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Major Article

Incidence of health care–associated extended-spectrum β-lactamase-positive patients before and after discontinuation of contact precautions

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Background: Isolation of patients with multidrug-resistant organisms has been recommended in several guidelines. Recent evidence has suggested potential negative effects of isolation on patient well-being and facility throughput. Published literature shows a difference in transmission risk of extended-spectrum β-lactamase (ESBL)-producing organisms, suggesting that contact precautions may not be necessary for all ESBL-positive organisms.

Methods: Incidence rates of health care–associated ESBL organisms were measured before and after eliminating the use of contact precautions for patients with only ESBL-positive organisms. The National Healthcare Safety Network surveillance methodology was used to measure incidence. Surgical site infections and carbapenem-resistant Enterobacteriaceae were excluded from the surveillance incidence.

Results: The incidence of health care–associated ESBL infections from January 2014 through November 2015 was 3.71 per 10,000 patient days. The incidence from December 2015 through August 2017 was 3.00 per 10,000 patient days. This rate change was statistically significant ($P = .022$)

Conclusions: This study found that discontinuing the use of contact precautions for patients colonized or infected with ESBL-positive organisms did not lead to an increased rate of health care–associated ESBL-positive infections or colonization.

Extended-spectrum β-lactamase (ESBL)-producing organisms have been reported in the literature since the late 1980s. The difficulty in finding effective antimicrobial treatment for these resistant organisms is a growing concern for health care providers. Recent estimates from the Centers for Disease Control and Prevention attribute approximately 26,000 infections per year involve ESBL-producing organisms.[1] Further studies have described the increasing prevalence of ESBL-producing organisms[2,3] and their role in health care–associated infections (HAI).[4]

The Health Care Infection Control Practices Advisory Committee Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Health Care Setting recommends the use of standard plus contact precautions for patients infected or previously colonized with target multidrug-resistant organisms (MDRO) in acute care hospitals.[5] Despite this recommendation, the specifics of target MDROs have not been codified and give facilities the flexibility to determine precautions for specific organisms. The role of contact precautions for ESBL-producing organisms has been questioned in several studies.[6-9] Additionally, a randomized controlled trial of universal gowning and gloving in the intensive care units (ICUs) did not show reduced rates for methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE) transmission, organisms with well-known links to environmental contamination.[10]

The role of the environment in ESBL transmission has been explored. Studies on environmental contamination demonstrated that ESBL-producing *Klebsiella pneumoniae* were more likely to lead to environmental contamination than ESBL-producing *Escherichia coli*, although they were not able to assess risk for transmission.[11] In comparison to other environmental pathogens, transmission attributable to environmental contamination is limited in the literature, however, Nseir et al[12] found that there was no relationship between ESBL-producing gram-negative bacilli and acquisition of those bacteria by subsequent room occupants.

Community transmission, especially between household contacts of ESBL carriers, has become increasingly important as a significant mode of transmission. Estimates of 14%-35% of observed community prevalence were attributable to household transmission.[13] Transmission models have also shown that household or out-of-hospital

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transmission factors may outweigh nosocomial transmission as a factor in the overall incidence of infection or colonization with ESBL-producing organisms.[14] Haverkate et al[13] reviewed isolates from household contacts of ESBL-carrying patients identified during a hospital stay and determined through modeling that these household contacts were most likely colonized prior to the patient's hospitalization. Community transmission through contaminated meat and other food sources has also been implicated as a major transmission route within the community.[15]

In recent literature, use of contact precautions and isolation measures have been examined relating to quality of care. Several studies have demonstrated negative impacts on patients as well as increased costs related to the use of contact precautions in hospitals.[16-18] Patients in isolation precautions were reported to be twice as likely to experience an adverse outcome, such as falls, pressure ulcers, and electrolyte errors compared with patients not in isolation.[16] Additionally, providers were half as likely to examine patients in isolation compared with patients on standard precautions.[19] A recent literature review found negative impacts on mental well-being, including higher scores for depression, anxiety, and anger among isolated patients.[20] A risk assessment should be performed when considering a change in practice regarding contact precautions.

The aim of this study was to review the incidence of HAI and colonization of patients with ESBL-producing organisms both before and after discontinuing the use of contact precautions.

METHODS

Tampa General Hospital (TGH) is a 1,010 bed, nonprofit, academic medical center and is home to a level 1 trauma center for both adults and pediatrics, comprehensive burn and stroke center, solid organ transplant center, level IV neonatal ICU, and has the largest neuroscience ICU in the region. Our facility has 158 intensive care beds plus an additional 82 neonatal ICU beds. Forty-three percent of our beds are semiprivate. TGH is affiliated with the University of South Florida Morsani College of Medicine, located in an urban core setting, and is the only safety net hospital for adults in the Tampa Bay area. The University of South Florida institutional review board provided ethics approval for this study.

In November 2015, the TGH infection prevention committee reviewed surveillance data on health care–associated ESBL-positive organisms, hand hygiene, and isolation compliance rates, as well as challenges with bed placement related to isolation needs. These factors, in addition to the growing literature on adverse effects of isolation, led to the approval of a proposal to eliminate the use of routine contact precautions for patients colonized or infected with ESBL-producing organisms as a sole reason for isolation. The change in practice went into effect December 2015.

