imperative because current AST systems may not accurately characterize the resistance profile. Moreover, the interpretation of AST outputs should be undertaken with caution, especially in the setting of cascade reporting.

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Pathogen and Procedure Trends Among Surgical-Site Infections at a Children's Hospital: A 20-Year Experience

To the Editor—Surgical-site infections (SSIs) are common healthcare-associated infections that increase patient morbidity and mortality and cost the US healthcare system billions of dollars annually.[1] The 1999 Centers for Disease Control and Prevention (CDC) SSI prevention guidelines define a set of recommendations based on relative pathogen frequency and patient- and procedure-based SSI risk known at that time.[2] Most of the effort in SSI prevention has been built around these guidelines since their publication.[3,4] Additional recommendations have been published to direct specific aspects of SSI prevention, such as antimicrobial prophylaxis, in addition to their implementation and tracking.[5,6] While these updated guidelines have included new data, they are built upon the foundation of the 1999 CDC guidelines. Despite SSI rate improvement, SSIs remain the most common and costly healthcare-acquired infection in the United States.[1]

We hypothesized that targeted SSI prevention efforts based on the 1999 guidelines could have changed the relative pathogen frequency, possibly indicating a need to refine our approach to SSI prevention. We used SSI data from our medical center over 2 decades to study trends in SSI pathogen frequency.

METHODS

Pathogens associated with SSIs in incision class I and II surgical procedures[2] performed between January 1, 1994, and December 31, 2015, were obtained through the Infection Prevention and Control Program at Cincinnati Children's

TABLE 1. Prevalence of Pathogens Associated With Single-Pathogen and Polymicrobial SSIs

	Period					
Single-Pathogen SSIs	1994–1999	2000–2005	2006–2011	2012–2015	*P* Value	% Change Between Groups
MSSA	45 (28.1)	56 (26.2)	70 (35.9)	53 (36.1)	.03	3.50
MRSA	1 (0.6)	17 (7.9)	32 (16.4)	29 (19.7)	<.01	7.00
Coagulase-negative *Staphylococcus*	34 (21.3)	64 (29.9)	21 (10.8)	22 (15.0)	<.01	−4.20
Streptococcus spp.	6 (3.8)	6 (2.8)	8 (4.1)	4 (2.7)	.81	−0.10
Enterococcus spp.	7 (4.4)	11 (5.1)	6 (3.1)	8 (5.4)	.92	0.08
Other gram-positive isolates[a]	1 (0.6)	3 (1.4)	15 (7.7)	7 (4.8)	<.01	1.70
Pseudomonas aeruginosa	13 (8.1)	18 (8.4)	16 (8.2)	10 (6.8)	.65	−0.40
Enterobacter spp.	15 (9.4)	12 (5.6)	13 (6.7)	6 (4.1)	.12	−1.30
Other gram-negative isolates[b]	34 (21.3)	22 (10.3)	11 (5.6)	7 (4.8)	<.01	−4.40
Yeast/Mold	4 (2.5)	5 (2.3)	3 (1.5)	1 (0.7)	.11	−0.68
Total single-pathogen SSIs	160	214	195	147		
MSSA	9 (12.5)	9 (9.8)	11 (26.2)	6 (19.4)	.17	1.60
MRSA	0 (0.0)	7 (7.6)	4 (9.5)	3 (9.7)	.61	0.70
Coagulase-negative *Staphylococcus*	18 (25.0)	40 (43.5)	14 (33.3)	9 (29.0)	.40	1.20
Streptococcus spp.	10 (13.9)	14 (15.2)	3 (7.1)	6 (19.4)	.76	−0.32
Enterococcus spp.	30 (41.7)	23 (25.0)	9 (21.4)	6 (19.4)	.04	−2.87
Other gram-positive isolates[a]	4 (5.6)	7 (7.6)	12 (28.6)	3 (9.7)	.10	1.43
Pseudomonas aeruginosa	14 (19.4)	20 (21.7)	8 (19.0)	10 (32.3)	.33	1.33
Enterobacter spp.	21 (29.2)	15 (16.3)	7 (16.7)	3 (9.7)	.04	−2.28
Other gram-negative isolates[b]	50 (69.4)	55 (59.8)	19 (45.2)	16 (51.6)	.14	−2.87
Yeast and mold	7 (9.7)	16 (17.4)	4 (9.5)	3 (9.7)	.99	0
Total polymicrobial SSIs	163	206	91	65		

NOTE. Each value is expressed as the number of SSIs associated with that pathogen and the percentage of SSIs in which the pathogen was recovered. MSSA, methicillin-sensitive *Staphylococcus aureus*; MRSA, methicillin-resistant *S. aureus*.
[a]Other gram-positive isolates: Actinomyces spp., Bacillus spp., Clostridium spp., Corynebacterium spp., Eubacterium spp., Gemella spp., Lactobacillus spp., Propionibacterium spp., Peptostreptococcus spp, unidentified gram-positive cocci.
[b]Other gram-negative isolates: *Acinetobacter* spp., *Aeromonas* spp., *Argobacterium spp, Alcaligenes spp, Bacteroides spp, Capnocytophagia* spp., *Citrobacter* spp., *E coli, Eikenella* spp., *Flavobacterium* spp., *Fusobacterium* spp., *Hafnia spp, Haemophilus spp, Klebsiella spp, Moraxella* spp., *Morganella* spp., *Neisseria* spp., *Proteus* spp., other *Pseudomonas* spp., *Pantoea* spp., *Providencia* spp., *Prevotella* spp., *Serratia* spp., *Sphingobacteria* spp., *Xanthomonas* spp., unidentified gram-negative rods.

