Prevalence of carriage of community-acquired Methicillin-resistant Staphylococcus aureus among children attending the pediatric OPD at a tertiary care hospital

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ABSTRACT

Background: Community-associated methicillin-resistant Staphylococcus aureus (CA-MRSA) infections are commonly recognized in persons without traditional risk factors. Nasal carriage of MRSA is an important risk factor for subsequent MRSA infection and transmission of this pathogen. The aim of this study was to estimate the prevalence of carriage of community acquired MRSA and to describe its antibiotic susceptibility pattern among the pediatric population.

Methods: A prospective longitudinal study was conducted in our hospital for a period of 6 months. All pediatric patients age less than 15 years attending the pediatric OPD were included in the study. A total of 325 children were included in the study based on our inclusion and exclusion criteria. Nasal smear was collected by tilting back the child’s head and gently inserting a sterile cotton swabs pre-wetted with sterile saline and slowly rotating against the turbinate of both anterior nares. The following antibiotics were tested for sensitivity pattern: penicillin, piperacillin, erythromycin, clindamycin, cotrimoxazole, vancomycin, linezolid, rifampin, ciprofloxacin and daptomycin. Any S. aureus that is resistant to Cefoxitin was defined as MRSA.

Results: The prevalence of Staphylococcus aureus was found to be 26.7% of the entire microorganism detected and 6.4% (n = 21) of the entire study subjects had methicillin resistant Staphylococcus aureus. Of testing the susceptibility of the various antibiotics vancomycin was the only drug found to be 100% sensitive followed by linezolid and piperacillin (90%). 50% sensitivity was seen with erythromycin and very poor sensitivity was seen in cefuroxime and ciprofloxacin (<50%).

Conclusions: CA-MRSA strains tend to replace HA-MRSA in health-care settings, making infection control measures less effective. Hospital based antibiotic policy has to be created and strictly followed to minimize the burden of antibiotic resistance.

Keywords: Antibiotic resistance, Community acquired, MRSA, Prevalence
factors, such as dialysis, intravenous permanent catheters, or intravenous drug abuse.1-5

The rapid spread of CA-MRSA has been characterized by outbreaks of cutaneous infections in healthy individuals, but can also cause soft tissue and bone infections, sepsis and endocarditis, as well as necrotizing, frequently lethal pneumonia, especially after influenza infection. Recently, multiple studies have reported that the frequency with which MRSA are acquired in the community is increasing and that this is occurring predominantly among persons without typical health care-associated risk factors for MRSA acquisition.6-9

The nose and open skin areas (e.g., wounds and device exit sites) are considered the most important sites for colonization. Nasal carriage of MRSA is an important risk factor for subsequent MRSA infection and transmission of this pathogen.10-12 The highest rates of CA-MRSA carriage (>50%) are reported in North and South America, Asia, and Malta. Intermediate rates (25-50%) are reported in China, Australia, Africa, and some European countries, such as Portugal (49%), Greece (40%), Italy (37%) and Romania (34%).13

Studies have shown that family members can serve as reservoirs for MRSA and that transmission can occur between family members including young children. However, the prevalence of colonization of family contacts of patients with active CA-MRSA infections is unclear and no controlled studies that included all contacts within families have been previously reported. In addition, molecular typing data from these familial MRSA transmissions is limited.14,15

After the discovery of penicillin, the mortality of SA infections was reduced dramatically. However, soon after the introduction of penicillin, penicillinase-producer SA strains were described. However, soon after the introduction of methicillin, SA strains with a modified transpeptidase that had low affinity for beta-lactam antibiotics were described. MRSA is mainly transmitted through skin-to-skin contact. India is a country with high population density, where the antibiotic consumption in humans is extremely high and there is no regulation of the use of antibiotics in livestock and poultry. This combination makes a perfect scenario for the spread of drug-resistant bacteria in the community.16,17 Although the prevalence of HA - MRSA has been described in some Indian hospitals, the prevalence of CA-MRSA in India is not well known.