No changes were made in the use of contact precautions for patients who met definitions for other MDROs, (ie, MRSA, VRE, carbapenem-resistant Enterobacteriaceae [CRE], et cetera) For this review, the preintervention period was defined as January 2014 through November 2015, and the postintervention period was defined as December 2015 through August 2017. Although the pre- and postintervention time periods differed, both populations were large enough to illustrate the aim of this study.

A patient search was performed in the clinical documentation support system, extracting all documented results for ESBL-producing organisms from January 2014 through August 2017. All documented cases of ESBL infections or colonization (both community-associated and health care–associated) were included for review. We extracted data on infection classification, age, sex, admission date, organism, site of infection or colonization, documented history of ESBL-positive organism, and concurrent isolation status for any other organisms at the time of the documented infection. Infections were classified as community-associated infections or HAIs using the established definitions of the National Healthcare Safety Network. These definitions classify an infection as health care–associated if the date of event is on or after hospital inpatient day 3. Patients with a documented history of the same ESBL-producing organism and source (ie, urine, blood, wound) were only counted as 1 event. Patients with repeat infections or colonization during the study period were only counted once. *Enterobacteriaceae* that met definitions for either CRE or carbapenemase producer-CRE were omitted from the study as there was no change in use of contact precautions for CRE and carbapenemase producer-CRE if they also were ESBL-producing. Surgical site infections were excluded from the data due to often lengthy, 30- or 90-day surveillance windows in which patients may be sent home or to another facility for rehabilitation.

Incidence density rates were calculated and defined as the number of cases per 10,000 patient days for HAIs and the number of cases per 10,000 encounters (admissions, emergency department, and/or observation visits) for community-associated cases. These are consistent with measurements used in other HAI analyses through the National Healthcare Safety Network.

We explored the data using descriptive statistics and a 2-tailed Z-test for pre- and postintervention relationships. Additionally, we applied an interrupted time series analysis of health care–associated ESBL incidence density rates to assess interaction of trends on the model. Serial autocorrelation, seasonality, and stationarity were tested and adjusted using the Durbin-Watson statistic and the Dicky-Fuller unit root test, as applicable. Time series variables including trend over total study time, trend since implementation, and trend pre- and postintervention were fit and analyzed using autoregressive integrated moving average analysis techniques. All analyses were performed using SAS BASE 9.4 (SAS Institute, Cary, NC).

RESULTS

Overall, 1,273 laboratory results were eligible for inclusion and review. There were 387 documented HAI ESBL infections from January 2014 through August 2017. The pooled ESBL incidence density rate in the prediscontinuation period was 3.71 per 10,000 patient days. After discontinuation of routine contact precautions, the postintervention period pooled ESBL incidence density rate was 3.0 per 10,000 patient days. The rate of documented health care–associated ESBL infection after discontinuation of contact precautions was 25% lower compared with the baseline period ($P < .001$). As a comparison background measure, the admission prevalence rate of community-associated cases increased from 13.11 per 10,000 in the preintervention period to 17.20 in the postintervention period ($P = .001$). When analyzed by individual organism species and infection type, no statically significant change was noted (Table 1).

The interrupted time series autoregressive integrated moving average model revealed no significant difference between pre- and postintervention incidence rate trends. The variable of total time (from start of preintervention period to end of postintervention period) revealed an overall decreasing trend in ESBL transmission. None of the independent variables achieved statistical significance in the model. The Durbin-Watson statistic confirmed no autocorrelation (Durbin-Watson = 2.11) and the Dickey-Fuller unit root test confirmed stationarity of the outcome variable (tau, −6.54; $P < .001$) for the model.

In addition, results demonstrated approximately 378 patients with ESBL-positive organisms who were not placed in isolation precautions in the postintervention period.

DISCUSSION

Our study demonstrated no increase in the incidence of health care-acquired ESBL-producing incidence after discontinuation of

Table 1
Rates of extended-spectrum β-lactamase organisms preintervention and postintervention period

	Preintervention			Postintervention			
	Number	Denom	Rate	Number	Denom	Rate	*P* value
Community prevalence rate	370	282145	13.114	516	299983	17.201	.001
HAI incidence rate (all organisms)	221	595336	3.712	166	553748	2.998	<.001
Incidence by organism							
Escherichia coli	124	595336	2.083	94	553748	1.698	.13
Klebsiella pneumoniae	51	595336	0.857	45	553748	0.813	.80
Enterobacter spp	31	595336	0.521	19	553748	0.343	.15
Other	15	595336	0.252	8	553748	0.144	.21
Incidence by infection type							
Colonization	106	595336	1.781	101	553748	1.824	.86
BSI	6	595336	0.101	3	553748	0.054	.40
UTI	50	595336	0.840	27	553748	0.488	.21
SST	14	595336	0.235	5	553748	0.090	.06
PNEU/LRI	27	595336	0.454	18	553748	0.325	.28

