Original Article

An Investigation of MRSA from the Burns Ward: The Importance of Hand Hygiene

Microbiology Section

SHALINI DUGGAL, NIRMALJIT KAUR, CHAROO HANS

ABSTRACT

Introduction: MRSA (Methicillin Resistant *Staphylococcus aureus*) deserves special attention in health care settings. It becomes difficult to treat this infection/eradicate its colonization once it has established. However, its spread can be controlled. An increase in MRSA isolation from the wound swabs of the burns patients over a period of four months prompted us to undertake the present investigation.

Material and Methods: Eleven HCWs (Health Care workers) were screened. Hand smears and nasal swabs were cultured and identified by standard microbiological methods. A re-orientation programme was arranged for all HCWs in the burns ward and the importance of standard work precautions, especially hand hygiene was highlighted. Swabs were taken from the same workers after six weeks.

Results: Out of eleven health care workers, seven were found to be MRSA carriers (63.6%). Swabs which were taken from the same workers after six weeks, revealed a decrease in the MRSA colonization in the hands by 75% and in the nose by 25%. Also, the number of MRSA isolations from the wound swabs of patients in the burns ward decreased from 35.3% to 13.9%.

Conclusion: The current study emphasizes the need for an early diagnosis of MRSA and for being vigilant so that if any outbreak of multidrug resistant organisms occurs in a ward/ ICU, steps to control them can be initiated at the earliest. It also highlights the importance of hand hygiene so that the hands that deliver care may not deliver germs.

Key Words: MRSA, Burns, Hand hygiene

INTRODUCTION

Staphylococcus aureus are gram-positive cocci which possess the ability to colonize as well as to cause infections in individuals, which may range from simple cutaneous infections to toxic shock syndrome and life threatening blood stream infections. The control of this organism becomes difficult especially when it is multidrug resistant thus limiting the treatment options. To almost every new drug which is introduced, resistance follows soon.

S. aureus strains have developed resistance to virtually all antibiotic classes which are available clinically. These include cell wall inhibitors such as ß-lactams and glycopeptides, ribosomal inhibitors including macrolide-lincosamide-streptogramin B (MLS_B), aminoglycosides, tetracyclines, fusidic acid, DNA gyrase blocking quinolones, the antimetabolite-trimethoprim sulfamethoxazole, the RNA polymerase inhibitor-rifampin, newer oxazolidinones, etc [1,2].

Penicillin was the first beta lactam antibiotic to be introduced in 1940. Soon resistance to it emerged in 1942. ß-lactamase (Penicillinase) was extracted in 1944. Penicillinase stable ß-lactams such as cephalosporins and semi synthetic penicillins such as methicillin and nafcillin became available in the late 1950s [3]. Methicillin was introduced in 1959 but its natural resistance in *S. aureus* was identified soon after by Jevons in 1960 [4]. Such isolates are known as MRSA (Methicillin resistant *Staphylococcus aureus*). The drug of choice for such cases is vancomycin. Vancomycin intermediate resistant isolates of *S. aureus* (VISA) were first described in 1997 in Japan [3]. Vancomycin resistant *S. aureus* (VRSA) was first described in June 2002 in the U.S. in a dialysis patient [3]. VISA and VRSA strains, though they are rare, are serious threats to the treatment of infections which are caused by such organisms. Other treatment options for the MRSA infections are linezolid, rifampicin + flouroquinolones, pristinamycin, co-trimoxazole, (trimethoprim-sulphamethoxazole), doxycline or minocycline and clindamycin [5].

Methicillin is a β-lactamase resistant penicillin. Methicillin/ oxacillin resistance implies resistance to all penicillins, cephalosporins, carbapenems and ß-lactamase inhibitor combinations. These isolates are generally also resistant to other classes of drugs, including macrolides, tetracyclines, aminoglycosides, chloramphenicol, etc [6].

