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Concise Communication

Trends in methicillin-resistant *Staphylococcus aureus* bloodstream infections using statewide population-based surveillance and hospital discharge data, Connecticut, 2010–2018

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Abstract

We compared methicillin-resistant *Staphylococcus aureus* (MRSA) bloodstream infections (BSIs) captured by culture-based surveillance and MRSA septicemia hospitalizations captured by administrative coding using statewide hospital discharge data in Connecticut from 2010 to 2018. Observed discrepancies between identification methods suggest administrative coding is inappropriate for assessing trends in MRSA BSIs.

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Staphylococcus aureus infections range in severity from superficial skin and soft-tissue infections (SSTIs) to life-threatening septic shock, and they account for significant morbidity and mortality in the United States.[1] The Centers for Disease Control and Prevention (CDC) Emerging Infections Program (EIP) uses population-level culture-based surveillance to monitor trends in invasive methicillin-resistant *Staphylococcus aureus* (MRSA) infections.[2] Although previous research suggests that *International Classification of Disease, 9th Revision, Clinical Modification* (ICD-9-CM) coding in administrative data is a poor indicator of true MRSA infection, codes have recently been used to describe trends and to study clinical outcomes.[3–8]

Interestingly, results using ICD-9-CM codes show a stable trend in MRSA septicemia, the ICD-9-CM code most representative of MRSA bacteremia events, which differs from the declining trend in MRSA bloodstream infections (BSIs) seen in culture-based surveillance.[1,2,6,7] Considering these discrepancies, we compared MRSA septicemia hospitalizations identified using administrative codes with MRSA bloodstream infections identified using culture-based surveillance within 1 region to update our knowledge of the performance of administrative codes.

Methods

We obtained EIP MRSA BSI data through statewide active laboratory- and population-based surveillance conducted by the Connecticut EIP from January 1, 2010 through December 31, 2018. A case of MRSA BSI was defined as a positive blood culture for MRSA in a Connecticut resident who did not have a positive invasive culture from a normally sterile site in the preceding 30 days. Only cases hospitalized in Connecticut were included in the analysis.

Administrative codes from hospital discharge data were used to identify cases of MRSA septicemia hospitalizations among Connecticut residents discharged from a Connecticut hospital from January 1, 2010, through December 31, 2018. Cases were identified using the ICD-9-CM diagnosis code for MRSA septicemia (038.12; January 1, 2010, to September 31, 2015) and the ICD-10-CM diagnosis code for sepsis due to MRSA (A41.02; October 1, 2015, to December 31, 2018). The first 10 diagnosis codes were captured because codes beyond the tenth position are not available in hospital discharge data. Only hospitalizations of Connecticut residents were included. Recurrent hospital stays within 30 days of a discharge coded for MRSA septicemia were excluded.

Case counts of MRSA identified in administrative codes and using EIP surveillance were plotted annually from 2010 to 2018, and unadjusted trends were modeled using negative binomial regression. Differences in trends between the 2 data sources were assessed using an interaction term, and aggregate case counts were assumed to be independent between the 2 data sources. We calculated the percent change between 2010 to 2018, and the magnitude of the difference in case counts from the 2 case-identification methods (using percent difference) overall and for each year.

Results

In total, 5,475 hospitalized MRSA BSI cases were identified by Connecticut EIP surveillance from 2010 to 2018. ICD codes in statewide hospital discharge data captured 4,320 MRSA septicemia hospitalizations during the same period. Administrative data

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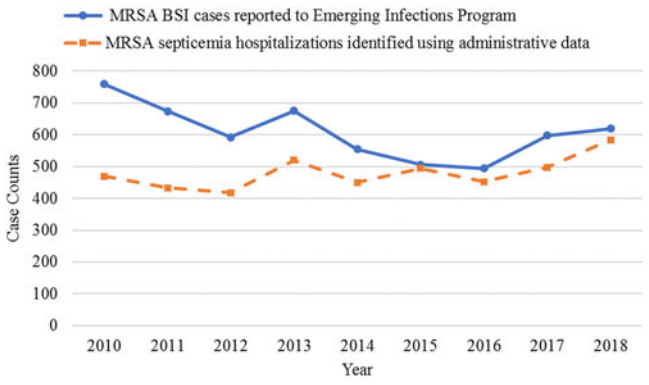

Fig. 1. Annual number of cases of methicillin-resistant *Staphylococcus aureus* (MRSA) bloodstream infections (BSIs) and MRSA septicemia hospitalizations, 2010–2018.

identified 21.1% fewer cases than EIP surveillance. Modeled case counts identified significantly different trends in EIP surveillance compared with administrative codes ($P = .0012$). Models estimated a 21.4% (95% confidence interval [CI], 5.9%–34.4%) decrease in the number identified by EIP and a 20.7% (95% CI, 0.1%–45.7%) increase in the number of cases identified by administrative codes.

