Methicillin-Resistant Staphylococcus Aureus : Prevalence And Risk Factors Among Healthcare Workers :

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Abstract : Background & Objectives: Awareness of Methicillin-resistant *Staphylococcus aureus* (MRSA) is still lacking in various regions of developing countries. The present study was carried out to assess the prevalence and to establish significant risk factors for colonization with MRSA in health care workers. Methods: A cross sectional study was carried out. Ninety one health care workers and were screened for MRSA by nasal swabbing. MRSA strains were detected by disc diffusion and chromogenic agar. The D test was also carried out to detect inducible clindamycin resistance. Hand hygiene practices were surveyed. Results:Twenty MRSA carriers were identified among the 91 health care workers (21.98%; CI_{95}:13.97-31.88 %). A high prevalence was found in emergency ward (62.5 %; CI_{95}: 24.49 -91.48 %) ($p < 0.05$) .The surgical and orthopedic departments also showed high prevalence (54.55% and 75% respectively) ($p < 0.001$). Inducible clindamycin resistance was found in 20.45% samples. Chromogenic agar was found to have high sensitivity and results were similar to those of disc diffusion ($p<0.001$). Interpretation & Conclusion**:** The presence of significant risk factors aids in identification of high risk groups among hospital staff. Selective surveillance and effective lab techniques implemented in these groups will reduce the burden of MRSA in hospitals [Deshmukh DG et al NJIRM 2013; 4(4) : 32-37]

Key Words: Health care workers, Methicillin-resistant Staphylococcus aureus, Risk factors, Infection control strategy.

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Introduction: Methicillin-resistant *Staphylococcus aureus* (MRSA) is one of the most important cause of hospital acquired infections. MRSA infection increases the morbidity, mortality, length of hospital stay and economic burden on hospitals. Although there is a continuing discussion whether Health care workers should also be screened on a regular basis in endemic, non-outbreak situations[1], we consider screening of health workers to be of prime importance because: (1) health workers provide the main mode of transmission among patients[2], (2) Colonized health workers have been known to cause outbreaks in various settings in the past[3]. (3) Awareness of carrier status has been known to improve health worker compliance to preventive strategies [4] (4) MRSA is an occupational hazard to the health worker [5] in the form of life-threatening infections and frequent transmission to family members[4]. Detection of colonized status will enable the health worker to begin topical decolonization and will prevent spread to colleagues, patients and family members. Most infection control strategies attempt at universal surveillance and decolonization. A high risk approach is seldom used even though previous studies have shown carriers to be concentrated in certain locations, departments and designations. We endeavored to find out similar "pockets" of MRSA carriers in our hospital and studied reasons for the same. A high risk approach will be cost effective in resource constrained settings, which is applicable in many Indian hospitals. This study focused on the initial assessment of the magnitude and size of the MRSA problem in our hospital and suggestions for formulation of an infection control strategy.

Material and Methods: A cross sectional study was conducted in a tertiary care teaching hospital of Yavatmal, India from May to October 2012. Nasal swabs of 91 health care worker samples were collected and subjected to MRSA screening using conventional methods in the Microbiology lab. A study questionnaire was prepared and was used for assessing risk factors and for surveying hand hygiene habits. The Institutional ethics committee approval was obtained. All the health care workers were explained about the purpose of the study and were ensured strict confidentiality. Written informed consents were taken from each of the health care workers prior to the study. The standard microbiological methods were followed in this study during culture and antibiotic sensitivity test following universal precautions.

The health care worker samples were inoculated on 5% sheep blood agar (Hi Media™, Mumbai, India). Growth was identified as *Staphylococcus aureus* by standard methods (Gram's stain, catalase test, mannitol fermentation and coagulase test). Staphylococcal isolates were then confirmed as MRSA by disc diffusion (30 µg Cefoxitin) and inoculation on chromogenic agar (MeReSA agar, Hi Media™, Mumbai, India) as per Clinical and Laboratory Standards Institute (CLSI) guidelines[6]. The isolates were considered methicillin resistant if the diameter of zone of inhibition was 14 mm or less and by growth on chromogenic agar[7]. Antibiogram was performed against the following antibiotics- Penicillin(10 units), Ampicillin(10 µg), Gentamycin(10 µg),Erythromycin(15 µg), Ciprofloxacin(5µg), Co-trimoxazole(25 µg), Clindamycin(2 µg) and Doxycyclin(30 µg) .

