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Validity of *ICD-9-CM* Coding for Identifying Incident Methicillin-Resistant *Staphylococcus aureus* (MRSA) Infections: Is MRSA Infection Coded as a Chronic Disease?

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Abstract

BACKGROUND AND OBJECTIVE—Investigators and medical decision makers frequently rely on administrative databases to assess methicillin-resistant *Staphylococcus aureus* (MRSA) infection rates and outcomes. The validity of this approach remains unclear. We sought to assess the validity of the International Classification of Diseases, 9th Revision, Clinical Modification (*ICD-9-CM*) code for infection with drug-resistant microorganisms (V09) for identifying culture-proven MRSA infection.

DESIGN—Retrospective cohort study.

METHODS—All adults admitted to 3 geographically distinct hospitals between January 1, 2001, and December 31, 2007, were assessed for presence of incident MRSA infection, defined as an MRSA-positive clinical culture obtained during the index hospitalization, and presence of the V09 *ICD-9-CM* code. The kappa statistic was calculated to measure the agreement between presence of MRSA infection and assignment of the V09 code. Sensitivities, specificities, positive predictive values, and negative predictive values were calculated.

RESULTS—There were 466,819 patients discharged during the study period. Of the 4,506 discharged patients (1.0%) who had the V09 code assigned, 31% had an incident MRSA infection, 20% had prior history of MRSA colonization or infection but did not have an incident MRSA infection, and 49% had no record of MRSA infection during the index hospitalization or the previous hospitalization. The V09 code identified MRSA infection with a sensitivity of 24% (range, 21%–34%) and positive predictive value of 31% (range, 22%–53%). The agreement between assignment of the V09 code and presence of MRSA infection had a kappa coefficient of 0.26 (95% confidence interval, 0.25–0.27).

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CONCLUSIONS—In its current state, the *ICD-9-CM* code V09 is not an accurate predictor of MRSA infection and should not be used to measure rates of MRSA infection.

National estimates of the burden and distribution of methicillin-resistant *Staphylococcus aureus* (MRSA) infection would be valuable to clinicians, hospital administrators, insurers, and policy makers. Large multicenter studies have provided a national view of the rates and distribution of MRSA infection and its associated outcomes.¹⁻⁴ Many of these studies, as well as reports from groups such as the Agency for Healthcare Research and Quality (AHRQ) and California's Office of Statewide Health Planning and Development, rely on administrative data to track state and national rates of MRSA infection.¹⁻⁶ In addition, administrative data may be used alone or in combination with other types of data by hospitals for automated surveillance of healthcare-associated infections.⁷⁻⁹

The administrative code frequently used to assess rates of MRSA is the International Classification of Diseases, 9th Revision, Clinical Modification (*ICD-9-CM*) code for infection with drug-resistant microorganisms, which is labeled V09.¹⁻⁶ However, the purpose of the V09 code is to bill third-party payers for treatment of drug-resistant infections, and it may not be a valid measure for use in MRSA surveillance. Thus, unanticipated use of the V09 code, such as using it to represent a prior history of MRSA infection, could be responsible for increasing trends rather than increasing rates of infection.

Results of previous studies suggested that administrative coding may accurately identify some healthcare-associated infections but not others.¹⁰⁻²¹ Studies have found that administrative codes have high positive predictive values (PPVs) for identifying conditions such as sepsis, pneumonia, and *Clostridium difficile* infection, with PPVs ranging from 40.8% to 88.9%.¹⁵⁻²⁰ However, studies that validated *ICD-9-CM* coding to identify healthcare-associated infections (defined as surgical site infection, bloodstream infection, urinary tract infection, or pneumonia) had PPVs of 20% and 21.7%.^{11,12} Sherman et al¹² found that most discharged patients classified as having a healthcare-associated infection using administrative data were misclassified. One study assessed the sensitivity and PPV of the V09 *ICD-9-CM* code to identify MRSA infections over a 6-month period at an Illinois hospital. They reported that use of this code underestimated the true number of MRSA infections with a sensitivity of 59%, yet had a high PPV of 92%.²²

The purpose of this multicenter study was to assess the validity of the V09 *ICD-9-CM* code for identification of MRSA infection by determining its corresponding sensitivity, specificity, PPV, and negative predictive value (NPV), compared with MRSA-positive clinical culture. We also aimed to assess whether the V09 code is currently used to represent prior history of MRSA infection, in addition to incident infection.

