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Letter to the Editors-in-Chief

Predictive value of the present-on-admission indicator for hospital-associated hemorrhage

1. Introduction

Major hemorrhage is a common presenting diagnosis for admission to the hospital, but it can also occur during hospitalization without provocation or as a complication of anticoagulant use. Full-dose anticoagulant use is known to be the most important risk factor for in-hospital gastrointestinal bleed (GIB) [1]. The ability to distinguish between hemorrhage that develops prior to hospitalization vs. hemorrhage associated with hospitalization is important for accurate quality assessment [2]. Additionally, some hospital-associated conditions, such as pressure ulcer or catheter-associated urinary tract infection, cannot be used for billing; if hospital-associated hemorrhage is added to this list, distinguishing hospital-associated hemorrhage from hemorrhage prior-to-admission will become financially relevant.

In 2007, the Centers for Medicare and Medicaid Services (CMS) introduced a present-on-admission (POA) "indicator"/flag required for most of the medical diagnoses that are listed in the mandated hospital discharge record. A provision in the Deficit Reduction Act requires the use of this POA indicator on all claims submitted to Medicare for discharges on or after October 1, 2007 [3]. POA indicators may be flagged "Y" (diagnosis POA), "N" (diagnosis not POA), "U" (document insufficient to determine if condition was POA), "W" (provider unable to clinically determine if condition POA), and "1" (diagnosis exempt from POA reporting). Hospitals rely on the POA indicator to distinguish prior-to-admission diagnoses from hospital-associated diagnoses [4]. A 2011 study of the POA indicator for "secondary" diagnoses (the "principal" diagnosis, by definition, must be present at admission) found that the overall predictive value of the POA indicator for these diagnoses was 74.3%, with a tendency to select POA = Y even when the diagnosis was not present, at for profit hospitals; and to select POA = N even when the diagnosis was present on admission, at teaching hospitals [5]. Our past study of the validity of the POA indicator specifically for venous thromboembolism (VTE) [6] also found a positive predictive value (PPV) of approximately 75% for both POA = Y and POA = N. There have been previous studies of the accuracy of diagnosis codes for hemorrhage for the actual presence of hemorrhage [7]. No previous studies specifically assessed the accuracy of the POA indicator for hemorrhage prior-to-admission as compared to hospital associated hemorrhage.

We sought to determine the PPV of the POA indicator for hemorrhage, evaluating the POA indicators for patients with discharge diagnosis codes of GIB and intracranial hemorrhage (ICH), two of the most common and serious hemorrhagic diagnoses during hospitalization.

2. Materials and methods

2.1. Setting and data sources

Our study was conducted at two university medical centers, the University of California, San Francisco (UCSF) and the University of California, Davis (UCD). Both centers are members of Vizient (formerly University Health system Consortium) [8]. Both universities send Vizient clinical, billing, and administrative data including demographic information, ICD-10-CM diagnosis codes, and core measures such as mortality, length of stay, complication rates, and hospital-associated (HA) conditions. The Vizient Clinical Database/Resource Manager (CDB/RM) provides its members with encounter information, comparative inpatient and outpatient data from associated medical centers and hospitals, and core measures including patient outcomes [10]. Each medical center has access to patient data from its own institution, including patient identifiers. Each site in our study independently retrieved patient-level data from Vizient for use in analysis.

The Institutional Review Board at UCSF approved this study.

2.2. Population and chart selection

The study was a retrospective cohort study during the time period Jan 1, 2016 to September 30, 2016. Using the Vizient cohort database and Resource Manager ((CDB/RM), we identified and downloaded all demographic information, diagnosis codes and their associated POA indicators, and procedure codes for inpatient encounters among non-pregnant adult patients age ≥ 18 discharged *without* a principal diagnosis of GIB or ICH but with at least *one* non-principal diagnosis for GIB or ICH by ICD-10-CM code (Appendix A).

Cases from each site were then stratified into four main categories based on the type of hemorrhage (GIB vs ICH), and on the POA indicator (POA = Y vs POA = N). Because each case could have more than one hemorrhage diagnosis code (i.e. both a subarachnoid hemorrhage and a bleeding peptic ulcer), each was categorized as primarily ICH or GIB based on whether the first coded hemorrhage diagnosis was for ICH or GIB. A convenience sample of forty cases from each of these eight categories (GIB at Institution #1 that was POA = Y; GIB at Institution #1 that was POA = N; GIB at Institution #2 that was POA = Y; etc.) at each individual site were randomly selected. Cases were then abstracted manually, for an expected total of 320 total cases.

