The Impact of ICD-9-CM Code Rank Order on the Estimated Prevalence of *Clostridium difficile* Infections

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**Background.** US estimates of the *Clostridium difficile* infection (CDI) burden have utilized *International Classification of Disease, Ninth Revision, Clinical Modification* (ICD-9-CM) diagnosis codes. Whether ICD-9-CM code rank order affects CDI prevalence estimates is important because the National Hospital Discharge Survey (NHDS) and the Nationwide Inpatient Sample (NIS) have varying limits on the number of ICD-9-CM codes collected.

**Methods.** ICD-9-CM codes for CDI (008.45), *C. difficile* toxin assay results, and dates of admission and discharge were collected from electronic hospital databases for adult patients admitted to 4 hospitals in the United States from July 2000 through June 2006. CDI prevalence per 1000 discharges was calculated and compared for NHDS and NIS limits and toxin assay results from the same hospitals. CDI prevalence estimates were compared using the \( \chi^2 \) test, and the test of equality was used to compare slopes.

**Results.** CDI prevalence measured by NIS criteria was significantly higher than that measured using NHDS criteria (10.7 cases per 1000 discharges versus 9.4 cases per 1000 discharges; \( P < .001 \)) in the 4 hospitals. CDI prevalence measured by toxin assay results was 9.4 cases per 1000 discharges (\( P = .57 \) versus NHDS). However, the CDI prevalence increased more rapidly over time when measured according to the NHDS criteria than when measured according to toxin assay results (\( \beta = 1.09 \) versus 0.84; \( P = .008 \)).

**Conclusions.** Compared with the NHDS definition, the NIS definition captured 12% more CDI cases and reported significantly higher CDI rates. Rates calculated using toxin assay results were not different from rates calculated using NHDS criteria, but CDI prevalence appeared to increase more rapidly when measured by NHDS criteria than when measured by toxin assay results.

The incidence and severity of *Clostridium difficile* infection (CDI) have been increasing in recent years [1–7], but national surveillance efforts and interhospital comparisons have been limited by the lack of a standard CDI surveillance system. As a result, the *International Classification of Disease, Ninth Revision, Clinical Modification* (ICD-9-CM) codes assigned at hospital discharge have been used as a proxy to estimate CDI prevalence in the United States [8–12].

Using administrative data (ICD-9-CM codes) to compare CDI rates between hospitals has several potential advantages. Administrative discharge data are inexpensive to obtain, are systematically collected, and utilize a single ICD-9-CM code to designate CDI (008.45), thus potentially providing a nationally representative method for tracking CDI rates [8, 13, 14]. Two administrative databases have been used to estimate CDI prevalence in the United States: the National Hospital...
Estimates based on a variety of criteria affect the estimated CDI prevalence and how these definitions compare with toxin assay results at multiple healthcare facilities. The data collection discrepancies between these 2 data sets may account for the conflicting results of previous studies of CDI burden. CDI prevalence estimates were compared using the test of equality. Calculation of \( \kappa \) statistics was performed to measure the agreement between \( C. \text{difficile} \) toxin assay results and ICD-9-CM codes. Statistical analyses were performed with Epi Info, version 6 (CDC); SPSS for Windows, version 17.0 (SPSS), and Stata, version 9.2.

RESULTS

We identified a total of 10,832 cases of CDI, of which 2925 (27%) had an ICD-9-CM code alone, 1643 (15.2%) had a positive toxin assay result alone, and 6264 (57.8%) had both the ICD-9-CM code and positive toxin assay result. The overall CDI prevalence of all ICD-9-CM codes (ie, ICD-9-CM code in any position) was 10.9 per 1000 discharges, and the median rank-order of the ICD-9-CM code was 4. Compared with the total CDI cases captured by ICD-9-CM codes in any position, the NIS and NHDS criteria captured 99% (\( n = 9056 \)) and 87% (\( n = 7978 \)), respectively (Figure 1).

