

Improved Coding of Postoperative Deep Vein Thrombosis and Pulmonary Embolism in Administrative Data (AHRQ Patient Safety Indicator 12) After Introduction of New ICD-9-CM Diagnosis Codes

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Background: Symptomatic venous thromboembolism is a common postoperative complication. The Agency for Healthcare Research and Quality (AHRQ) has developed a Patient Safety Indicator 12 to assist hospitals, payers, and other stakeholders to identify patients who experienced this complication.

Objectives: To determine whether newly created and recently redefined ICD-9-CM codes improved the criterion validity of Patient Safety Indicator 12, based on new samples of records dated after October 2009.

Research Design, Subjects, Measures: Two sources of data were used: (1) UHC retrospective case-control study of risk factors for acute symptomatic venous thromboembolism occurring within 90 days after total knee arthroplasty in teaching hospitals; (2) chart abstraction data by volunteer hospitals participating in the Validation Pilot Project of the AHRQ.

Results: In the UHC sample, the positive predictive value (PPV) was 99% (125/126) and the negative predictive value was 99.4% (460/463). In the AHRQ sample, the overall PPV was 81% (126/156).

Conclusions: The PPV based on both samples shows substantial improvement compared with the previously reported PPVs of 43%–48%, suggesting that changes in ICD-9-CM code architecture and better coding guidance can improve the usefulness of coded data.

Key Words: AHRQ, post operative VTE, PSI 12, administrative data validation, predictive values

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Symptomatic venous thromboembolism (VTE) is a common postoperative complication.^{1–7} The Agency for Healthcare Research and Quality (AHRQ) has developed a Patient Safety Indicator (PSI 12) to assist hospitals, payers, and other stakeholders to identify patients who experienced this complication (<http://www.qualityindicators.ahrq.gov/>). The Centers for Medicare and Medicaid Services has deemed that VTE diagnosed in-hospital after total hip arthroplasty or total knee arthroplasty (TKA) is a “reasonably preventable” hospital-acquired condition and withhold additional payment in the absence of another complication that would qualify for the same Medicare Severity Diagnosis-related Group (<http://www.cms.gov/hospitalacqcond/downloads/hacfactsheet.pdf>). This policy reduced hospital Medicare payments by an average of \$7683 for each of 1082 orthopedic surgical patients in fiscal year 2011.⁸ Additional funds will be placed at risk starting in fiscal year 2015, when PSI 12 will be incorporated into Medicare’s hospital value-based purchasing program.⁹ However, prior studies of the validity of postoperative VTE diagnoses, based on PSI 12 specifications, reported poor specificity, with positive predictive values (PPVs) of 43% [95% confidence interval (CI), 34%–53%] in VA hospitals,¹⁰ 44% (95% CI, 37%–51%) in academic medical centers,¹¹ and 48% (95% CI, 42%–67%) in a national sample of volunteer hospitals.¹¹ False-negative errors were extremely rare, with an estimated sensitivity in the academic sample of 100% for identifying acute lower extremity or pelvic VTE and 95.5% for identifying any acute venous thrombosis.¹¹

In a combined analysis of 573 PSI-flagged cases from 2 of the 3 studies cited above,¹¹ we found that 74 (12.9%) had a documented prior/chronic VTE, which was presumably present at admission, 73 (12.7%) had an acute VTE before the operation, 19 (3.3%) had an acute VTE of undetermined timing, 83 (14.5%) had acute upper extremity thrombosis (of which 58 were disqualified solely for this reason), 34 (5.9%) had superficial vein thrombosis (25 were disqualified solely for this reason), and 12 (2.1%) had thrombosis of unknown

site (9 were disqualified solely for this reason). Only 48 (8.4%) of flagged cases had no mention of VTE in the abstracted record. After reviewing these data with various stakeholders, we concluded that PSI 12 captured upper extremity and superficial thromboses because the existing diagnosis codes in the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) lacked specificity; codes for these diagnoses were available under the “thrombophlebitis” heading (451.xx), but not under the currently preferred “thrombosis” heading (453.xx). In addition, coders reported confusion about how to code chronic thromboses that are diagnosed after admission and are therefore reported as not present on admission (on Medicare claims and in states that require present-on-admission coding). On the basis of these findings and other studies in the peer-reviewed literature,^{12–14} AHRQ proposed an entirely new set of ICD-9-CM codes for superficial, upper extremity, and chronic venous thrombosis, which the ICD-9-CM Coordination and Maintenance Committee implemented effective from October 2009 (Supplemental Digital Content, Appendix A, <http://links.lww.com/MLR/A453>).

The intent of the present study was to determine whether these new codes improved the criterion validity of PSI 12, based on new samples of records dated after October 2009. As in the previous study, we recruited and combined 2 samples¹: 15 academic medical centers that collaborated with UHC to identify VTE cases related to TKA; and² 7 volunteer hospitals that joined AHRQ’s PSI Validation Pilot project. Because of resource constraints and organizational priorities, each sample was somewhat smaller or more clinically restrictive than the corresponding sample from our earlier studies.