Hospital Medical Center. All SSIs were identified prospectively and met the CDC's National Nosocomial Infection Surveillance System (NNISS) or National Healthcare Safety Network (NHSN) criteria for SSIs at the time they occurred.[7]

Multiple reports of single pathogens from the same procedure were considered to represent a polymicrobial infection and were consolidated and counted as a single SSI. Cases were excluded from the final analysis if the associated surgery occurred prior to January 1, 1994, the SSI had no culture obtained or no pathogen identified, the result was reported as mixed flora, or if the SSI was associated with an incision class III or IV surgical procedure.[7] Cases were subsequently divided by the year in which the surgery was performed.

Procedures were stratified into 4 periods: 1994–1999, 2000–2005, 2006–2011, and 2012–2015. The organisms of single-pathogen and polymicrobial infections were determined for each period for SSIs meeting the inclusion criteria. Linear trends were analyzed for pathogen prevalence among single-pathogen SSIs and among polymicrobial SSIs utilizing variance-weighted least-squares regression, with $P < .05$ considered statically significant. Analyses were performed using STATA version 14.0 software (StataCorp, College Station, TX).

RESULTS

In total, 1,278 unique SSIs were reported at CCHMC during the study period, of which 953 were single or polymicrobial SSIs. Pathogens identified for single and polymicrobial SSIs are listed in Table 1.

Staphylococci were the predominant pathogens for single-pathogen SSIs. Among single-pathogen SSIs, the proportion of both methicillin-resistant and methicillin-susceptible *S. aureus* (MRSA and MSSA, respectively) increased during the study period. MRSA increased from 0.6% to 19.7% ($P < .01$), while MSSA increased from 28.1% to 36.1% ($P = .03$) (Table 1). The proportion of most other pathogens declined steadily, with the exception of *Enterococcus* spp., *Streptococcus* spp., and *Pseudomonas aeruginosa*, for which no change was detected (Table 1). Among polymicrobial infections, >50% included a gram-negative organism. No significant change was noted for most pathogens associated with polymicrobial SSIs.

DISCUSSION

Our study demonstrates that the pathogens most commonly associated with SSIs in pediatric surgical cases are similar to those in adults.[2] Current interventions are designed to prevent infections caused by skin flora. However, their ongoing prevalence despite these interventions suggests that additional interventions are needed to prevent SSIs caused by these organisms.

Staphylococcus spp. were the most prevalent species identified, and the proportion of both MSSA and MRSA increased over time. The increase in MRSA is not particularly surprising given

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its emergence as a major community pathogen nationally.[8] The concurrent increase in cases of SSIs caused by MSSA, however, was unexpected. This finding suggests that despite the increase in MRSA, MSSA still plays a large role in causing SSIs. Therefore, preoperative screening for *Staphylococcus* spp., not just MRSA, may help guide preoperative antibiotic selection, skin preparation, and postoperative wound care to minimize the risk of infection with either of these organisms.[9]

The predominance of gram-negative organisms in polymicrobial SSIs suggests that external contamination of the wound, (eg, with fecal matter) plays a major role in polymicrobial SSI pathogenesis. This finding highlights the ongoing importance of postoperative wound management and the need for protective barriers to prevent contamination of the wound.[9]

Our conclusions are limited by our inability to account for potential correlations between patient-level characteristics, such as comorbidities, with particular organisms causing SSIs. [10] Another limitation was our inability to assess the direct influence of specific interventions that occurred in our medical center over the study period.[3] Further study is planned to examine such interactions.

Our study findings indicate that among pediatric patients, skin and bowel flora play a significant role in SSIs. Future interventions to target aspects such as preoperative screening and management of MSSA and MRSA colonization and postoperative wound management to prevent fecal contamination may reduce pediatric SSIs. Further study is planned to assess the effect of patient and procedure factors as well as interventions on both the incidence of and the type of pathogens associated with SSIs.

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Oak in Hospitals, the Worst Enemy of *Staphylococcus aureus*?

To the Editor—Although the infection risk to patients from contaminated healthcare surfaces has long been controversial, it is now recognized that the environment may facilitate transmission of several important healthcare-associated bacteria, including vancomycin-resistant enterococci, *Clostridium difficile*, *Acinetobacter* spp., and methicillin-resistant *Staphylococcus aureus* (MRSA).[1] In addition, the longer a nosocomial pathogen persists on a surface, the longer it may be a source for transmission to a susceptible patient or healthcare worker.[2] Therefore, regular and conscientious cleaning is a necessary measure for keeping surfaces free from microbes. The nature of surfaces can also be considered.[1] Although the use of wood is not banned in hospitals,[3] this material still generates controversy in terms of infection