The isolates were subjected to "D test" to detect inducible clindamycin resistance as per CLSI guidelines[6]. The test was done by placing clindamycin disc (2 µg) and erythromycin disc (15 µg) at a distance of 20 mm (edge to edge) on an agar plate. These plates were incubated at 37ºC for 24 hours. A flattening of the zone of inhibition around clindamycin disc proximal to erythromycin disc (shaped like the letter D) was looked for, which was designated as D test positive, indicating inducible clindamycin resistance[8]. Antibiotic sensitivity patterns of clinical isolates of the previous one year were compared to that of health care worker samples.

Epi Info™ 7 and Microsoft Excel version 10.0 were used for data consolidation and analyses. Significance was established by Pearson's Chi square test and Fisher's exact test for qualitative data and the correlation coefficient for continuous data. Prevalence rates were calculated with their 95% Confidence intervals (CI_{95}).

Results: Out of the ninety one health care workers screened, *S. aureus* was isolated in 88 samples, two samples isolated coagulase-negative staphylococci (CONS) and one sample isolated gram-negative rods. Twenty isolates were found to be methicillin resistant, thus the prevalence in the present study is 21.98% (CI_{95}, 13.97-31.88 %).

The following risk factors were postulated for MRSA carriage among health care workers: Gender, location in hospital, specialty (Department), category (designation), working hours per day, duration of service and hand hygiene habits. Location and specialty of health care worker were found as significant risk factors for colonization (Table 1).

Table I: Risk factor analysis

Risk factor	Test	p value
Gender	Pearson's Chi square Test	0.703
Department	Fischer's exact Test	0.021
Designation	Fischer's exact Test	0.316
Location	Fischer's exact Test	0.008
History of infection	Fischer's exact Test	0.646
Working hours	Fischer's exact Test	0.124
Length of service	Pearson's Chi square Test	0.792
Hand Hygiene habits	Fischer's exact Test	0.172

Emergency ward had highest prevalence (62.5 %; CI_{95}: 24.49 -91.48 %) which was significantly higher than other locations in the hospitals ($p<0.05$). The Surgery and Orthopedics departments had significantly higher prevalence among departments (54.55% and 75% respectively; $p< 0.001$). On analyzing the antibiotic susceptibility pattern [Table 2] almost complete susceptibility was seen to Ciprofloxacin in both patient and health care worker samples. Inducible clindamycin resistance was seen in 20.45% samples. Inducible clindamycin resistance was not significantly higher in MRSA samples (Fischer's exact test, two-tailed p-value – 0.5).All but one MRSA samples showed growth on chromogenic agar. Thus this chromogenic agar (MeReSA Agar) adequately represents results of disc diffusion and may be used for rapid diagnosis in outbreaks. Drug resistance to more than one antibiotic were seen in 72.52 % (66) of our samples. 56.04% samples showed resistance to 3 or more than 3 antibiotics. MRSA strains were resistant to 5.65 antibiotics on an average, while MSSA strains were resistant to 2.48 antibiotics averagely. In order to analyse the development of resistance among different departments better, we developed a resistance score.

