was recorded.

Type of sample	2014 (N=50) n (%)	2015 (N=13) n (%)
Urine	5(10%)	0(0%)
Tracheostomy	1(2%)	0(0%)
BAL	1(2%)	0(0%)
Blood	7(14%)	0(0%)
ETT	1(2%)	1(7.7%)
Swab	1(2%)	0(0%)
Oral Secretions	1(2%)	0(0%)
PUS	4 (8%)	0(0%)
PUS Swab	24(48%)	12(92.3%)
Sputum	3(6%)	0(0%)
Wound Swab	2(4%)	0(0%)

Table 3: Distribution pattern of MRSA positive cases in hospital 2014 and 2015.

Location	2014 (N=50) n (%)	2015 (N=13) n (%)
ICU	9(18%)	3(23%)
Cay Care	1(2%)	0(0%)
Isolation	14(28%)	6(46%)
MGW	8(16%)	2(15.5%)
OPD	11(22%)	2(15.5%)
Rose	7(14%)	0(0%)

Out of the total number of positive cultures in 2014 (1044), about 4.8% of samples were MRSA positive, the number was observed to decreased in 2015, only 1.3% of the total number of positive culture in 2015 (996) were tested to be MRSA positive (Table 1). Pus swab was most commonly used for collection of sample for culture in 2014 (48%) and 2015 (92.3%) (Table 2). Maximum number of MRSA positive cultures for hospital acquired MRSA were from samples obtained from isolation rooms, 28% and 46% for the years 2014 and 2015 respectively (Table 3). Numerically, the number of hospital acquired MRSA was less in 2015 (7.6%) when compared to 2014 (92.4%) (Table 4). However, the community acquired MRSA was more common when compared to hospital acquired MRSA. Sensitivity of Tigecycline and Chloramphenicol for treating MRSA declined from 2014 to 2015 (Table 5). There was increase in device utilization rates from 2014 to 2015 (Table 6) with a concomitant increase in hand hygiene rates. Out of 117 staff who were screened for MRSA in 2015, 6 tested positive for MRSA due to the exposure to the patients with MRSA (Table 7).

Table 4: Comparison of HAMRSA cases against CAMRSA.

Year	HA MRSA n (%)	CA MRSA n (%)
2014 (N=50)	10(20%)	40(80%)
2015 (N=13)	1(7.6%)	12(92.4%)

Table 5: Antibiotic sensitivity pattern of 2014 cases v/s 2015 cases.

MRSA	Vancomycin	Linezolid	Teicoplanin	Tigecycline	Doxycycline	Chloramphenicol
Sensitivity 2015	100%	100%	100%	92%	92%	92%
Sensitivity 2014	98%	100%	100%	100%	66%	98%

Table 6: Device utilization rates relation with MRSA infection.

DUR	2014	2015
ETT*	32.04	38.88
UC*	158.04	221.4
CL*	129.48	153.36
HD*	9.48	45.24

*ETT-Endotracheal tube, UC-Urinary catheter, CL-Central line, HD-Hemodialysis

Table 7: Comparison of hand hygiene rates.

Hand hygiene rates	
2014	2015
88.50%	95.83%

Table 8: Screening of health care workers for MRSA.

Year	2014	2015
No. of staff screened	84	117
No. of staff positive in screening	Nil	6

DISCUSSION

It was encouraging to see that the number of MRSA positive samples had decreased from 2014 to 2015, indicating better preventive measures and awareness of MRSA. It was similar to a previous study, where improved MRSA infection rates have been demonstrated in certain patient populations where more aggressive measures were taken than standard barrier and isolation practices.[8] Observing a substantial number of MRSA positive cultures in 2014, screening of patients for MRSA was conducted in 2015 to avoid missing of positive cases. A previous study has depicted that active screening for MRSA and decolonization, especially in ICU settings with a high MRSA infection rate is associated with a decrease in MRSA infections, mortality and medical cost.[7] Our study also suggests that surveillance programs are effective in decreasing these infections. In 2014, the maximum positive samples were recorded in pus followed by blood, urine and sputum, whereas the majority of the positive samples in 2015 were of pus. Hence, pus can be considered as a good sample to test for MRSA infection as seen in a previous study.[9]

The incidence of CA-MRSA was more as compared to HA-MRSA, similar findings were observed in a previous study.[10] However, most of these CA-MRSA infections involve skin and soft tissue types, which respond quickly to wound care (incision and drainage) and outpatient oral antimicrobial therapy.[10] In addition, patients with CA-MRSA infections have absence of risk factors associated with HA-MRSA infections, which include recent hospitalization, dialysis, nursing-home residence, and other co-morbid conditions such as diabetes, chronic renal failure, and chronic pulmonary diseases which bring them into contact with healthcare settings. Assessment of pattern of MRSA positive cases in hospital in 2014 depicted that the maximum cases of HA-MRSA were recorded in isolation units which was consistent in 2015. Owing to the increasing incidence of healthcare-associated infections (HAI), HAI has been identified as a focus area for achieving the goal of healthy people 2020, with reduction of invasive healthcare-associated MRSA infections named as a top priority.[11] Decreased sensitivity of MRSA to Tigecycline was observed which could be probably due to non-judicious use of drug, change in

strains of organisms and hence the sales of antibiotic recorded for Tigecycline was decreased to 121 in 2015 when compared to 159 in 2014.

Though the device utilization rates (DUR) were increased in 2015 in comparison to 2014, there was a decrease in number of cases of MRSA due to strict implementation of Bundles used to prevent HAI infections, along with better hand hygiene rates as observed amongst the healthcare workers in 2015 when compared to 2014. However, hand hygiene alone cannot singularly inhibit the influence of formidable risk factors such as HAI acquisition at an older age, admission to the ICU, length of stay longer than average, or the fourfold increased risk of infection in patients colonized with *S. aureus*.[12] Additional measures like decolonization of MRSA carriers, enhanced cleaning of healthcare equipment and hospital-wide culture change program for 3 years have proved to be effective in controlling endemic MRSA infection in other countries.[13]

Screening of staff for MRSA was carried out as part of patient and staff safety programme in critical care areas. In 2014, staff screened did not record positive cases, however, with admission of cases of MRSA positive in 2014, the staff were also exposed to the organisms and got colonized, which were screened positive for MRSA in 2015 and were decolonized to control the spread of disease. In one study, it was observed that MRSA infection rates decreased by 93% in cardiac surgical wounds after a program was initiated that not only screened patients, but also included additional interventions such as decolonizing hospital staff who screen positive, providing vancomycin prophylaxis for patients who screen positive, and administering mupirocin calcium nasal ointment for all patients regardless of screening status.[14]

Strict implementation of preventive measures such as hand hygiene, monitoring of device utilization and adherence to the bundles for prevention of healthcare associated infection are detrimental in reducing MRSA infection rate. Medical practitioners can play a crucial role in identification and control of MRSA infections by active screening of patients for MRSA, contact isolation of patients, and patients and healthcare staff education.

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