METHODS

This study was approved by the federal Office of Management and Budget and by the Institutional Review Board at the University of California Davis Medical Center. We provided each participating hospital in the AHRQ sample with a notice of data use indicating that all collected data would be considered confidential unless otherwise compelled by law, and that our data collection procedures complied with the HIPAA privacy rule provisions for disclosure of protected health information without subject authorization to a public health authority [45 CFR 164.512(b)].

The University of California, Davis, in partnership with UHC, conducted a retrospective case-control study of risk factors for acute symptomatic VTE occurring within 90 days after TKA in teaching hospitals. Fifteen volunteer organizations nationwide agreed to abstract medical records of up to 40 sampled cases or controls. Inclusion criteria for the sampling frame were admission between October 1, 2008 and March 31, 2010; presence of a principal ICD-9-CM procedure code of 81.54 or 81.55; and age 40 years or older. Patients with a pregnancy-related principal diagnosis (Major Diagnostic Category 14) or inferior vena cava interruption on or before the date of the first operating room procedure were excluded. Cases were defined as having one or more secondary diagnosis codes for acute VTE, as defined by AHRQ

PSI 12, version 4.1 (451.11, 451.19, 415.11, 415.19, 453.40–453.42, 453.8, 453.9, 451.2, 451.81, 451.9), coupled with a “present on admission” flag of “no” (POA = N), or were readmitted with a principal diagnosis of VTE (same codes) within 90 days of the day of surgery. A probability sample of VTE cases (up to a maximum of 20), and 20 eligible TKA patients who did not develop acute VTE during the index hospitalization or within 90 days of surgery, were randomly selected for abstraction. A chart abstraction tool was constructed, pretested, and revised as appropriate. Personnel at each site were taught how to obtain the desired information and enter it into a web-based application for review and verification by UHC staff.

We recruited hospitals for participation in the Validation Pilot Project through the AHRQ quality indicators technical support listserve. Our team conducted web-based informational sessions to introduce the study and to outline expectations of participants. Seven hospitals volunteered to join the AHRQ sample. Each hospital applied the AHRQ PSI software to identify patients meeting the specifications for PSI 12, version 4.1 (as above) with a discharge date between October 1, 2009 and March 31, 2010. If >30 cases were flagged, abstractors started in reverse consecutive order with the most recent case. Each hospital identified one or more nurse abstractors, who were trained using web-based teleconferences, written guidelines, and other instructional resources. Abstractors collected relevant data from both paper and electronic medical records, as appropriate, and transmitted these data electronically to Battelle using a secure file exchange server (<http://fx.battelle.org>). SAS version 9.2 was used for all data analyses. We conducted quality checks and queried abstractors about discrepant responses.

RESULTS

In the UHC sample, there were 126 cases flagged by PSI 12 for VTE after TKA surgery, of which 125 cases were verified as postoperative deep vein thrombosis (DVT) or pulmonary embolus (PE) based on chart review. The PPV in this sample was 99% (125/126). The only false-positive case had a saphenous vein (superficial) thrombosis. Of the 463 abstracted “controls” that were not flagged by PSI 12, 458 had no evidence of VTE, 2 had nonqualifying venous thromboses (superficial or upper extremity), and 3 had an unreported but qualifying thrombosis (false negative). The negative predictive value in this sample was 99.4% (460/463) (Table 1).

In the AHRQ sample, 7 volunteer hospitals abstracted a total of 171 records (all of which were flagged by PSI 12). A total of 141 cases (83%) had acute DVT, 11 cases (6%) had chronic DVT (without acute DVT), 1 case had subacute DVT, and 16 cases (9%) had thromboses of unknown acuity. Two cases (1%) had both acute and subacute/chronic DVT. In 33 (18%) cases, the DVT was clearly or presumably POA, based on diagnosis within the first 24 hours of hospitalization. The DVT was reported as not POA for 133 (78%) cases, and POA status was missing for 5 more cases (3%). Combining the POA and acuteness variables, 33 cases (18%) were presumed to be false positive because they were reported as POA and 3 additional cases (1.8%) were presumed

TABLE 1. Demonstration of the Chart Abstraction Results Under the Newly Created and Recently Redefined ICD-9-CM Codes and the Old ICD-9-CM Version

Postoperative Deep Vein Thrombosis and Pulmonary Embolism AHRQ PSI 12		Effective Date of ICD-9-CM Changes	
		No Specific Code for Superficial, Upper Extremity, and Chronic Venous Thrombosis Defined Before October 2009/List of the Codes Were Used by Participating Hospitals	New Codes for Superficial, Upper Extremity, and Chronic Venous Thrombosis Defined After October 2009
UHC			
Flagged, N = 126			
True positive	125		
False positive	1	Saphenous vein (superficial) = 1 453.42 (FP) = 1	453.6 (FP) = 1
Not flagged, N = 463			
True negative	458		
False negative	5	Superficial VTE = 2 Unreported but qualifying = 3 453.42, 453.40 (FN) = 2 Unreported but qualifying (FN) = 3	453.6 (FN) = 2 Unreported but qualifying (FN) = 3
AHRQ volunteer hospitals			
Flagged, N = 171			
True positive	126		
False positive	30	POA = 15 Upper extremity VTE = 8 Central vein VTE = 1 Superficial VTE = 3 Chronic VTE = 3 No specific code (FP) = 15 453.41, 453.42 (FP) = 8 No specific code (FP) = 1 453.42, 453.40 (FP) = 3 No specific code (FP) = 3	POA code (FP) = 15 453.81 to 453.84 (FP) = 8 453.85 and 853.86 (FP) = 1 453.6 (FP) = 3 453.5x or 453.7x (FP) = 3
Excluded	15	PPV from our previous study PPV from UHC = 44% PPV volunteer hospitals = 48%	PPV from the current study PPV from UHC = 99% PPV volunteer hospitals = 81%