METHODS

This retrospective cohort study included all adults discharged from University of Maryland Medical Center (Baltimore, MD), Stroger Hospital of Cook County (Chicago, IL), and University of Utah Health Sciences Center (Salt Lake City, UT) between January 1, 2001, and December 31, 2007. Each discharge was treated as an independent event, and therefore a given patient may have been included in the study more than once. Retrospective data were collected from 3 hospital medical informatics databases: the University of Maryland Medical Center central data repository, the University of Utah Data Warehouse, and the Cook County Health and Hospitals System electronic data warehouse database.²³ These databases contain medical, microbiologic, and administrative data. These databases have been repeatedly validated and used in many studies of infectious diseases.²⁴⁻³⁴

There are multiple *ICD-9-CM* codes that define the V09 *ICD-9-CM* code in greater detail, ranging from the V09.0 code for penicillin resistance to the V09.91 code for “infection with drug-resistant microorganisms unspecified with multiple drug resistance.” The *ICD-9-CM* code for MRSA infection was considered present if any of the V09 codes were present in the first 15 discharge diagnostic codes. This definition was intentionally broad, to maximize the sensitivity of the V09 code for identifying MRSA infection. A subanalysis was performed limiting the definition of the V09 *ICD-9-CM* code to presence of the V09.0 code for penicillin resistance and at least 1 additional *ICD-9-CM* code for *S. aureus*, including: 038.11 (*S. aureus* septicemia), 482.41 (*S. aureus* pneumonia), and 041.11 (*S. aureus* infection, unspecified site). The narrow definition in the subanalysis was chosen to maximize the specificity and PPV of the V09 *ICD-9-CM* code for identifying MRSA infections.

An incident MRSA infection was defined as present if a clinical culture from blood, sputum, urine, or a wound obtained during the index hospitalization was positive for *S. aureus* and the isolate was resistant to oxacillin by screen agar test. This definition has been validated in a previous study performed at the University of Maryland Medical Center during an overlapping study period.³⁵ That study found that 82% of cases with an MRSA-positive clinical culture met the National Healthcare Safety Network definition for MRSA infection.

Data on prior history of MRSA colonization or infection was collected to assess whether presence of the V09 *ICD-9-CM* code for the index hospitalization could be the result of exposure to MRSA during a previous hospitalization. Prior history of MRSA colonization or infection was defined as a record of any MRSA-positive culture, either surveillance or clinical cultures, during any previous hospitalization to the index hospital.

The number and percentage of patients discharged who had the V09 *ICD-9-CM* code assigned and/or MRSA infection were summarized. Contingency tables were created to calculate the sensitivity, specificity, PPV, and NPV of the V09 code to identify the presence of an MRSA-positive clinical culture. Changes in the PPV over time were measured using the χ^2 test for trend. The κ statistic was calculated to measure the agreement between presence of MRSA infection and assignment of the V09 code.³⁶ Statistical analysis was performed using SAS software, version 9.1 (SAS Institute). This study was approved by the institutional review boards of all 3 hospitals.

RESULTS

During the 7-year study period, there were 192,921 patient discharges from Hospital A, 126,461 patient discharges from Hospital B, and 147,437 patient discharges from Hospital C. Overall, 466,819 patient discharges were included in this study (Table 1). For the 5,774 (1.2%) discharged patients with an MRSA-positive clinical culture, there were 1,597 positive blood cultures, 2,510 positive wound cultures, 2,022 positive sputum cultures, and 432 positive urine cultures. Of these 5,774 discharged patients with an MRSA-positive clinical culture, 706 (2%) had an MRSA-positive culture for more than 1 sampling site during the index hospitalization.

Approximately 1% of patient discharges (4,506 of 466,819) had any V09 *ICD-9-CM* code assigned; 92% had the V09.0 code and the remaining 8% had one of the codes in the range V09.1–V09.91. Among all 3 study hospitals, the V09 code was able to identify incident MRSA infections that occurred during the index hospitalization with a sensitivity of 24% (range, 21%–34%) and a PPV of 31% (range, 22%–53%) (Table 2). The PPV was lowest in 2005, at 24%, then increased to 37% in 2007 (χ^2 test for trend, $P < .01$) (Table 3). The ability of the V09 code to predict incident MRSA infection was highest for patient

discharges with an MRSA-positive wound culture (PPV, 16%) and lowest for patient discharges with an MRSA-positive urine culture (PPV, 2%) (Table 4). The agreement between the assignment of the V09 *ICD-9-CM* code and the presence of MRSA infection was fair, with an overall κ coefficient of 0.26 (95% confidence interval, 0.25–0.27).

