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Novel Method to Detect Cardiac Device Infections by Integrating Electronic Medical Record Text with Structured Data in the Veterans Affairs Health System

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Background: Cardiovascular implantable electronic device (CIED) infections are highly morbid, yet infection control resources dedicated to preventing them are limited. Infection surveillance in outpatient care is also challenging because there are no infection reporting mandates, and monitoring patients after discharge is difficult. **Objective:** Thus, we sought to develop a replicable electronic infection detection methodology that integrates text mining with structured data to expand surveillance to outpatient settings. **Methods:** Our methodology was developed to detect 90-day CIED infections. We tested an algorithm to accurately flag only cases with a true CIED-related infection using diagnostic and therapeutic data derived from the Veterans Affairs (VA) electronic medical record (EMR), including administrative data fields (visit and hospital stay dates, diagnoses, procedure codes), structured data fields (laboratory microbiology orders and results, pharmacy orders and dispensed name, quantity and fill dates, vital signs), and text files (clinical notes organized by date and type containing unstructured text). We evenly divided a national dataset of CIED procedures from 2016–2017 to create development and validation samples. We iteratively tested various infection flag types to estimate a model predicting a high likelihood of a true infection, defined using chart review, to test criterion validity. We then applied the model to the validation data and reviewed cases with high and low likelihood of infection to assess performance. **Results:** The algorithm development sample included 9,606 CIED procedures in 67 VA hospitals. Iterative testing over 381 chart reviewed cases with 47 infections produced a final model with a C-statistic of 0.95 (Table 1). We applied the model to the 9,606 CIED procedures in our validation sample and found 100 infections of the 245 cases identified by the model to have a high likelihood of infection We identified no infections among cases the model as having low likelihood. The final model included congestive heart failure and coagulopathy as comorbidities, surgical site infection diagnosis, a blood or cardiac microbiology order, and keyword hits for infection diagnosis and history of infection from clinical notes. **Conclusions:** Evolution of infection prevention programs to include ambulatory and procedural areas is crucial as healthcare delivery is increasingly provided outside traditional settings. Our method of algorithm development and validation for outpatient healthcare-associated infections using EMR-derived data, including text-note searching, has broad application beyond CIED infections. Furthermore, as integrated healthcare systems employ EMRs in more outpatient settings, this approach to infection surveillance could be replicated in non-VA care.

Table 1. CIED Infection Detection Algorithm Logistic Regression Results for Development and Validation in 2016-2017 VA Data

	Development Sample (n=381 CIED procedures, 47 infections)	Validation Sample (n=295 CIED procedures, 100 infections)
Variables	OR (95%CI)	OR (95%CI)
Comorbidity		
Congestive heart failure	**0.12 (0.04-0.39)**	**0.52 (0.23-1.21)**
Coagulopathy	**7.76 (1.94-30.93)**	**0.74 (0.23-2.39)**
Pulmonary circulation disease		
Billing Data		
Emergent problem		
ICD10 code for SSI only	**12.09 (3.47-42.1)**	**24.63 (8.88-68.31)**
Pharmacy Data		
No Abx ≥ 3 days		
Abx ≥ 3 days to treat staph		
Abx ≥ 3 days – not related to staph		
Laboratory Data		
No Micro order	ref	ref
Micro order - Blood	**6.35 (1.85-21.77)**	1 (0.28-3.53)
Micro order - Cardiac	**5.7 (1.71-19.05)**	1.72 (0.79-3.74)
Misc Micro order	0.56 (0.05-6.47)	ERR
Text Note Data		
Diagnosis of infection	**25.99 (3.14-215.49)**	**7.63 (2.25-25.84)**
History of infection	**0.09 (0.02-0.32)**	**0.05 (0.02-0.15)**
Model c- statistic	0.96	0.90

ERR=error in model because there were too few cases with a misc micro order in our validation chart review sample.

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Novel Method to Evaluate Diagnostic Shifting After a Pediatric Antibiotic Stewardship Intervention

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Background: Audit-and-feedback interventions track clinician practice patterns for a targeted practice behavior. Audit and feedback of antibiotic prescribing data for acute respiratory infections (ARI) is an effective stewardship strategy that relies on administrative coding to identify eligible visits for audit. “Diagnostic shifting” is the misclassification of a patient’s diagnosis in response to audit and feedback and is a potential unintended consequence of audit and feedback. Objective: To develop a method to identify patterns consistent with diagnostic shifting including both positive shifting (improved diagnosis and documentation) and negative shifting (intentionally altering documentation of diagnosis to justify antibiotic prescribing), after implementation of an audit-and-feedback intervention to improve ARI management. **Methods:** We evaluated the intervention effect on diagnostic shifting within 12 University of Utah pediatric clinics (293 providers). Data included 66,827 ARI diagnoses: pneumonia, sinusitis, bronchitis, pharyngitis, upper respiratory infection (URI), acute otitis media (AOM), or serous otitis with effusion (OME). To determine whether rates of ARI diagnoses changed after the intervention, we developed logistic generalized estimating equation (GEE) models with robust sandwich standard error estimates to account for clinic-wise clustering. Outcomes included the change in each ARI diagnosis relative to the competing 6 diagnoses included in audit-and-feedback reports before and after intervention implementation. Models tested for a change in outcomes after the intervention (ie, diagnostic shift) after adjustment for month of diagnosis. For each diagnosis, we estimated the population attributable fraction (PAF) for antibiotic prescriptions due to combined shifts in