2.3. Chart review and abstraction criteria

For chart abstraction we created a form using Research Electronic Data Capture (REDCap), a secure, HIPAA compliant, web-based research tool [9]. Encounter information was extracted for each case from the Vizient download by each institution using R Programming and was uploaded into the abstraction tool. Abstraction for each site was performed by a reviewer at that site, with reviewers blinded to the POA indicator for each hemorrhage code. Each chart was reviewed to confirm that the coded hemorrhage actually occurred and to determine whether it was present on admission or occurred during the hospital stay.

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Table 1
Predictive value of POA = N and POA = Y for hemorrhage diagnoses.

Diagnosis/POA combination	Coded POA = N (n)	% HA hemorrhage (95% CI)	Coded POA = Y (n)	% Hemorrhage PTA (95% CI)
Overall	166	85% (80% - 90%)	209	86% (82% - 90%)
Type of Hemorrhage				
GIB	95	84% (76% - 92%)	109	83% (75% - 91%)
ICH	71	86% (78% - 94%)	100	89% (83% - 95%)
Anticoagulation Status				
Taking AC[a]	25	23/25: 92% (82%–100%)	38	33/38: 87% (77%–97%)
Not taking AC	134	84% (78% - 90%)	165	88% (82% - 94%)
Sites				
Site 1	90	83% (75% - 91%)	118	90% (84% - 96%)
Site 2	76	87% (79% - 95%)	91	80% (72% - 88%)

POA = Present on Admission. HA = Hospital Associated. PTA = Prior-to-Admission. 95% CI = 95% confidence interval GIB = Gastrointestinal Bleed. ICH = Intracranial Hemorrhage. AC = Anticoagulation.

[a] Given the very low numbers overall, both the actual fraction and percentages are shown.

2.4. Statistical analysis

Using the information obtained, we calculated the predictive value of POA = N for hospital-associated hemorrhage, and POA = Y for hemorrhage prior-to-admission.

All statistical and data analysis were performed using R programming (version 3.2.4) and Stata (version 14).

3. Results

From January 1 to September 30 of 2016, at our institutions, there were 1260 cases with at least one secondary ICD-10-CM diagnosis code for GIB or ICH. Because several cases had 2 or more secondary diagnosis codes for hemorrhage, there were 1397 codes present in total—791 GIB POA = Y, 229 GIB POA = N, 310 ICH POA = Y, and 67 ICH POA = N. Among the 1260 cases, 934 cases had a primary GIB code (732 POA = Y, 202 POA = N) and 326 had a primary ICH code (277 POA = Y, 49 POA = N). 80 total charts from each of these four categories were randomly selected and abstracted except for the ICH POA = N group, as there were only 49 available cases. In this instance, all 49 cases were selected, giving a total of 289 charts for abstraction and 380 total diagnoses abstracted. Of the sampled cases, 40% were 66 years of age or older, 56% were male, 53% were white, and 60% had a length of stay 10 days or less. Twenty-two percent died during admission. Of the 380 diagnosis codes indicating hemorrhage 3% (n = 11) did not have a hemorrhagic event on manual chart review.

Among patients with these hemorrhage codes, codes flagged POA = Y were adjudicated to be hemorrhage prior-to-admission in 141/166, for a PPV of 85% (95% confidence interval [CI], 80%–90%), whereas hemorrhage codes flagged POA = N were adjudicated as hospital associated in 179/209, for a PPV of 86% (95% CI, 82%–90%). The accuracy of the POA indicator did not vary significantly based on whether the event was an intracranial hemorrhage or gastrointestinal bleed, nor by whether the patient was taking anticoagulation at the time of admission, nor between institutions (Table 1).

4. Discussion

In this study of inpatients with secondary diagnoses of GIB or ICH, we found the POA indicator to have high predictive value in differentiating hospital-associated hemorrhage from hemorrhage prior-to-admission, with a PPV of 85% that did not vary by diagnosis, anticoagulation status, or site.

Our results suggest that the POA indicator can help to temporally differentiate hemorrhage prior-to-admission from hospital associated hemorrhage, which will be important to studying the possible adverse effects of anticoagulation in the hospital and programs to improve prophylactic anticoagulation, neither of which will want to confuse a contraindication (hemorrhage prior-to-admission) with a complication (hospital associated hemorrhage) [10]. Furthermore, if hospital associated hemorrhage itself, like hospital-associated VTE, ever becomes a quality measure, then the differentiation of POA = Y and POA = N could become important for financial reasons. Our study helps to establish the appropriateness of the indicator for these uses and increase the confidence of researchers, quality improvement officers, and others using or planning to use the POA indicators in this way.