AHRQ indicates Agency for Healthcare Research and Quality; FP, false positive; FN, false negative; ICD-9-CM, International Classification of Diseases, 9th Revision, Clinical Modification; POA, present on admission; PPV, positive predictive value; PSI, Patient Safety Indicator; VTE, venous thromboembolism.

to be false positive because they appeared chronic by sonographic criteria, even though they were not diagnosed within 24 hours of admission.

In 19 cases (11%), DVT occurred before the first major operating room procedure. In 143 cases (83%), DVT occurred after the first major operating room procedure. Timing with respect to surgery was missing for 6 cases (4%) and 3 cases (2%) had DVT both before and after the first major operating room procedure. Of the 19 DVT cases reported as preoperative, 10 had acute DVT, 6 had chronic DVT, 1 had subacute DVT, and 2 cases had unknown acuity.

With respect to the specific segment(s) of the venous system identified to have thrombus, 2 cases (1.2%) were presumed to be false positive because the thrombus was limited to the superficial lower extremity veins or the superior vena cava. Eight additional cases (4.7%) were presumed to be false positive because the location of the thrombus was limited to other upper extremity or thoracic veins.

Considering all the above factors, the overall PPV of PSI 12 in this sample was 81% (126/156) after excluding 15 records that would have been disqualified if the hospital had used POA codes in its sampling procedure.

DISCUSSION

The PPV based on both samples shows substantial improvement compared with the previously reported PPVs of 43%–48%.¹⁰ The PPV was especially high (99%) in a limited cohort of patients admitted to academic medical centers for TKA. The NPV based only on these elective

orthopedic surgery patients at academic medical centers was 99.3%, suggesting a sensitivity of at least 84% (if the underlying prevalence is 4% or greater in this population).¹⁵ The PPV in a broader sample of surgical patients from both teaching and nonteaching hospitals was somewhat lower (81%). AHRQ PSI 12 can now be used to flag postoperative DVT/PE and to monitor trends over time, at least at large hospitals of the type that participated in this study.

The most important limitation of this study is that the PPV from the UHC sample is based on patients who underwent TKA. TKA patients represent a population that is at high risk based on the surgical procedure, but is medically stable (because of the elective nature of TKA) and thus relatively unlikely to have chronic VTE. In addition, UHC hospitals are academic medical centers that may have different documentation and coding practices from other hospitals. According to the 2010 Nationwide Inpatient Sample, teaching hospitals had a slightly higher mean rate of PSI 12 than nonteaching hospitals (9.79 vs. 8.26 per 1000 surgical hospitalizations), but it is unclear whether this difference is due to improved documentation and coding, confounding by unadjusted risk factors, or less aggressive use of prophylactic modalities. The mean PSI 12 rate decreased slightly faster between 2008 and 2010 at teaching hospitals than at nonteaching hospitals (10.2% vs. 4.5% decline), suggesting that teaching hospitals may have responded to new coding opportunities (and thus improved the PPV of PSI 12) more quickly than nonteaching hospitals.¹⁶

Regardless of their teaching status, all hospitals in this study volunteered to participate and may have different

quality and coding practices than nonparticipating centers. All data were collected by individuals employed by the participating hospitals, with central adjudication of discrepancies, but no mechanism for duplicate abstraction to ensure reliability. Finally, abstractors relied on the information contained in sampled records and generally avoided querying physicians or others to obtain additional information.

Although the current samples are not fully comparable to previously reported samples, these findings suggest that the introduction of more specific ICD-9-CM codes and widespread POA reporting has improved the PPV of PSI 12, and therefore the ability of researchers, providers, and quality improvement professionals to use administrative data to track and compare rates of postoperative VTE. In particular, the prevalence of false positives due to upper extremity and superficial venous thromboses, or acute DVT or PE POA, is substantially lower than has been previously reported. These data provide a case study demonstrating the usefulness of improving code sets such as ICD-9-CM, and educating coders about how to apply new codes, for enhancing the value of administrative data. The same approach is being applied to improve the validity and usefulness of other quality indicators based on ICD-coded data. For example, additional specificity was added to the codes for central venous catheter-associated infections in 2011, partially to improve the PPV of PSI 7, which was previously reported to be^{17,18} 38% and 61% in Veterans Affairs and non-Veterans Affairs hospitals, respectively. Future research should confirm the generalizability of our PSI 12 findings to other indicators with readily identifiable, coding-related sources of ascertainment error.

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