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Risk Factors for Persistent MRSA Colonization in Children with Multiple Intensive Care Unit Admissions

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Abstract

We studied MRSA colonized children with multiple ICU admissions to assess the persistence of MRSA colonization. Our data found that children with more than one year between ICU admissions had a higher MRSA colonization prevalence than the overall ICU population, supporting empiric contact precautions for children with prior MRSA colonization.

Background

Methicillin-resistant *Staphylococcus aureus* (MRSA) remains a significant source of morbidity and mortality in the acute care pediatric setting.[1, 2] Hospitalized patients colonized with MRSA are at increased risk for MRSA infections and serve as a reservoir to spread the organism to other patients.[3] Efforts to prevent MRSA transmission in healthcare facilities often include screening programs to identify, cohort, and isolate MRSA carriers. Hospitals track patients with antibiotic-resistant organisms so they can be readily identified during subsequent admissions in an attempt to decrease MRSA transmission in health care facilities. Labeling children as “MRSA positive” and placing them under contact precautions can have negative consequences.[4] Additionally, the use of contact precautions adds costs to a financially extended healthcare system[5]. Minimal data exist on the duration of MRSA colonization in children to inform whether MRSA colonized children should be empirically isolated during subsequent visits, especially if prolonged periods of time have passed between admissions. Our objective was to determine the proportion of children that remain persistently colonized with MRSA on subsequent admission to the pediatric intensive care unit (PICU) and to identify characteristics that are associated with persistent colonization.

Materials and Methods

Setting and Design

The Johns Hopkins Hospital is a tertiary health care center with a 40-bed PICU. Since March 1, 2007, anterior nares swabs have been obtained at the time of admission and weekly

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thereafter from children in the PICU and cultured for MRSA using chromogenic agar (BBL CHROMagar MRSA, Franklin Lakes, NJ). Children admitted between March 1, 2007 and June 10, 2011 were eligible for inclusion in the current study. Any PICU admission during which a patient's surveillance or clinical culture grew MRSA contributed to the overall prevalence. Patients were included if they met the following criteria: had a surveillance or clinical culture grow MRSA at any time during a PICU admission and were screened for MRSA colonization at the time of the subsequent PICU admission. Multiple paired admissions were included if each pair met the above criteria. The outcome, persistent MRSA colonization, was defined as having MRSA isolated from a surveillance or clinical culture within 48 hours of the subsequent admission.

Data Collection

Electronic medical records and laboratory databases were reviewed to collect patient characteristics including age, race, gender, presence of any complex chronic condition (e.g., respiratory, hematological, cardiac, gastrointestinal[6], PICU admission dates, dates of all MRSA surveillance cultures, antibiotics prescribed, and additional cultures growing MRSA.

Statistical Analyses

Data were maintained in Microsoft Access 2007 (Microsoft Corp., Redmond, WA, USA) and analyzed using Stata 11 (Stata Corp., College Station, TX). Risk ratios (RR) and confidence intervals were calculated from log binomial regression models using the Generalized Estimating Equations (GEE) while accounting for clustering using an exchangeable correlation structure and robust variance estimates. Bivariate models were constructed for all variables and variables were selected for inclusion in a multivariable model if $P<0.10$ in bivariate models.[7]

Results

During the study period, there were 7,559 PICU admissions. Of these, 6541 patients were screened for MRSA at time of admission and 326 (5%) were either colonized with MRSA or had MRSA recovered from a clinical culture within 48 hours of admission. One hundred and thirty-six paired admissions met eligibility criteria, of which 121 patients (89%) grew MRSA from surveillance cultures and 53 (39%) from a clinical culture during the initial admission. Patients were 49% male and had a median age of 4.4 years. At the time of subsequent admission, 63 patients (46%) had persistent MRSA colonization. Of those admissions with persistent MRSA colonization, 60 (95%) grew MRSA from surveillance cultures and 22 (35%) grew MRSA from clinical cultures within 48 hours of admission (not mutually exclusive). The median time between admissions was 80 days. Of the 20 patients who had at least one year between PICU admissions, 5 (25%) had persistent MRSA colonization. Compared with the overall MRSA admission prevalence, the MRSA admission prevalence was higher in those with MRSA colonization or infection during the previous admission (46% vs 5%, $p<0.001$) and also in those with MRSA colonization or infection during a previous admission that was more than a year ago (25% vs 5%, $p=<0.001$).