Community prevalence rate = community cases per 10,000 patient encounters (admissions and emergency department visits); HAI incidence rate = healthcare- associated extended-spectrum β-lactamase infections per 10,000 patient days.
BSI, bloodstream infection; *Denom*, denominator; *HAI*, health care–associated infection; *LRI*, lower respiratory infection; *PNEU*, pneumonia; *SST*, skin and soft tissue; *UTI*, urinary tract infection.

routine contact precautions for patients infected or colonized with ESBL-producing organisms. Incidence rates remained low, comparable to rates found in other studies.[7,8]

Overall, the rate of ESBL-incidence decreased over the entire study period. This is likely do to multimodal efforts to reduce HAI in general, such as emphasis on basic prevention measures such as hand hygiene, environmental cleaning, best practice prevention bundles, and emphasis aimed at other MDROs, namely MRSA, VRE, and *Clostridium difficile*. Continuous efforts focusing on quality improvement initiatives are ongoing, however, no significant program changes affecting MDROs were initiated during the postintervention period.

Evidence is mounting that transmission occurs in the community setting, not merely in health care facilities.[13-14,21-25] Ender et al[26] documented a case report of familial transmission during minimal contact, indicating high transmissibility of ESBL. Haverkate et al[13] reported a high number of patients were carriers of ESBL prior to hospitalization. Numerous studies have been reported outside of the United States, which limited comparison of prevalence rates.[3,7,8] Other MDRO prevalence studies performed in the United States show varying prevalence rates depending on the region of the country and the organism (ie, higher VRE rates in northern vs increasing MRSA rates in the southern United States).[27] No studies have been identified that indicate baseline rates of ESBL in our local area. Therefore, our facility community prevalence rates were used as a surrogate for the local background prevalence.

We found that community-associated cases presenting at time of admission significantly rose over the study period. This may be attributed to factors described earlier in household and community transmission models, leading to increasing out-of-hospital colonization rates.

We also found no difference between species of ESBL-producing organisms, although differences in transmission by species has been observed by others such as Freeman et al[11] and Hilty et al.[14] As shown by Cholley et al,[28] *E coli* has been shown to have a lesser rate of transmission.

Most of our study isolates were *E coli*, in line with previous results from community- and hospital-associated studies. ESBL-producing *Klebsiella* and *Enterobacter* did not demonstrate increased rates, although our study had a limited sample of non-*E coli* isolates.

As stated in national guidelines,[29] standard plus contact precautions are recommended for patients with targeted MDROs in the acute care setting. Recommendations from the Society for Healthcare Epidemiology of America, which were updated in 2018, re-emphasized the need for use of contact precautions for MRSA, VRE, and other epidemiologically significant organisms such as ESBL-producing organisms.[31] Numerous studies have been published reviewing discontinuation of other MDROs.[30] Not until recently have national guidelines given recommendations as to the length of precautions and laboratory requirements for clearance of isolation, emphasizing a large variety of isolation practices throughout the United States.[5,31] Current recommendations do not specify when to initiate contact precautions,[31] allowing for individual institutions to determine the best response for handling a specific MDRO based on the significance of the organism, endemic rates, patient population, and the institution's laboratory capabilities.[5]

Assessment of isolation practices can impact other facets of health care. Specifically, Stelfox et al[16] found that isolation patients were 7 times more likely to experience a preventable adverse outcome. Although the authors of that study did not find a difference in mortality outcomes, they saw marked decreases for isolation patients in measures of patient engagement, satisfaction, and safety measures. In our study, approximately 378 patients were not isolated for an ESBL-positive organism owing to the change in routine practice. This potentially reduces the risks of adverse events for this group of patients.

Although we appreciate the significance of ESBL-producing pathogens, in both community-associated and health care–associated infections, our experience did not reveal an increased risk of transmission when routine contact precautions were not used during hospitalization. Further study is needed to assess transmission modes and evaluate the impact of contact precautions. As many facilities struggle with patient flow and isolation, assessing the need for contact precautions can help focus efforts on organisms with greater environmental risk and reduce negative effects of excess isolation.

Our study includes several limitations. First, we did not screen for ESBL colonization on admission to our facility, thus increasing the possibility of mistakenly identifying community-associated colonization or infection as health care–associated after several days of hospitalization. Second, we did not have the resources to review detailed patient comorbidities, exposure to procedures, or other clinical factors to determine whether there were differences in the pre- and postintervention period based on those factors. In addition, as seen in Table 1, the majority of our ESBL isolates were *E coli*, which limited the comparison of ESBL *E coli* and other ESBL-producing organisms that may have differences in transmissibility in the health care environment. As discussed by Cholley et al,[28] differences in transmission were present between ESBL *E coli* and ESBL *K pneumoniae* isolates. Finally, genetic typing of each isolate was not performed, so we were unable to determine related transmission or patterns of the same genetic organisms.

CONCLUSIONS

These findings demonstrated no increased rate of transmission of ESBL-positive organisms after the use of contact precautions was discontinued. Community prevalence increased over the study period. In addition, we were able to potentially avoid adverse risks and costs associated with contact precautions in the population who would previously have been placed in precautions. Further study is needed to evaluate any potential effects on transmission in the community- and nonhospital-based health care settings.

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