letters were mailed to 140 patients recommending HIV, hepatitis B, and hepatitis C testing. After receiving the notification letter, patient D contacted the clinic. He was hospitalized for hepatitis C in a different county during August 2022. Patient D received a procedure on the same day, in July, as the other 3 patients and immediately after patient B. To encourage testing and to ensure receipt of exposure notification letters, we called all 140 patients; 100 (71%) were successfully contacted and 76 (54%) reported they had scheduled or completed recommended postexposure testing. Recommendations to the clinic included updated infection control practices, proper use of syringes and needles, keeping multidose vials in a dedicated clean medication preparation area (away from immediate patient treatment areas), staff training, and an outbreak notification sign for the clinic to post.[8] We continued cross referencing the exposure patient list with the California Department of Public Health and LACDPH HCV registries. No additional patients with a positive HCV RNA test result were reported.

Although we were unable to identify a specific source of HCV transmission, evidence supports the possibility that a multidose medication vial was contaminated by reuse of a needle or syringe. Improper handling of multidose vials has been linked to multiple bloodborne pathogen outbreaks[2,3] and are the basis of CDC recommendations for safe injection practices when using multidose vials.[9] Single-use vials, drawing medication outside the patient's room, and random audits of infection control practices by infection prevention staff or departments of public health could prevent future outbreaks.[9] Our investigation highlights an ongoing need to assure that providers consistently apply policies and procedures to prevent healthcare-associated transmission of bloodborne pathogens when using multidose vials.

Acknowledgments.

Financial support. This research was supported by the Epidemiology and Laboratory Capacity for Prevention and Control of Emerging Infectious Diseases (grant no. CK19-1904).

Competing interests. All authors report no conflicts of interest relevant to this article.

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Cracking the code(s): Optimization of encounter-level diagnosis coding to inform outpatient antimicrobial stewardship data modeling

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In 2016, the Centers for Disease Control and Prevention (CDC) released Core Elements of outpatient antimicrobial stewardship program (ASP) which include leadership commitment, action for policy and practice, data tracking and reporting, and education.[1] Compared to the inpatient setting, outpatient ASP involves a significantly higher number of encounters, dramatically shorter encounter durations, and little direct control over dispensing.[2] Thus, accurate, specific, and actionable prescribing data are foundational to outpatient ASP activity because they inform provider

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Cite this article: Stevens RW, *et al.* (2024). Cracking the code(s): Optimization of encounter-level diagnosis coding to inform outpatient antimicrobial stewardship data modeling. *Infection Control & Hospital Epidemiology*, 45: 550–552, https://doi.org/10.1017/ice.2023.296

Table 1. Encounter volumes (%) by study period

Diagnosis Group	Total Encounters (N = 29,558), No. (%)	Preimplementation Encounters (n = 14,858), No. (%)	Postimplementation Encounters (n = 14,700), No. (%)	*P* Value
Cystitis	14,904 (50.4)	4,555 (30.7)	10,349 (70.4)	<.001
Pyelonephritis	1,298 (4.4)	594 (4)	704 (4.8)	<.001
Catheter-associated	111 (0.4)	11 (0.07)	100 (0.7)	<.001
Asymptomatic bacteriuria	114 (0.4)	38 (0.3)	76 (0.5)	<.001
UTI, site not specified	13,131 (44.4)	9,660 (65)	3,471 (23.6)	<.001

Note. UTI, urinary tract infection.

education, development of clinical decision support (CDS) tools, and comparison reporting.

The ability to effectively assess prescribing trends in ambulatory encounters often hinges on the association of antimicrobial prescriptions with encounter-level diagnosis codes. Inaccuracies in diagnosis code selection can hinder or mislead programmatic assessment of antimicrobial prescribing trends, therefore inextricably linking the practices of diagnostic coding and ASP. Following identification of UTI as an outpatient ASP syndrome target, our health-system identified that most UTI encounters were being coded with the single *International Classification of Disease Tenth Edition* (ICD-10) code N39.0 (ie, urinary tract infect, site not specified). This code lacks sufficient syndrome-level specificity to facilitate assessments of prescribing appropriateness. Herein, we describe the outcomes of a CDS tool (ie, diagnosis calculator) developed to facilitate appropriate and specific diagnosis code selection during UTI encounters.