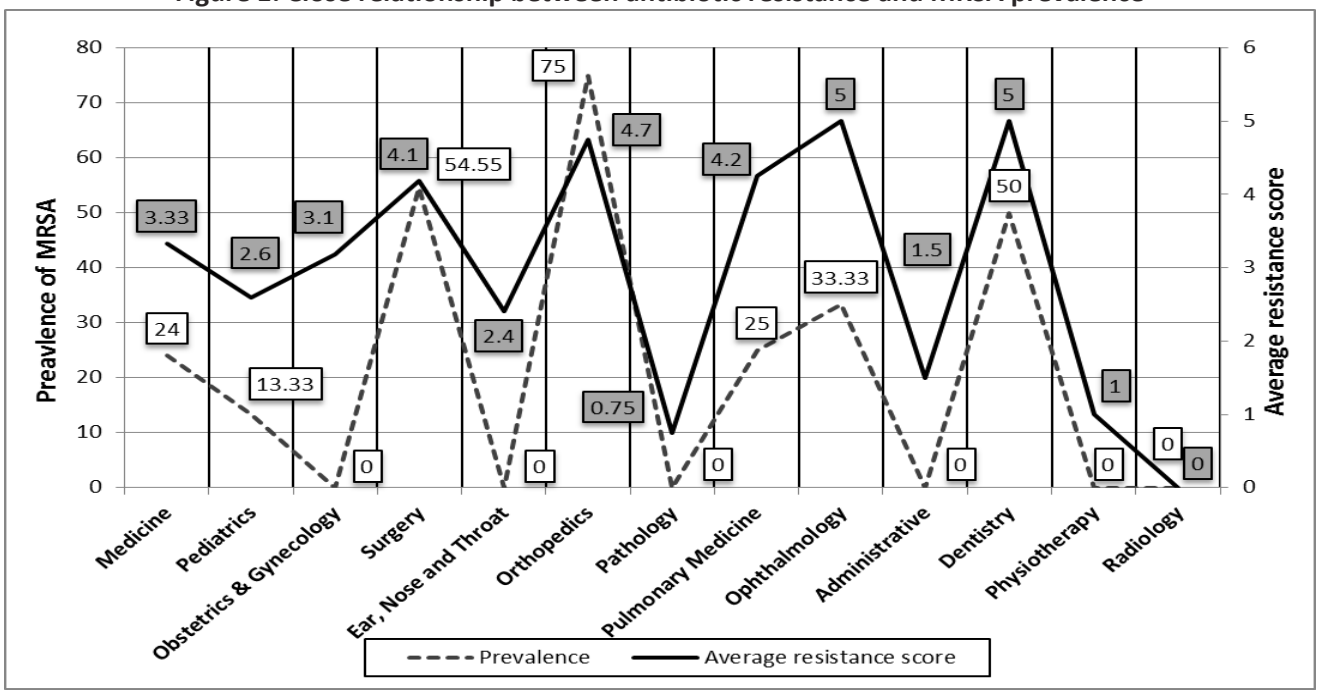
Table II: Antibiotic susceptibility pattern of MRSA and MSSA health care worker strains

Name of Antibiotic	MRSA			MSSA		
	Number of strains	No of resistant	Percentage resistance	Number of strains	No of resistant	Percentage resistance
Penicillin	20	18	90%	68	24	35.29%
Ampicillin	20	15	75%	68	22	32.35%
Erythromycin	20	16	80%	68	48	70.58%
Gentamycin	20	8	40%	68	9	13.23%
Doxycyclin	20	7	35%	68	14	20.58%
Ciprofloxacin	20	1	5%	68	0	0%
Co-trimoxazole	20	18	90%	68	41	60.29%
Clindamycin	20	12	60%	68	28	41.17%

Resistance score was calculated by the sum of number of antibiotics to which resistance was found in each sample. For e.g. If a certain sample only showed resistance to penicillin and ampicillin it would be given a resistance score of 2.

The average resistance score for each department was found to be closely correlated with department-wise MRSA prevalence (Correlation coefficient 0.804) [Figure 1]

Figure 1: Close relationship between antibiotic resistance and MRSA prevalence



Thus the trend of antibiotic resistance can be used to monitor the prevalence of multi-drug resistance organisms (MDRO's) in the hospital. The hand hygiene parameters measured were (a)frequency of hand hygiene, (b)hand wash after removing gloves, (c)hand wash before aseptic task and (d)product used. Significant association could not be established between any parameter and MRSA carrier status. All four parameters were combined in the form of a hand hygiene score (with each parameter given equal weightage), yet significant association could not be established. Additionally

reported duration of hand wash and observed duration of hand wash was inconsistent. This indicates that self-reported adherence to hand hygiene is not a reliable measure.

The following limitations to hand hygiene adherence were reported by health workers and observed during health care worker survey:

1. Lack of time/ high patient influx.
2. Lack of soap/hand sanitizer product within proximity of health care worker
3. Paucity of running water facilities.
4. Misconception that using gloves suffices and overrides the need for hand hygiene practices. (But most health workers reported to wash hands after glove removal because of dust remaining on hand).

Discussion: The prevalence in the present study is 21.98% (CI_{95} - 13.97-31.88 %) Tsering et al reported a similar prevalence of 20.92%, samples collected and diagnostic methodology used was similar to our study and thus the results are comparable[9].

The high prevalence in the emergency wards can be attributed to the fact that a large number of patients are to be treated in quick succession and that staff working there are exposed to patients having a wide variety of ailments. Askarian et al has reported similar high prevalence in emergency ward[10]. The number of MRSA carriers in the emergency department is known to reflect the colonization pressure at the time of admission to a hospital[4]. This high prevalence in emergency department may represent a community acquired strain of MRSA present in the patients. Weinerman et al has defined three categories used by health providers to describe requirements for emergency care[11]:Non-urgent, urgent and emergent. Flesh et al has reported that only 5% Patients of patients presenting in emergency ward required emergent care[12]. These patients undergo numerous procedures and are at greatest risk of acquiring and transmitting nosocomial infections.