The overall CDI prevalence calculated with the NIS criteria (10.7 per 1000 discharges) was significantly higher than the CDI prevalence calculated with the NHDS criteria (9.4 per 1000 discharges; \( P < .001 \)) but was not different from the CDI prevalence of all ICD-9-CM codes (10.9 per 1000 discharges; \( P = .33 \)). The CDI prevalence measured by means of toxin assay results (9.4 per 1000 discharges) was no different from the CDI prevalence measured by NHDS (\( P = .57 \)). The agreement between the NHDS criteria and toxin assay was good, with an overall \( \kappa \) value of 0.638, and hospital-specific \( \kappa \) values ranging from 0.560 to 0.702.

METHODS

The study population included all adult patients admitted to 4 US hospitals participating in the CDC Epicenters Program from 1 July 2000 through 30 June 2006. These hospitals included Barnes-Jewish Hospital (St Louis, Missouri), Brigham and Women’s Hospital (Boston, Massachusetts), Ohio State University Medical Center (Columbus, Ohio), and University Hospital (Salt Lake City, Utah). Patients aged \( \geq 18 \) years were included in our analyses. During the study period, 3 of the 4 laboratories at the study hospitals rejected formed stool specimens for \( C. \text{difficile} \) testing.
Figures 2 and 3 present annual CDI prevalence by surveillance definition, overall and stratified by hospital, respectively. Overall, the CDI prevalence by means of the NIS criteria was the highest across the study period (Figure 2). The median rank order of the ICD-9-CM code for CDI was 3 at hospitals A and B and 4 at hospitals C and D. Hospital B is the only hospital where the annual CDI prevalence was highest by means of toxin assay results during every year of the study (Figure 3). The toxin assay rate was the highest rate only at Hospital B (Figure 3). Compared with the NHDS criteria, the toxin assay rate was higher at hospital A (toxin assay rate, 13.7 cases per 1000 discharges versus NHDS rate, 13.1 cases per 1000 discharges; $P = .03$) and hospital B (toxin assay rate, 12.0 cases per 1000 discharges versus NHDS rate, 9.4 cases per 1000 discharges; $P < .001$), whereas the toxin assay rate was lower at hospital C (toxin assay rate, 4.3 cases per 1000 discharges versus NHDS rate, 5.3 cases per 1000 discharges; $P < .001$) and hospital D (toxin assay rate, 6.9 cases per 1000 discharges versus NHDS rate, 8.7 cases per 1000 discharges; $P < .001$).

Overall, ICD-9-CM codes overestimated the number of cases of CDI relative to use of the toxin assay (Figure 2). While the overall annual rates increased almost every year of the study period regardless of the surveillance definition, the annual increase in the prevalence of CDI varied by definition. The annual increase in prevalence according to the NIS criteria was greater than that according to the NHDS criteria ($\beta = 1.34$ versus $\beta = 1.09$; $P = .003$). The annual increase in prevalence according to the NHDS criteria was greater than that according to the toxin assay ($\beta = 1.09$ versus $\beta = 0.84$; $P = .008$).

**DISCUSSION**

To our knowledge, this is the first study to examine how current methods used to estimate the prevalence of CDI in the United States compare with the use of toxin assay results to estimate the prevalence of CDI. The results of this multicenter study suggest that the CDI prevalence measured using all ICD-9-CM codes was higher than the CDI prevalence measured using the NIS, which, in turn, was higher than the CDI prevalence measured using the NHDS. These results were not surprising, given that the NIS captures more ICD-9-CM codes than the NHDS but does not capture all ICD-9-CM codes. In this study, the overall CDI prevalence measured by the NHDS criteria was the same as the CDI prevalence measured by the positive toxin assay results. Previous research indicates that ICD-9-CM codes overestimate CDI prevalence [16–18]. NHDS, by limiting the data set to the first 7 ICD-9-CM codes in each discharge record, may eliminate patients who do not truly have CDI. However, in this study, the annual increase in CDI prevalence as measured by the NHDS criteria was greater than that revealed by positive toxin assay results, indicating at some point that the CDI prevalence identified by the NHDS criteria may become greater than the CDI prevalence identified by toxin assay results.