Methods

The ICD-10 codes related to UTI were stratified into 5 diagnostic groups: asymptomatic bacteriuria, cystitis, pyelonephritis, catheter-associated infections, and UTI not otherwise specified (NOS) within the data modeling platform (Slicer-Dicer, Epic, Verona, WI) (Supplementary Table 1 online). Another group was created for antimicrobial agents commonly utilized for UTI (Supplementary Table 2 online). A UTI diagnosis calculator (Supplementary Fig. 1 online) was constructed and implemented in the electronic health record (EHR, Epic). This calculator requires the user to select patient characteristics (eg, pregnancy and catheter status) and infection-related features (eg, lower- vs upper-tract disease, presence of hematuria, acute vs chronic vs recurrent), thereby facilitating selection of the most appropriate and the specific ICD-10 code. The calculator was implemented across the entire Mayo Clinic Enterprise on January 1, 2022, with stepwise introduction onto all applicable diagnosis code preference lists by March 2023. Education was provided to end users in the form of enterprise-wide newsletter communications, EHR super-user training, and primary-care departmental presentations. Additionally, changes to EHR diagnosis records were implemented that sent users directly to the calculator when "UTI, NOS" selection was attempted as a visit diagnosis.

This before-and-after quasi-experimental study included a preimplementation period from July 1, 2021, through December 31, 2021 (6 months) and a postimplementation period from March 1, 2023, through August 31, 2023 (6 months). Enterprise-wide encounters for patients aged ≥18 years were included if (1) an ICD-10 code from any of the UTI diagnosis groups was utilized, (2) an antibiotic from the antimicrobial group was prescribed during the encounter, and (3) the patient was seen by primary care, urgent care, emergency department, or obstetrics/gynecology. The outcome of interest was the percentage of total encounters coded into each UTI diagnosis group. We used the χ^2 test to assess differences in encounter volumes by diagnosis.

Results

Encounter-level diagnosis coding was evaluated across a total of 29,558 encounters during the 2 study periods, with 14,858 encounters in the preimplementation period and 14,700 encounters in the postimplementation period. A statistically significant reduction in the use of ICD-10 code N39.0 occurred following implementation of the calculator (65% vs 23.6%; $P < .001$). This change was accompanied by increases in the percentage of encounters comprised of primary ICD-10 codes from other, more syndrome-specific, UTI diagnostic groups (Table 1). The largest increase in code utilization occurred in the cystitis group, in which this group accounted for 30.7% of all encounters in the preimplementation period compared to 70.4% in the postimplementation period ($P < .001$).

Discussion

Outpatient ASP metrics are often "encounter based" (eg, encounter-level prescribing rates), and encounter-level diagnosis codes are commonly leveraged to associate antimicrobial prescribing with specific infectious syndromes.[3,4] A tiered diagnostic approach has commonly been applied wherein encounter ICD-10 codes are stratified into syndromes for which antibiotics are always, sometimes, or never appropriate (eg, tier I, II, and III, respectively).[5,6] This approach has allowed institutions to stratify encounters by syndrome(s) within data models; however, reliance on diagnoses coding also introduces inaccuracies when code selection is incorrect or lacks specificity.

Accurate diagnosis code selection has important implications for ASP data modeling in UTIs. Apart from asymptomatic bacteriuria (ASB), other UTIs (ie, complicated cystitis, uncomplicated cystitis, catheter associated cystitis, and pyelonephritis) would all be categorized as tier I in the aforementioned structure. However, optimal drug selection, dosing, and durations of therapy vary widely across diagnoses.[7] Therefore, if diagnosis codes are

https://doi.org/10.1017/ice.2023.296 Published online by Cambridge University Press

used to describe trends and/or identify opportunities in prescribing optimization, then coding specificity is paramount to data modeling and subsequent intervention development. Others attempting to steward antimicrobials in ambulatory UTI encounters have also attempted improvements in diagnostic specificity through CDS tools and found improvements in coding specificity.[8]

We evaluated outpatient UTI-related ICD-10 code utilization before and after implementation of a diagnosis CDS (ie, diagnosis calculator). Diagnostic calculator implementation resulted in significant improvement in coding specificity. Our study was limited by the exclusion of some infrequently utilized antimicrobials from the antimicrobial group and by lack of chart review in each individual case to confirm appropriate code selection from the calculator. Nevertheless, these findings add to the existing body of evidence suggesting that CDS as an effective means for improving diagnostic specificity that can facilitate ASP efforts toward accurate data modeling and prescribing assessments.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2023.296

Acknowledgments. The authors thank Sue Christensen and Evan Draper for the contribution to this work through the design and implementation of Tableau and Slicer-Dicer data models facilitating the monitoring of code utilization. We also thank the Mayo Clinic Outpatient Antimicrobial Stewardship Team for their signification contributions to the local implementation and education of the CDS tool.

Financial support. No financial support was provided relevant to this article.

Competing interests. All authors report no conflicts of interest relevant to this article.

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