The aim of this study was to estimate the prevalence of carriage of community acquired MRSA and to describe its antibiotic susceptibility pattern among the pediatric population.

METHODS

A prospective longitudinal study was conducted in our hospital for a period of 6 months. The study was started after getting the clearance from the institutional ethical committee.

All pediatric patients age less than 15 years attending the pediatric OPD were included in the study. Children on antibiotic prophylaxis, children with recent history of hospitalization, severely ill children requiring immediate resuscitation and those who refuse to give consent for the study were excluded from the study.

A written informed consent was obtained from the caregivers accompanying the children. A total of 325 children were included in the study based on our inclusion and exclusion criteria and in the above-mentioned study period. Patient details and information regarding the demography, nutritional status and the presenting complaints were noted. A thorough general and systemic examination were carried out in all patients and all the positive findings were recorded. Nasal smear was collected by tilting back the child’s head and gently inserting a sterile cotton swabs pre-wetted with sterile saline and slowly rotating against the turbinate of both anterior nares. So, two nasal swabs were collected and both the swabs were inserted in a test tube and properly transported to the microbiology laboratory for culture and sensitivity analysis.

Nasal swabs were processed within 2 hr of collection and primary plating was done on mannitol salt agar (MSA) without cefoxitin to screen for S. aureus. After inoculation, plates were incubated at 35 °C in oxygen and read after 24 and 48 hr. Each distinctive morphotype of mannitol fermenting colonies (yellow colonies) were selected from the MSA plate and sub-cultured on a 5% sheep blood agar plate. The colony is confirmed as S. aureus by catalase, slide coagulase (Staphaurex, Remel) and DNase tests. BD PhoenixTM Automated Microbiology System (Becton Dickinson, Franklin Lakes, New Jersey) was used for identification and antibiotics susceptibility testing for S. aureus species, which included testing for inducible clindamycin resistance. The following antibiotics were tested for sensitivity pattern: penicillin, pipercillin, erythromycin, clindamycin, cotrimoxazole, vancomycin, linezolid, rifampin, ciprofloxacin and daptomycine. Any S. aureus that is resistant to cefoxitin was defined as MRSA.

All data were entered and analysed using SPSS version 21. Mean and standard deviation were calculated for all the parametric variables. Chi-square test was used for deriving the statistical inference considering P <.05 as statistically significant.

RESULTS

Table 1 shows the age and gender wise distribution of the study subjects. The total number of pediatric subjects in the present study was 325 and the minimum age was 1 year, and the maximum age was 13 years with a mean
age of 7.3 years. The male subjects were slightly more than the female subjects with a male: female ratio of 1.3: 1, but the distribution of male and female subjects in different age group was almost similar without any statistical significant difference between them.

Table 1: Age and gender wise distribution of the study subjects.

| Age group (in years) | Gender   | Total | P value |
|----------------------|----------|-------|---------|
|                      | Male     | Female|         |
| 1-3                  | 26 (14.1%) | 21 (14.8%) | 47 (14.4%) |
| 4-6                  | 47 (25.5%) | 33 (23.4%) | 40 (12.3%) |
| 7-9                  | 57 (30.9%) | 35 (24.8%) | 92 (28.3%) |
| 10-12                | 46 (25%) | 51 (36.1%) | 97 (29.8%) |
| >12                  | 8 (4.3%) | 1 (0.7%) | 9 (2.7%) |
| Total                | 184 (100%) | 141 (100%) | 325 (100%) |
| Mean±SD              | 7.2±3.8 | 7.5±3.2 | 7.35±3.1 |

The microorganisms which were identified from the nasal smear of the study subjects were tabulated in Table 2. Gram positive cocci found in clusters was found to be the most common microorganism followed by gram positive cocci in pairs, coagulase negative Staphylococcus aureus was found in 8% of the subjects and only 14% of the nasal smears showed no growth.