Demographic characteristics including age, gender, race, and insurance status were similar between patients with and without persistent MRSA colonization (Table 1). Of the 4 patients that received mupirocin in the 30 days prior to the second admission, none had MRSA recovered during the second admission. In unadjusted analysis, exposure to other antibiotics with activity against MRSA within 30 days of the subsequent PICU admission was not associated with persistent colonization. Persistent MRSA colonization had a non-statistically significant association with having both clinical and surveillance cultures growing during

the first admission (RR-1.37, p=0.09). Persistently colonized patients had a trend towards shorter duration between PICU admissions when compared to patients that did not have persistent MRSA colonization (0.37 vs 0.63 years, p=0.07). After adjusting for having both surveillance and clinical cultures grow MRSA on the first admission, for every additional year between PICU admissions the risk of persistent colonization decreased by 42% (aRR 0.58 95% CI – 0. 35–0.97). After adjusting for time between PICU admissions, there was a trend towards increasing risk of persistent colonization among patients having both clinical and surveillance cultures grow MRSA during the first visit (aRR 1.35 95% CI 1.0–1.81).

Discussion

The duration of MRSA colonization in children is poorly studied and in those with repeated ICU admissions it is unknown. Our data show that MRSA colonization persists in up to 25% of children with more than one year between ICU admissions. Our results are in accord with studies in hospitalized adults that found persistent colonization in up to 21% of patients tested after four years.[8] Similar to our findings a study of pediatric outpatients found that 18% of MRSA colonized children remained colonized at 12 months.[9]

The current practice of isolating known MRSA patients upon readmission to the hospital is to minimize the risk of having unidentified reservoirs for MRSA transmission in healthcare facilities. The MRSA prevalence in children with at least one year between PICU admissions (25%) was well above the MRSA prevalence in our general PICU population (5%). Therefore, our data support the use of empiric contact precautions for previously MRSA colonized children upon admission to the PICU.

Despite a large population, there were only 136 paired visits. There were few children with more than 365 days between PICU admissions in this single-center study and the findings should be confirmed in other populations. Anterior nares cultures for detection of MRSA have lower sensitivity than cultures from multiple body sites so patients may have been misclassified which may have underestimated the risk of persistent colonization.[10]

Given the higher prevalence of MRSA colonization in those with prior MRSA colonization and infection compared with the overall MRSA colonization prevalence in this population, the current practice of empiric contact precautions upon PICU admission appears justified in patients with previous MRSA colonization. Larger longitudinal studies are needed to further corroborate these findings and guide management of patients with a history of MRSA colonization.

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Table 1

Characteristics of patients with and without persistent MRSA colonization on sequential Pediatric Intensive Care Unit admissions

Variables	Persistent MRSA colonization (n=63)	No Persistent MRSA colonization (n=73)	[d]Unadjusted		[d]Adjusted	
			RR(95% CI)	P-Value	aRR(95%CI)	P-Value
Age, median (range)	4.30(0.220.5)	4.9(0.3–18.7)	-	-	-	-
Male gender, number (%)	30(47.62)	37(50.68)	0.92(0.62,1.37)	0.67	-	-
African American, number (%)	24(38.10)	36(49.32)	0.79(0.54,1.16)	0.23	-	-
Time between visits in years, mean (SD)	0.37(0.59)	0.63(0.72)	0.61(0.36,1.05)	0.07	0.58(0.35,0.97)	0.037
Clinical culture grew MRSA during first admission, number (%)	27(47.86)	26(35.62)	1.15(0.80,1.67)	0.44	-	-
Surveillance culture grew MRSA during first admission	58(92.06)	63(86.30)	1.42(0.75,2.69)	0.28	-	-
Both clinical and surveillance cultures grew MRSA during the first admission	22 (34.92)	16 (21.92)	1.37(0.96,1.96)	0.09	1.35(1.0,1.81)	0.051
[a]Complex chronic medical condition, number (%)	50(79.37)	58(79.45)	1.00(0.63,1.59)	0.99	-	-
Clindamycin, n (%)	5(7.94)	2(2.74)	1.62(0.89, 2.92)	0.11	-	-
Bactrim, n (%)	6(9.52)	5(6.85)	1.15(0.60., 2.22)	0.67	-	-
Linezolid, n (%)	1(1.59)	1(1.37)	0.98(0.82, 1.16)	0.80	-	-
Vancomycin [b], n (%)	25(39.68)	14(19.18)	1.03(0.97,2.19)	0.906	-	-
Mupirocin [b c], n (%)	0(0)	4(5.48)			-	-

RR – Relative Risk; aRR – adjusted relative risk

[a]ICD9 codes were collected for each patient's hospitalization and categorized into underlying complex chronic medical conditions.[6,7] For comparison, patients were grouped as having any or no complex chronic condition.

[b]Only includes antibiotics received at our institution within 30 days prior to second PICU admission.

[c]All four patients with recent mupirocin use were excluded from adjusted analysis.

[d]Risk ratios calculated using log binomial models