Among patients discharged with a V09 *ICD-9-CM* code assigned, 1,386 (31%) had an incident MRSA infection during the index hospitalization, 879 (20%) had prior history of MRSA colonization or infection but did not have an MRSA infection during the index hospitalization, and 2,241 (49%) had no record of any MRSA colonization or infection during the index hospitalization or previous hospitalizations. These values varied by hospital. Of the 2,720 patients discharged from Hospital A who had the V09 code assigned, 609 (22%) had an MRSA infection during the index hospitalization, 663 (24%) had prior history of MRSA colonization or infection but did not have an MRSA infection during the index hospitalization, and 1,448 (53%) had no record of any MRSA infection during the index or previous hospitalizations. Similarly, of the 887 patients discharged from Hospital B who had a V09 code assigned, 302 (34%) had an MRSA infection during the index hospitalization, 150 (17%) had prior history of MRSA colonization or infection but did not have MRSA infection during the index hospitalization, and 435 (49%) had no record of any MRSA infection during the index or previous hospitalization. The V09 *ICD-9-CM* code was more accurate at predicting MRSA infections at Hospital C: of the 899 patients discharged with the V09 code assigned, 475 (53%) had an MRSA infection during the index hospitalization, 66 (7%) had prior history of MRSA colonization or infection but did not have an MRSA infection during the index hospitalization, and 358 (40%) had no record of any MRSA infection during the index or previous hospitalizations.

Further evaluation of the patients discharged with the V09 code assigned but no MRSA infection nor prior history of MRSA infection showed that 6% had been assigned the V09.8 code that indicates infection resistant to vancomycin, a code that could represent detection of vancomycin-resistant enterococci. To assess whether a narrower *ICD-9-CM* definition of an MRSA infection would be more accurate, we performed a subanalysis limiting the *ICD-9-CM* definition of an MRSA infection to presence of the V09.0 code for penicillin resistance and at least 1 additional *ICD-9-CM* code for *S. aureus*. Among all 3 hospitals, 3,466 discharged patients (0.7%) met this narrow *ICD-9-CM* definition for presence of MRSA infection. The agreement between the narrow definition and presence of microbiologically confirmed MRSA infection remained fair, an overall κ coefficient of 0.25 (95% confidence interval, 0.23–0.26). This definition was able to identify incident MRSA infection with a sensitivity of 20%, a specificity of 99%, a PPV of 34%, and an NPV of 99%. Even with this narrow *ICD-9-CM* definition of MRSA infection, 48% of patients discharged with the *ICD-9-CM* definition of an MRSA infection did not have an MRSA infection during the index hospitalization nor a prior history of MRSA colonization or infection.

DISCUSSION

This 7-year, multicenter study demonstrated that the V09 *ICD-9-CM* code was not a sensitive predictor of MRSA infection in 3 geographically distinct medical centers. Among the 3 institutions, at least 40% of the uses of the V09 code did not represent an incident MRSA clinical infection during the index hospitalization for which the code was assigned. Another, 7%–23% of uses of the V09 code represented an infection that took place during a previous hospitalization, a finding similar to that for the coding of chronic diseases such as diabetes mellitus.

A single-center, 6-month study performed by Schaefer et al²⁰ also demonstrated that the V09 *ICD-9-CM* code had low sensitivity. In that study, only 59% of 396 discharged patients with confirmed MRSA infection had the V09.0 code assigned and had an *ICD-9-CM* code for *S. aureus* infection among the first 15 discharge diagnostic codes assigned. In contrast to our study, they reported that the V09 code was able to predict MRSA infection with a PPV of 92%.²⁰ This difference could be the result of more accurate discharge diagnostic coding at their institution, compared with that at our study sites. Our PPVs ranged from 23% to 53% and did not greatly increase in our subanalysis that used the more narrow definition of the V09 *ICD-9-CM* code.

The PPVs from our study are similar to those of studies that assessed the accuracy of *ICD-9-CM* codes for healthcare-associated infections (surgical site infection, bloodstream infection, urinary tract infection, or pneumonia) but were much lower than those of studies that validated *ICD-9-CM* codes for *C. difficile* infection.^{9,10,16-18} *ICD-9-CM* coding may be superior for the identification of *C. difficile* infections, compared with identification of MRSA infections, because there is a *C. difficile*-specific code (008.45). In contrast, the V09 code is a general code that represents “infection with drug-resistant microorganisms.”