Table 2: Distribution of various microorganisms identified from nasal smear.

| Microorganism                  | Frequency | Percentage |
|--------------------------------|-----------|------------|
| Gram positive cocci in clusters| 61        | 18.7       |
| Gram positive cocci in pairs   | 53        | 16.3       |
| Gram negative cocci            | 28        | 8.6        |
| Gram positive bacilli          | 44        | 13.5       |
| Gram negative bacilli          | 29        | 8.9        |
| CONS                            | 26        | 8          |
| Micrococc                      | 38        | 11.6       |
| No growth                      | 46        | 14.1       |
| Total                          | 325       | 100        |

The prevalence of staphylococcus aureus was found to be 26.7% of the entire microorganism detected and 6.4% (n = 21) of the entire study subjects had methicillin resistant staphylococcus aureus (Table 3). The methicillin resistant staphylococcus aureus was found to be more common in advanced pediatric age group (>10 years) than that of the younger age pediatric subjects and this difference was found to be statistically significant. Similarly, male pediatric subjects were more prone to have MRSA than the female children and the difference was statistically significant (p <.05) (Table 4).

Table 3: Prevalence of Staphylococcus aureus and methicillin resistant Staphylococcus aureus among the study subjects.

| Microorganism                  | Frequency | Percentage |
|--------------------------------|-----------|------------|
| Staphylococcus aureus          | 87        | 26.7       |
| Methicillin resistant Staphylococcus aureus | 21 | 6.4 |

Table 4: Age and sex wise distribution of the subjects with MRSA carriage.

| Age group | Gender   | Total | P value |
|-----------|----------|-------|---------|
| 1-3       | 2 (66.6%) | 1 (33.3%) | 3 (100%) |
| 4-6       | 1 (100%)  | 0     | 1 (100%) |
| 7-9       | 2 (66.6%) | 1 (33.3%) | 3 (100%) |
| 10-12     | 4 (100%)  | 0     | 4 (100%) |
| >12       | 7 (70%)   | 3 (30%) | 10 (100%) |
| Total     | 16 (76%)  | 5 (24%) | 21 (100%) |
| P         | <.0001    |       |         |

Table 5: Antibiotic susceptibility pattern for MRSA identified in present study subjects.

| Antibiotic | No. of MRSA isolates showing sensitivity pattern (n = 21) | Percentage |
|------------|----------------------------------------------------------|------------|
| Vancomycin | 21                                                       | 100        |
| Piperacillin| 19                                                      | 90.4       |
| Linezolid  | 19                                                      | 90.4       |
| Co-Amoxiclav| 17                                                      | 80.9       |
| Cotrimoxazole| 16                                                     | 76.1       |
| Erythromycin| 11                                                      | 52.3       |
| Clarithromycin| 15                                                     | 71.4       |
| Cefuroxime | 10                                                      | 47.6       |
| Ciprofloxacin| 8                                                       | 38         |

Of testing the susceptibility of the various antibiotics vancomycin was the only drug found to be 100% sensitive followed by linezolid and Piperacillin (90%). 50% sensitivity was seen with erythromycin and very poor sensitivity was seen in cefuroxime and ciprofloxacin (<50%) (Table 5).

DISCUSSION

Studies had shown that the anterior nares to be the main reservoir for S. aureus in adults and children. Nasal carriage of S. aureus has been demonstrated to be a significant risk factor for nosocomial and community-acquired infection in a variety of populations. Self-inoculation is thought to occur when organisms from the nose colonize other areas of the skin, leading to infection through skin lesions. Multiple studies of infected patients demonstrate the same MRSA strain in both the nose and the infection site, and eradication of nasal carriage with topical antimicrobials in most cases eliminates the...
organism from other body sites. Studies have found that nasal colonization with MRSA poses an increased risk of infection over that seen with MSSA (Methicillin sensitive staphylococcus aureus) carriage. In fact, our review revealed that at least 8 different definitions have been used to classify MRSA infections as community acquired.