When comparing the CDI prevalence measured using the NHDS criteria with the toxin assay results at the hospital level, the CDI prevalence was higher by toxin assay results at hospitals A and B, whereas the prevalence was higher by the NHDS criteria at hospitals C and D. Hospital A’s results may be due in part to the fact that this institution became more vigilant to ensure that all medical records were adequately reviewed by medical coders in a timely fashion midway through the study period. Hospital B’s results may reflect laboratory practices at this institution. During the study period, this hospital’s
microbiology laboratory tested formed stools for C. difficile toxin. This practice is discouraged because testing asymptomatic patients may falsely elevate the CDI prevalence by 2 mechanisms: asymptotically colonized patients without CDI can have positive toxin assay results, and testing for C. difficile in low-prevalence populations will increase the number of false-positive test results [19, 20]. This may explain the higher CDI prevalence by toxin assay results than that by the NHDS criteria at this institution. Last, the NIS and NHDS databases do not exclude on the basis of stool consistency either. Therefore, it was unknown what effect this might have on our results.

There are limitations to the use of administrative data for disease surveillance purposes. The ICD-9-CM codes are assigned by medical coders. Not all medical coders have the same level of training and certification, which may result in variable coding practices from coder to coder and facility to facility. For a patient to receive an ICD-9-CM code, the diagnosis must be clearly stated in the medical records by a treating physician. Additional variability may occur if physician documentation is inconsistent. Patients who receive the ICD-9-CM code for CDI but who do not have laboratory confirmation frequently have a history of CDI but lack ongoing symptoms of CDI [17, 18]. Furthermore, ICD-9-CM codes are assigned after discharge, creating a time lag in the availability of data, and ICD-9-CM codes do not provide any information about date or place of onset of CDI. Therefore, ICD-9-CM codes alone are not ideal for CDI incidence surveillance.

Despite the limitations of ICD-9-CM codes, there are limitations to the use of laboratory results on C. difficile toxin tests for CDI surveillance as well. The “gold standard” to detect pathogenic C. difficile from stool, toxigenic culture, is labor and resource intensive and takes several days until results are final. As a result, there are an increasing number of methods and algorithms to detect C. difficile or its toxins in stool, all of which differ in sensitivity and specificity. Stool handling and processing can also affect the sensitivity and

\[\text{Figure 3.} \quad \text{Yearly hospital Clostridium difficile infection rates by surveillance definition at hospitals A, B, C, and D. ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; NHDS, National Hospital Discharge Survey; NIS, Nationwide Inpatient Sample.}\]
specificity of an assay. Testing practices vary in interpretation of positive results. Although this practice is uncommon, the diagnoses for some patients are made by means of endoscopy alone [18]. Indiscriminate repeated testing for C. difficile can falsely elevate CDI incidence by as much as 27% [20]. Most importantly, CDI is a clinical diagnosis. Testing stool samples obtained from patients who do not have clinical symptoms compatible with CDI will result in positive test results for patients without CDI. In addition, the NIS and NHDS databases do not exclude patients with recurrent disease or patients with repeated toxin assay tests. To keep comparisons consistent, we did not exclude these patients either. As a result, this may have overestimated the true CDI prevalence by toxin assay.

An alternative CDI surveillance system already in use is that of the National Healthcare Safety Network (NHSN), which has been augmented by mandatory C. difficile public reporting requirements of many states in the United States. Currently, the NHSN is collecting data on C. difficile using 2 different reporting methods: (1) infection surveillance and (2) laboratory-identified events [21]. To date, 166 facilities are participating in the NHSN C. difficile infection surveillance reporting, 576 facilities are participating in the C. difficile laboratory-identified event reporting, and 36 facilities are participating in both reporting methods (D. Sievert, PhD, personal communication, 4 June 2010). Review of data from the 36 facilities performing both methods of surveillance will be important to further our understanding as to whether use of laboratory data alone in the absence of clinical information from facilities that do not test formed stool for C. difficile is a valid method for CDI surveillance.

This study indicates that current estimates of CDI prevalence in the United States based on ICD-9-CM codes may be falsely elevated. Fortunately, the NHSN is currently collecting data for CDI surveillance. The NHSN system provides a standardized method of CDI surveillance and will be able to assess the utility of laboratory-based CDI surveillance. Thus, the NHSN system may represent a substantial improvement in the quality of data available for hospital-based CDI surveillance, national CDI prevalence estimates, and interhospital CDI prevalence comparisons.

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