Burn wounds are open and raw wounds which allow various micro-organisms which are capable of establishing themselves, to grow and multiply resulting in serious infections. MRSA with limited treatment options is particularly difficult to treat. The control of this organism is therefore very important so that it does not spread to other patients. The present study was conducted as an investigation to track the source of the infections when an increase in MRSA cases was seen in the burns ward.

MATERIAL AND METHODS

The present study was conducted during a period of four months during which pus/wound swabs from wounds which were suspected of infection from the burns ward were cultured routinely on blood agar, MacConkey's agar and in BHI broth. After overnight incubation at 37°C, the isolates were identified by standard microbiological methods [7] and their antibiotic sensitivity was studied. During this process, an increase in the MRSA isolates

was seen from the burns ward. Considering the pathogenic potential of MRSA in such patients with limited treatment options, an investigation was conducted in the burns ward to find out the source of the infection. All the staff members of the burns unit, with access to the patients were screened for MRSA colonization. Fingerprints from their hands and nasal swabs were taken. For reasons of compliance, samples could not be taken from other sites like the axilla, the umbilicus, the perineum, etc. An HCW was classified as a "carrier", if at least one of the samples grew MRSA. In total, eleven HCWs were screened. Their fingerprints, both from the left and right hands, were taken directly on blood agar plates and these were incubated at 37°C overnight. The nasal swabs were moistened with sterile saline before sampling and were processed in the same way as the pus/ wound swabs were processed. Swabs were also taken from the main dressing table, the small dressing trolley; the patient trolley and the dressing room sink and these were also processed as mentioned above. After overnight incubation, suspected colonies which morphologically resembled staphylococci were selected. Their gram staining and catalase, slide and tube coagulase tests were done. The gram positive cocci which were catalase and coagulase positive were identified as *S. aureus* and they were subjected to the antibiotic susceptibility test on Mueller Hinton agar (MHA) at pH 7.2-7.4, by uniformly inoculating them by a cotton swab which was lightly saturated with a suspension of visual equivalence to 0.5 Mac Farland's nephelometric standards. Within 15 minutes of inoculation, an oxacillin (1µg) disc along with other antibiotic discs, were put 30 mm centre to centre from each other. Other antibiotics which were tested were cefuroxime (30 µg), tetracycline (30 µg), erythromycin (15 µg), co-trimoxazole (25 µg), ciprofloxacin (5µg), amoxicillin/clavulanic acid (20 + 10 µg), vancomycin (30 µg), linezolid (30 µg) and clindamycin (2 µg). If the zone of inhibition of oxacillin was ≤ 10 mm i.e. resistant, the strains were re-tested with the same concentration as the oxacillin disc on MHA with 2-4% NaCl and incubated at 30-35°C for complete 24 hours. If they were found to be resistant, these isolates were recorded as MRSA and were followed up. A reorientation in the infection control practices was done for the burns ward staff by the Microbiology Department and the standard work precautions were explained to them. The importance of hand hygiene was specifically highlighted.

Hand washing with antibacterial soaps and an alcoholic hand rub was advised and mupirocin ointment for nasal application and barrier nursing was advocated, to contain the infection. After six weeks, repeat samples from the staff were taken and the results were compared.

RESULTS

In January 2007, there was no isolate of *S. aureus* in the burns ward. In February, within a period of one week four isolates were identified, all of them being MRSA.

During a period of 4 months i.e. 1st Feb-31st May, 51 pus/ wound swabs were received from the burns ward, out of which 13 samples were sterile. In 12 such samples more than one organism was isolated. The most common organism which was isolated was *Pseudomonas aeruginosa* and it was isolated in 27 cases. Out of 19 *S. aureus* strains which were isolated, 18 were methicillin resistant (95% of all *S. aureus* isolates) [Table/Fig-1]. These were 100% susceptible to vancomycin and linezolid.