Studies that validated the *ICD-9-CM* code for *C. difficile* infection had findings were similar to those of our study, in that many of the patients discharged with an *ICD-9-CM* code assigned but no current infection had prior history of that infection documented in their medical charts.^{17,19} One such study found that 59% of patients discharged without *C. difficile* infection but with an *ICD-9-CM* code for *C. difficile* had prior history of *C. difficile* infection in the medical records, and 57% of these discharged patients were tested for *C. difficile* infection but the test result was negative.¹⁹ Thus, administrative coders may code for infections such as *C. difficile* or MRSA infection if these bacteria are mentioned in the medical record for any reason. This could explain the interhospital variation in the proportion of discharged patients without infection but with a V09 *ICD-9-CM* code assigned and a prior history of MRSA colonization or infection in our study. Hospital A lists prior history of MRSA colonization or infection prominently in patient medical records for infection control purposes, while this documentation is less prominent in the charts of Hospitals B and C.

A review by Jhung and Banerjee³⁷ stated that administrative data used consistently over time can be appropriate for measuring national trends in healthcare-associated infections. However, our study showed that a portion of the instances of use of the V09 *ICD-9-CM* code represent an infection that took place during a previous hospitalization. Thus, an increase in the rate of use of the V09 code could represent readmission of patients with a history of MRSA colonization or infection, rather than a true increase in the rate of MRSA infection. An increase such as this could be further biased by the nationwide push for active detection of MRSA on admission to acute care hospitals.³⁸⁻⁴⁰

On October 1, 2008, the V09 *ICD-9-CM* code was replaced with *ICD-9-CM* codes specific to MRSA. These include codes for personal history of MRSA detection (V12.04), MRSA colonization (V02.54), MRSA pneumonia (482.24), MRSA septicemia (038.12), and MRSA in diseases classified elsewhere (041.12).⁴¹ The new code for personal history of MRSA will allow prior history of MRSA colonization or infection to be coded separately from current MRSA infection. Similarly, the code for MRSA colonization may allow for further classification of discharged patients who were given the *ICD-9-CM* code for MRSA infection but did not have an MRSA infection or prior history of MRSA colonization or infection. However, the general MRSA code, 041.12, may still be overused in a similar fashion as the V09 code. Although the new *ICD-9-CM* codes have narrower definitions than the V09 code, they may still be misused if administrative coders do not receive adequate

training. In addition, the primary purpose of all *ICD-9-CM* codes is billing, not surveillance or research; thus, these codes should be interpreted with caution when used out of their original context. Therefore, these new *ICD-9-CM* codes should be validated extensively before they are used for MRSA surveillance or research purposes.

Although the use of administrative databases is convenient, other national databases may have higher validity when assessing rates of MRSA infection. Some studies have assessed the proportion of infections associated with *S. aureus* isolates that were resistant to methicillin by using antimicrobial susceptibility testing results stored in The Surveillance Network (TSN) Database–USA (Focus Technologies).^{42,43} TSN is a repository of susceptibility results from more than 200 microbiology laboratories in the United States. When TSN data were compared with the 1999 National Nosocomial Infections Surveillance System data, the proportion of *S. aureus* isolates with oxacillin resistance among *S. aureus* isolates from intensive care units was identical.⁴⁴ The gold standard for tracking disease rates is an active, population-based national surveillance system, such as the Centers for Disease Control and Prevention's Active Bacterial Core surveillance (ABCs)/Emerging Infections Program Network. The ABCs incorporate active laboratory-based and population-based surveillance for many bacterial pathogens, including MRSA. This surveillance system operates among 10 geographically diverse sites, representing approximately 41 million persons.⁴⁵ Using its data, Klevens et al⁴⁶ determined that the US national standardized incidence rate of invasive MRSA infection was 31.8 cases per 100,000 population in the year 2005. Unfortunately, surveillance systems such as ABCs are very expensive and require a great deal of infrastructure. A less expensive surveillance strategy is the use of electronic algorithms. These algorithms utilize electronic pharmaceutical, microbiologic, and administrative data to track infections.⁷⁻⁹ These algorithms are limited by the poor validity of administrative data, yet the addition of other electronic data may bolster the ability of the algorithms to accurately identify infections.