Additionally it is for these patients that asepsis may often be compromised. Thus it is essential that staff working in the emergency ward have been trained in aseptic practice and it should be assured that their skills and knowledge are up-to-date. Aseptic precautions and strict hand hygiene should be followed especially when patient needs emergent care.Our study found Surgery and Orthopaedics departments to have significantly higher prevalence over other departments ($p<0.001$).This has been reported earlier[9, 10, 13].The high prevalence in surgical units can be attributed to the pre-operative surgical prophylaxis routinely prescribed to all patients, which may hasten the development of resistant organisms in these departments. These patients commonly have indwelling devices and the healing surgical wound may act as a good media for growth of MRSA. In addition post-operative hospital stay in surgical and orthopaedic wards lengthens patients total hospital stay in comparison to other departments, thus increasing transmission between patients and health workers. As high prevalence in surgical departments has been reported from a number of setups it is vital to focus preventive strategies in this department. We found that self-reported adherence could not accurately measure hand hygiene adherence.It has been previously reported that health workers over-estimate their compliance[14].O' Boyle et al has also explained these inconsistencies by reporting that while health care workers may have internal motivational factors (which are often expressed at the time of self-reporting), but true adherence is guided by intensity of work in the clinical settings[15]. The strength of the survey

Method was that it could be used to measure knowledge of health worker, attitude towards infection control practices and several limiting factors to increased adherence. Interviewing health workers about their own hand hygiene practices is also known to focus health care worker on their habits[16]. Thus survey method of hand hygiene can be used as a tool to improve awareness regarding current guidelines, help health care workers to recognize their short comings and perhaps bring about a positive behavioral change .It may be also used to find the short comings in the hospital management in providing adequate facilities and taking required corrective actions.

Challenges to hand hygiene adherence and strategies to overcome them: Health care workers who were interviewed knew the importance of hand hygiene in preventing spread of infections but most of them were not aware of MRSA in particular. This underscores the need of educational activities among health workers regarding common hospital acquired infections and the importance of preventive strategies in controlling them. Joshi et al has reported that health care workers perceived practical problems in implementation of hand hygiene guidelines which could be discussed and dealt with in a focused discussion group[17].

Although alcohol based hand rubs were present in most wards they were not placed within proximity of health care workers. Thus strategic placing of hand rubs at the point of care will be crucial to improve adherence. Alp et al has also reported the importance of training of health care workers and easy access of hand hygiene products in developing countries[18].

Most health workers on being shown the "How to hand wash?" poster had the common misconception that this procedure was to be carried out only in operation theatres. One of the doctors observed using an alcohol sanitizer was seen starting with the recommended procedure, but failed to complete all the steps. This problem can be tackled effectively by using two posters.

1. The WHO "How to hand wash?" which should be placed above sink or near alcohol rub dispensers so that health workers can follow the complete procedure thus ensuring thorough and effective hand hygiene
2. "The World Health Organization's Five Moments for Hand Hygiene" poster which should be placed at point of care so that staff is sure how often hand hygiene must be carried out.

Our setup lacked an infection control plan. We have suggested some points based on observations made and recent clinical research which may assist formulation of an infection control plan.

a) Focused preferential surveillance of high risk groups will not only make the infection control strategy economical but will also detect majority of the cases[19].
b) The infection control strategy should be formulated and managed at the hospital wide level. But surveillance and feedback should be decentralized and done at unit based level as it has been found to be more successful[20].
c) Surveillance should always be followed by decolonization. Studies have shown pairing the two is more cost effective and reduces mortality and infection rate on the long run[21].
d) Setup of hospital antibiotic policy. This includes combining the best available research evidence with detailed knowledge of local clinical needs and antimicrobial resistance. Such a policy will foster appropriate antibiotic stewardship.
e) Visible leadership presence, messaging and release of resources are the key factors in making any infection control program a true success[22].