Comparison of these data show annual discrepancies in most years (Fig. 1). The largest difference between the 2 data sources occurred in the first year (2010), when the number of MRSA BSIs identified among EIP data was 760 compared to 470 MRSA septicemia hospitalizations among hospital discharge data. Case counts were most similar between EIP and discharge data in 2015: 506 and 495 cases, respectively. Discrepancies in case counts increased in 2016 and 2017 (43 and 100 discrepant cases, respectively) and decreased to 35 discrepant cases (ie, 619 EIP surveillance versus 584 administrative cases) in 2018.

Discussion

According to these findings from Connecticut, culture-based surveillance and coded hospital discharge data show substantial differences in trends of case counts of MRSA BSIs and MRSA septicemia hospitalizations from 2010 to 2018. The discrepancies identified in this analysis are consistent with results of other analyses showing different trends in MRSA BSI incidence when administrative data are used.[1,2,5–7] Reasons suggested by the authors of these publications include limitations of administrative data and differences in the areas under surveillance.[5–7] Recently published papers seem to hold code-based surveillance methodology as a benchmark for assessing progress in clinical outcomes related to MRSA infection, as long as the limitations are well described.[7] We have shown that even when using data from the same set of hospitals, administrative data do not approximate results from an audited active laboratory-based surveillance system. When assessing MRSA BSI case counts, there is no consistent trend among hospital discharge data that mirrors trends seen in EIP, both in this analysis and overall.[1,2,5–7] As noted in the results, case counts and trends appear to be more similar between MRSA septicemia coding and blood cultures in later years, but this does not appear to be directly aligned with the ICD-10-CM transition (see the Supplemental Material online). Ongoing monitoring of recent trends will be important prior to assuming that measuring trends with administrative codes is appropriate.

The EIP surveillance and administrative data sources may not capture the same infections. This discrepancy could be related to differences in the criteria used by administrative coders to define septicemia and the EIP surveillance definition for MRSA bloodstream infection (ie, positive blood cultures).[7] There are clinical differences between septicemia and BSIs; however, researchers commonly use septicemia codes in administrative data as a surrogate for BSIs.[8] However, if non-BSI MRSA positive cultures were included as MRSA septicemia in the administrative data, we would expect administrative data to estimate more MRSA BSIs than EIP surveillance, opposite of our study's findings. Additional potential causes for the discrepancy in the cases identified include that positive cultures are obtained in only 50% of sepsis cases and that coding for sepsis has increased over time, even when sepsis incidence measured by objective clinical data has not.[9,10]

Our analysis has several limitations. Connecticut hospital discharge data only capture the first ten discharge diagnosis codes. However, sensitivity analyses indicate that the lack of diagnosis codes after the tenth position does not meaningfully explain the discrepancies in case counts and results seen because <5% of MRSA septicemia codes occurred after the tenth position (see the Supplemental Material online).

Our comparison again highlights concerns regarding the accuracy and credibility of using administrative data to track changes in MRSA BSI incidence over this 9-year period. Validations of *S. aureus* administrative coding in both the ICD-9-CM and ICD-10-CM eras are needed to evaluate the appropriateness of using administrative codes in epidemiological research for other purposes. For example, a recent study published using administrative data alone found significant associations with increased in-hospital mortality, length of stay, and 30-day readmission for patients with MRSA bacteremia compared with MSSA bacteremia, citing Klein et al as precedent for using ICD-9-CM codes for identification.[7,8] The impact that potential misclassification of *S. aureus* identification has on studies evaluating clinical outcomes is unclear. The concerning discrepancy between trends in case counts from Connecticut suggest that administrative data do not correctly assess historical trends in MRSA BSIs, and validation of codes should be conducted before future use in studies of MRSA epidemiology.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2020.72

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