Majority of studies of CA-MRSA have assessed patients presenting for hospital admission for any reason, and relatively few studies have been conducted among randomly selected healthy members of the community. Most studies of hospitalized patients have used a time-based approach to distinguish between community-acquired and nosocomial infections (e.g., infections present on admission or diagnosed within 48–72 hours of admission were considered to be community acquired) and in our study also we followed the same criteria for diagnosing community acquired methicillin resistant staphylococcus aureus. Knowledge of the prevalence of MRSA nasal carriage in a community provides a sense of the probability of contracting an MRSA infection in that community. Since CA-MRSA was first reported in 1993, it continues to emerge, and nowadays, in many areas, it is more common than HA-MRSA strains.

In India not many data have been published on the prevalence of MRSA colonization among children. previous Indian studies have reported CA-MRSA prevalence of 4.6–10.6%, whereas a study performed in the urban area of Bangalore reported that 22.5% of 1000 healthy individuals were carriers of SA, and in 72.7% of them, SA was methicillin resistant. The results of the present study is almost in par with the previous Indian studies where we found the overall prevalence of S. aureus was 26.7% and the prevalence of MRSA in the present study was 6.4% and similarly a study done at Saudi Arabia had also reported the prevalence rate of MRSA as 4.6% and the same study had also shown the prevalence of MRSA as 23.2% among the S. aureus carrier patients which is almost similar to the present study where we found the prevalence of MRSA among S.aureus carrier patients was 24.1%.

In another study from Andhra Pradesh, India, a carriage rate of 16% for S. aureus (19% MRSA) was documented. Studies from Taiwan and the U.S. have documented prevalence of nasal carriage of S. aureus among children ranging from 16–23% respectively. In contrast, Chatterjee, SS et al studied 489 school children aged 5–15 years by PCR and found nasal colonization of S. aureus in 256 (52.5%) of children, which is much higher compared to the present study and other reports. The comparatively higher prevalence rate may be attributed to the characteristics of the study population, although other factors (e.g., sampling and culture techniques) may have played a contributory role. The prevalence of colonization with S. aureus has previously been shown to be age dependent. In the present study, the prevalence varied across different age groups, with the lower prevalence in the first 12 months of life and the prevalence was more common in children aged more than 10 years of age and similarly male children found to have a higher prevalence rate than the female children which was found to be statistically significant which might be due to the higher exposure to the community and similar type of findings was also quoted in the studies conducted by Miller M et al and Regev-Yochay G et al.

In the current study we found the antibiotic resistance pattern was very high for erythromycin, ciprofloxacin and cephalosporins and the highest sensitivity pattern was observed for vancomycin followed by linezolid and pipercillin (>90%) and the present results was found to be in par with the study done by F. Alaklobi et al in Saudi Arabia. An Indian study had also shown that the levels of CA-MRSA resistant to vancomycin, linezolid, clindamycin, and gentamicin were low, and ciprofloxacin and cotrimoxazole resistance was common and in the present study also the cotrimoxazole resistance was found to be more common (25%), which is a commonly used antibiotic for pediatric patients.

Compared to the present study, a comparatively lower rate of resistance was found in the study conducted by Oguzkaya-Artan M, et al., where erythromycin resistance was noted in 6 of the 36 isolates (16.7%) and clindamycin resistance was present in 3 of the 36 isolates (8.3% total, 6.2 consecutive and 2.1% inducible); all tested isolated were susceptible to vancomycin, as noted in our study.

Present study had certain limitations like having a relatively smaller sample size, colonization from other body parts was not studied only from nasal cavity alone had been investigated and lastly molecular typing of the strains was not done due to lack of funding.

CONCLUSION

The prevalence of MRSA in the present study was found to be 6.4%, which seems to be relatively high, the spread of MRSA in the community can have important implication for hospital infection control programmes. When the prevalence of MRSA increases in the community, CA-MRSA strains tend to replace HA-MRSA in health-care settings, making infection control measures less effective for reducing the prevalence of MRSA. Hospital based antibiotic policy has to be created and strictly followed and so that the judicious use of giving high level antibiotics for ordinary infections leading onto increased prevalence of antibiotic resistance could be minimized.

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