References:

1. Collins CJ. Screening of healthcare workers for meticillin-resistant Staphylococcus aureus:the debate continues for high risk nonendemic settings. J Hosp Infect 2012; 80:92-93.
2. Albrich WC, Harbarth S. Health-care workers: source, vector, or victim of MRSA?.Lancet Infect Dis 2008;8: 289–301
3. Vonberg RP, Stamm-Balderjahn S, Hansen Set al. How often do asymptomatic healthcare workers cause methicillin-resistant Staphylococcus aureusoutbreaks? A systematic evaluation. Infect Control Hosp Epidemiol 2006; 27: 1123–27.
4. Eveillard M, Martin Y, Hidri N, Boussougant Y, Joly-Guillou ML.Carriage of methicillin-resistant Staphylococcus aureus among hospital employees: prevalence, duration, and transmission to households.Infect Control Hosp Epidemiol 2004; 25:114-120.
5. Haamann F, Dulon M, Nienhaus A.MRSA as an occupational disease: a case series. Int Arch Occup Environ Health2011;84:259-266.
6. 6. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial

susceptibility testing; 16 th informational supplement. CLSI M100-S16. Wayne, PA: Clinical and Laboratory Standards Institute; 2006.
7. McDougal LK, Thornsberry C. New recommendations for disk diffusion antimicrobial susceptibility tests for methicillin-resistant (heteroresistant) staphylococci.J Clin Microbiol 1984;19:482-8.
8. Steward CD, Raney PM, Morrell AK et al. Testing for induction of clindamycin resistance in erythromycin resistant isolates of Staphylococcus aureus. J Clin Microbiol 2005;43:1716-21.
9. Tsering DC, Pal R, Kar S.Methicillin-resistant Staphylococcus Aureus. Prevalence and current susceptibility pattern in Sikkim.J Global Infect Dis 2011;3:9-13
10. Askarian M, Zeinalzadeh A, Japoni A, Alborzi A, Memish ZA. Prevalence of nasal carriage of methicillin-resistant Staphylococcus aureus and its antibiotic susceptibility pattern in healthcare workers at Namazi Hospital, Shiraz, Iran. Int J Infect Dis. 2009 ;13(5):e241-7.
11. Weinerman, E. R. Ratner RS, Robbins A, Lavenhar MA. Yale studies in ambulatory medical care: V.Determinants of use of hospital emergency services.Am. J. Public Health 1966; 56: 1037-56
12. Flesh R, Brook R, Wassertheil-Smoller S, Jonas S. Monitoring utilization of municipal hospital emergency department. Hosp Topics 1976; 54 :43
13. Cesur S, Çokça F.Nasal Carriage of Methicillin-Resistant Staphylococcus aureus Among Hospital Staff and Outpatients.Infect Control Hosp Epidemiol 2004;25 : 169-171.
14. World Health Organization (WHO): WHO Guidelines on Hand Hygiene in Health Care (Advanced Draft): A Summary. Geneva, Switzerland: WHO, 2006.
15. O'Boyle CA, Henly SJ, Larson E. Understanding adherence to hand hygiene recommendations: the theory of planned behavior. Am J Infect Control 2001;29: 352-360.
16. Haas JP, Larson EL. Measurement of compliance with hand hygiene. J Hosp Infect2007; 66:6-14.
17. Joshi SC, Diwan V, Tamhankar AJ et al.Qualitative study on perceptions of hand hygiene among hospital staff in a rural teaching hospital in India. J Hosp Infect 2012;80(4): 340-4.
18. Alp E, Ozturk A, Guven M, Celik I, Doganay M, Voss A.Importance of structured training programs and good role models in hand hygiene in developing countries. J Infect Public Health 2011;4 :80-90.
19. Bhattacharya S. Is screening patients for antibiotic-resistant bacteria justifiable in the Indian context? Indian J Med Microbiol 2011;29: 213–7.
20. Gastmeier P, Schwab F, Chaberny I, Geffers C.Individual units rather than entire hospital as the basis for improvement: the example of two Methicillin resistant Staphylococcus aureus cohort studies.Antimicrob Resist Infect Control 2012;1: 8.
21. You JH, Chan CY, Wong MY, Ip M. Active Surveillance and Decolonization of Methicillin-Resistant Staphylococcus aureus on Admission to Neonatal Intensive Care Units in Hong Kong: A Cost-Effectiveness Analysis.Infect Control Hosp Epidemiol 2012;33: 1024-30.
22. Ling ML, How KB.Impact of a hospital-wide hand hygiene promotion strategy on healthcare-associated infections.Antimicrob Resist Infect Control 2012;1 : 13

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