A limitation of our study is that we assessed only the first 15 *ICD-9-CM* discharge codes for each patient. Schaefer et al²² found that among patients with a confirmed MRSA infection, 15% had the V09 *ICD-9-CM* code in their medical record beyond the 15th *ICD-9-CM* code. This limitation would cause a count that used the V09 code to underestimate the rate of MRSA infection, whereas our study found an overestimation. Our definition of MRSA infection (considered present if a clinical culture was positive for MRSA) may have overestimated the number of infections, as culture positivity may also be the result of colonization or contamination. However, this definition has been validated in a previous study, which found that 82% of MRSA-positive clinical cultures met the National Healthcare Safety Network definition of an MRSA infection.³⁵ Also, even when the definition of an MRSA infection was overestimated, 48% of patients discharged with the V09.0 and *S. aureus ICD-9-CM* codes did not have a clinical culture positive for MRSA. In its current state, the V09 *ICD-9-CM* code should not be used to determine trends in MRSA infection. Improvement of the V09 *ICD-9-CM* coding, such as creating an MRSA infection-specific *ICD-9-CM* code or establishment of a new way to assess trends in MRSA infection, could assist in the collection of accurate data on national trends in MRSA infection and the associated outcomes.

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TABLE 1

Contingency Table to Assess the Validity of the International Classification of Diseases, 9th Revision, Clinical Modification Code V09 to Predict a Clinical Culture Positive for Methicillin-Resistant *Staphylococcus aureus* (MRSA) for 466,819 Patients Discharged from 3 Study Hospitals

V09 code status	No. of clinical cultures, by result		Total
	Positive for MRSA	Negative for MRSA or no clinical culture for MRSA done	
Present	1,386	3,120	4,506
Absent	4,388	457,925	462,313
Total	5,774	461,045	466,819

TABLE 2

Validity of the International Classification of Diseases, 9th Revision, Clinical Modification Code V09 for Prediction of Methicillin-Resistant *Staphylococcus aureus* Infection, According to Study Hospital Location

Location	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
Hospital A	21.3 (19.8–22.8)	98.9 (98.8–98.9)	22.4 (20.8–24.0)	98.8 (98.8–98.9)
Hospital B	34.2 (31–37)	99.6 (99.5–99.6)	34.0 (30.9–37.2)	99.5 (99.5–99.6)
Hospital C	23.3 (21.5–25.2)	99.7 (99.6–99.7)	52.7 (49.4–55.9)	98.9 (98.9–99.0)
Total	24.0 (22.9–25.1)	99.3 (99.3–99.3)	30.8 (29.4–32.1)	99.1 (99.0–99.1)

NOTE. NPV, negative predictive value; PPV, positive predictive value.

TABLE 3

Validity of the International Classification of Diseases, 9th Revision, Clinical Modification Code V09 for Prediction of Methicillin-Resistant *Staphylococcus aureus* Infection, According to Study Year

Year	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
2001	15.1 (12.1–18.2)	99.7 (99.7–99.7)	30.6 (25.0–36.1)	99.3 (99.2–99.3)
2002	18.5 (15.5–21.5)	99.6 (99.5–99.6)	30.2 (25.6–34.7)	99.2 (99.1–99.3)
2003	24.3 (21.5–27.2)	99.4 (99.3–99.5)	36.6 (32.7–40.6)	98.9 (98.8–99.0)
2004	28.2 (25.1–31.4)	99.3 (99.2–99.3)	31.5 (28.1–35.0)	99.1 (99.1–99.2)
2005	17.4 (15.0–19.7)	99.2 (99.2–99.3)	23.9 (20.7–27.1)	98.8 (98.8–98.9)
2006	24.5 (21.8–27.3)	99.1 (99.0–99.1)	25.3 (22.4–28.1)	99.0 (98.9–99.1)
2007	33.9 (31.0–36.7)	99.1 (99.1–99.2)	37.0 (34.0–40.0)	99.0 (98.9–99.1)

NOTE. NPV, negative predictive value; PPV, positive predictive value.

TABLE 4

Validity of the International Classification of Diseases, 9th Revision, Clinical Modification Code V09 for Prediction of Methicillin-Resistant *Staphylococcus aureus* Infection, According to Type of Infection

Source of culture sample	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
Blood	29.3 (27.1–31.5)	99.1 (99.1–99.2)	10.4 (9.5–11.3)	99.8 (99.7–99.8)
Sputum	14.4 (12.9–16.0)	99.1 (99.1–99.1)	6.5 (5.8–7.2)	99.6 (99.6–99.6)
Urine	19.2 (15.5–22.9)	99.1 (99.0–99.1)	1.8 (1.4–2.2)	99.9 (99.9–99.9)
Wound	29.5 (27.7–31.3)	99.2 (99.2–99.2)	16.4 (15.3–17.5)	99.6 (99.6–99.6)
Any of the above	24.0 (22.9–25.1)	99.3 (99.3–99.3)	30.8 (29.4–32.1)	99.1 (99.0–99.1)

NOTE. NPV, negative predictive value; PPV, positive predictive value.