MRSA cases were also isolated from intensive care units; the ENT, Obstetrics and Gynaecology, Orthopedics, Surgery, Paediatrics and Skin wards and from Out Patient Departments (OPDs). Overall in the hospital, the rate of MRSA was 34.2% of all the *S. aureus* isolates. Others which were frequently isolated were *Pseudomonas, Acinetobacter, Escherichia coli, Klebsiella* and *Proteus.*

MRSA	Percentage
Hospital prevalence	34.2
Samples from Burns ward	94.7
Staff members from Burns ward	63.6

[Table/Fig-1]: Prevalence of MRSA

Effect of strengthening infection control practices	HANDS		NASAL SWABS	
	MRSA	MSSA	MRSA	MSSA
BEFORE	4	–	4	2
AFTER	1	–	3	1

[Table/Fig-2]: Details of carriers

Out of 11 HCWs of the burns ward which were screened for MRSA, 8 were identified as carriers of *S. aureus*. Seven of these isolates were MRSA i.e. 63.6% of all HCWs. MRSA was seen to colonize the hands and nose equally.

MRSA was also isolated from the patient trolley in the dressing room.

The sensitivity pattern of these isolates matched with those from the patients in being sensitive only to vancomycin, tetracycline and linezolid, but resistant to oxacillin, erythromycin, cefuroxime, ciprofloxacin, clindamycin, co-trimoxazole and the amoxicillin-clavulanic acid combination. However, due to resource limited settings, molecular support could not be established.

After strengthening the infection control practices, the number of MRSA isolations from the burns ward fell to only 'two' in June. Repeat samples from the HCWs also showed a decreasing trend [Table/Fig-2]. Hand washing alone decreased the incidence of MRSA by 75% and nasal carriage by 25% among the health care workers from the burns ward.

The frequency of hand washing was increased before and after handling patients and between handling patients, but the compliance for mupirocin was poor.

Last year, the overall rate of MRSA in our hospital was 22.6%. Only 10 strains of *S. aureus* were isolated from the burns patients and 3 were MRSA.

DISCUSSION

Historically, the resistance to Penicillinase stable penicillins has been referred to as "Methicillin resistance"; thus, the acronym 'MRSA' is still commonly used even though methicillin is not being used now-a-days, as the more stable and similar penicillins, oxacillin, flucloxacillin and dicloxacillin are available. Oxacillin is used as an indicator drug and as a marker of resistance in the susceptibility testing of all staphylococcal isolates as it is more resistant to degradation during storage and more likely to detect hetero-resistant strains [6]. There are two different MRSA clusters-HA-MRSA (hospital acquired MRSA) and CA-MRSA (community acquired MRSA) [8]. Clinically and epidemiologically, these are believed to be two separate evolutions. The hospital isolates are multi-resistant and clonal and are associated with risk factors like recent hospitalization or surgery, nursing home residency or

having an indwelling catheter or device. On the other hand, the CA-MRSA strains are pauci-resistant and polyclonal and produce skin diseases and severe pneumonia in otherwise healthy people. The MRSA in patients at risk are likely to be the multi-resistant hospital type, whereas in patients without risks, they are likely to be more susceptible but more invasive too. So, the MRSA which is isolated from the hospital environment or elsewhere in the community due to infection or colonization is particularly important and has to be checked. For HA- MRSA, the associated factors include prior antibiotic exposure, prolonged hospitalization, surgery, admission to an intensive care unit, nursing home residency and close approximation to a patient who was colonized or infected with MRSA. Inpatients having an *S. aureus* infection have on an average, 3 times the length of hospital stay, 3 times the total charges and 5 times the risk of in- hospital deaths as compared to in-patients without this infection [9].

Burn wounds provide a particularly rich environment for micro-organisms to grow as these are exposed surfaces which are raw, wet and rich in electrolytes, requiring frequent dressing changes, handling by multiple health care workers (HCW), the use of intraluminal devices and the empirical use of antibiotics including newer ones and due to the inherent immunocompromised state of the patients [10]. In the present study also, the sources were traced to the hands and nares of the HCWs and the contaminated dressing trolley which was used for all the patients for the purpose of dressing.

These patients are also on multiple antibiotics, which provided a survival chance to the multidrug resistant organisms (MDRO). Also, the limited therapeutic options for these MDROs may influence antibiotic usage in such a way that the normal flora may be suppressed and a favourable environment may be created for the development of colonization, when these sites are exposed to MDROs [11]. The most common microbial isolates from burns are *Pseudomonas aeruginosa, Staphylococcus aureus, Escherichia coli, Klebsiella* and *Proteus*.

According to a survey from the SENTRY Antimicrobial Surveillance Program, methicillin resistance varies from <2% in Netherlands to >70% in Japan and Hong Kong [12]. In Netherlands, it is low, as an important part of the Dutch strategy is to attempt the eradication of the carriage of such organisms immediately after discharge from the hospital so that it does not spread in the community [13]. In one study which was conducted in a tertiary care hospital in India, the MRSA carriage ranged from 28.4% in outpatients to 33.5% in the in-patients [14]. In All India Institute of Medical Sciences, Delhi, the prevalence of MRSA was 38.56% [15].

The prevention of nosocomial infections involves routine and terminal cleaning. Alcohol has proven to be effective as a topical sanitizer against MRSA. Alcohol based hand rubs should be placed in all the wards so that the staff can clean their hands more regularly. According to a Centre for Disease Control CDC report, hand washing alone would save the lives of around 30, 000 patients per year in the U.S., not from MRSA alone but from all nosocomial infections [16].

The application of mupirocin (2%) into the anterior nares of the HCWs is highly efficacious in eliminating *S. aureus* carriage [17].

The administration of vancomycin is associated with many problems not only as its route of administration is inconvenient but also as it is inferior in terms of efficacy as compared to the anti-staphylococcal penicillins [18].

MRSA are just as pathogenic as Methicillin Susceptible *S. aureus* (MSSA), but their treatment is challenging. Also, they spread easily in hospital settings, thus causing higher mortality rates and increased costs [19]. The scarcity of the treatment options and the morbidity and mortality which are associated with the MRSA infections, provide a strong argument for judicious use of antibiotics and the need for a well defined antibiotic policy so that the emergence of such organisms is prevented. This is applicable not only for the control of MRSA but also for other MDROs as well.

REFERENCES

[1] Nimmo GR, Bell JM, Mitchell D, Gorbell IB, Pearman JW, Turnidge JD. Antimicrobial resistance in *Staphylococcus aureus* in Australian teaching hospitals 1989-1999. *Microb Drug Resist* 2003; 9: 155-160.

[2] Kesah C, Ben Redjeb S, Odugbemi TO, Boye C, Dosso M. Prevalence of methicillin resistant *Staphylococcus aureus* in eight African hospitals and Malta. *Clin Microbiol Infect* 2003; 9: 153-156.

[3] Sampathkumar P. Methicillin resistant *Staphylococcus aureus*: the latest health scare. *Mayo Clin Proc* 2007; 82: 1463-1467.

[4] Jevons MP. "Celbenin" – resistant Staphylococci. *Br Med J* 1961; 1: 124-125.

[5] Birmingham MC, Rayner CR, Meagher AK, Flavin SM, Batts DH, Schentag JJ. Linezolid for the treatment of multidrug resistant gram-positive infections: experience from a compassionate use program. *Clin Infect Dis* 2003; 36(2): 159-168.

[6] Clinical and Laboratory Standards Institute Performance standards for antimicrobial susceptibility testing; Seventeenth informational supplement (M 100-S17. vol 27 No. 1).

[7] Collee JG, Miles RS, Wan B. Tests for the identification of bacteria. In: Collee JG, Fraser AG, Marmion BP, Simmons A, Eds. *Mackie & McCartney Practical Medical Microbiology*. 14th edn. Edinburg: Churchill Livingstone; 1996. pp. 131-150.

[8] Moreillon P, Que YA, Glauser MP. *Staphylococcus aureus* (including Staphylococcal toxic Shock). In: Mandell GL, Bennett JE, Dolin R, Eds. Mandell, *Douglas and Bennett's Principles and Practice of Infectious Diseases.* 6th Ed. USA: Elsevier; 2005. pp. 2321-51.

[9] Noskin GA, Rubin RJ, Schentag JJ, et al. The burden of *Staphylococcus aureus* infections on hospitals in the United States: An analysis of the 2000 and 2001 Nationwide inpatient sample database. *Arch intern Med* 2005; 165: 1756-1761.

[10] Pruitt BA Jr, McMannus AT, Kim SH, Goodwin CW. Burn wound infections: current status. *World J Surg* 1998; 22: 135-145.

[11] Martone WJ. Spread of vancomycin resistant enterococci: why did it happen in the United States? *Infect Control Hosp Epidemiol* 1998; 19: 539-545.

[12] Diekema DJ, Pfaller MA, Schmitz FJ, et al. Survey of infections due to *Staphylococcus* species: Frequency of occurrence and antimicrobial susceptibility of isolates collected in the United States, Canada, Latin America, Europe, and the Western Pacific region for the SENTRY Antimicrobial Surveillance Program, 1997-1999. *Clin Infect Dis* 2001; 32 (Suppl 2): S114-132.

[13] Bootsma MC, Diekmann O, Bonten MJ. Controlling methicillin- resistant *Staphylococcus aureus:* quantifying the effects of interventions and rapid diagnostic testing. *Proc Natl Acad Sci USA* 2006; 103 (14): 5620-5.

[14] Mathur SK, Singhal S, Prasad KN, et al. Prevalence of methicillin resistant *Staphylococcus aureus* in a tertiary care hospital in India. *Indian J Med Micro* 1994; 12: 96-101.

[15] Mohanty S, Kapil A, Dhawan B, Das BK. Bacteriological and antimicrobial susceptibility profile of soft tissue infections from Northern India. *Indian J Med Sci* 2004; 58: 10-15.

[16] CDC MMWR; Recommendations and Reports. October 25, 2002/ vol 51/ No. RR-16. Guidelines for hand hygiene in Health Care settings. Recommendations of the healthcare infection control practices advisory committee and the HICPAC/SHEA/APIC/IDSA Hand hygiene task force. pp. 1-45.

[17] Fernandez C, Gaspar C, Torrellas A, et al. A double- blind randomised, placebo- controlled clinical trial to evaluate the safety and efficacy of mupirocin calcium ointment for eliminating nasal carriage of *Staphylococcus aureus* among hospital personnel. *J Antimicrob Chemother* 1995; 35: 399-408.

[18] Siegman-Igra Y, Reich P, Orni-Wasserlauf R, Schwartz D, Giladi M. The role of vancomycin in the persistence or recurrence of *Staphylococcus aureus* bacteremia. *Scand J Infect Dis* 2005; 37(8): 572-578

[19] Rubin RJ, Harrington CA, Poon A, Dietrich K, Green JA, Moiduddin A. The economic impact of *Staphylococcus aureus* infections in New York City hospitals. *Emerg Infect Dis* 1999; 5:9-17.

AUTHOR(S):

1. Dr. Shalini Duggal
2. Dr. Nirmaljit Kaur
3. Dr. Charoo Hans

PARTICULARS OF CONTRIBUTORS:

1. Jr Specialist Microbiology, Dr Baba Saheb Ambedkar Hospital, Rohini, New Delhi.
2. Corresponding Author.
3. Consultant & Head, Department of Microbiology, Dr.R.M.L. PGIMER & Hospital, New Delhi-110001, India.

NAME, ADDRESS, TELEPHONE, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Nirmaljt Kaur, Senior Specialist, Department of Microbiology, Dr. R.M.L. PGIMER & Hospital, New Delhi-110001, India.
E-mail: njkbhatia@yahoo.co.in

DECLARATION ON COMPETING INTERESTS:

No competing Interests.

Date of Submission: **Dec 29, 2010**
Date of per review: **Mar 9, 2011**
Date of acceptance: **Apr 15, 2011**
Date of Publishing: **Jun 13, 2011**