This study has several limitations. The institutions analyzed are both large academic medical centers within the University of California system, and the results reflect the quality of the coding at each of the hospitals, which may not be representative [5]. Unlike tests of diagnostic accuracy which begin with a population with a known proportion of the true result—i.e. patients with hemorrhage known to be prior-to-admission vs. hospital associated—we began with the “diagnostic test result”—cases coded with hemorrhage and associated POA Indicators—and abstracted for the true results; this prevented us from calculating sensitivity and specificity. However, our study had important strengths, including use of blinded chart abstraction, a lack of variability between sites, and the calculation of a PPV which will be useful to researchers who likewise work “backwards” from discharge records.

In conclusion, at two academic medical centers in the University of California system, POA indicators for hemorrhage diagnosis codes were 85% accurate in differentiating hospital associated from non-hospital associated conditions. This suggests that these indicators could be useful for quality improvement and research purposes for hemorrhage, as they are for VTE.

Declaration of Competing Interest

Dr. Khanna has developed a communication platform that has been licensed by Voalte, Inc., a communication company. That work is not related to the current manuscript, and neither Voalte, Inc. nor any other external entity had any role in the development, conduct, or writing of this research.

No other conflicts of interest to report.

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Appendix A. Gastrointestinal bleed (GIB) and intracranial hemorrhage (ICH) codes included in this study

ICD-10-CM code	Description	Category
I85.01	Esophageal varices with bleeding	GIB
I85.11	Secondary esophageal varices with bleeding	GIB
K22.11	Ulcer of esophagus with bleeding	GIB
K22.6	Gastro-esophageal laceration-hemorrhage syndrome	GIB
K22.8	Other specified diseases of esophagus	GIB
K25.0	Acute gastric ulcer with hemorrhage	GIB
K25.2	Acute gastric ulcer with both hemorrhage and perforation	GIB
K25.4	Chronic or unspecified gastric ulcer with hemorrhage	GIB
K25.6	Chronic or unsp gastric ulcer w both hemorrhage and perf	GIB
K26.0	Acute duodenal ulcer with hemorrhage	GIB
K26.2	Acute duodenal ulcer with both hemorrhage and perforation	GIB
K26.4	Chronic or unspecified duodenal ulcer with hemorrhage	GIB
K26.6	Chronic or unsp duodenal ulcer w both hemorrhage and perf	GIB
K27.0	Acute peptic ulcer, site unspecified, with hemorrhage	GIB
K27.2	Acute peptic ulcer, site unsp, w both hemorrhage and perf	GIB
K27.4	Chronic or unsp peptic ulcer, site unsp, with hemorrhage	GIB
K27.6	Chr or unsp peptic ulcer, site unsp, w both hemor and perf	GIB
K28.0	Acute gastrojejunal ulcer with hemorrhage	GIB
K28.2	Acute gastrojejunal ulcer w both hemorrhage and perforation	GIB
K28.4	Chronic or unspecified gastrojejunal ulcer with hemorrhage	GIB
K28.6	Chronic or unsp gastrojejunal ulcer w both hemor and perf	GIB
K29.01	Acute gastritis with bleeding	GIB
K29.21	Alcoholic gastritis with bleeding	GIB
K29.31	Chronic superficial gastritis with bleeding	GIB
K29.41	Chronic atrophic gastritis with bleeding	GIB
K29.51	Unspecified chronic gastritis with bleeding	GIB
K29.61	Other gastritis with bleeding	GIB
K29.71	Gastritis, unspecified, with bleeding	GIB
K29.81	Duodenitis with bleeding	GIB
K29.91	Gastroduodenitis, unspecified, with bleeding	GIB
K31.811	Angiodysplasia of stomach and duodenum with bleeding	GIB
K31.82	Dieulafoy lesion (hemorrhagic) of stomach and duodenum	GIB
K50.111	Crohns disease of large intestine with rectal bleeding	GIB
K50.811	Crohns disease of both small and lg int w rectal bleeding	GIB
K50.911	Crohns disease, unspecified, with rectal bleeding	GIB
K51.011	Ulcerative (chronic) pancolitis with rectal bleeding	GIB
K51.211	Ulcerative (chronic) proctitis with rectal bleeding	GIB
K51.311	Ulcerative (chronic) rectosigmoiditis with rectal bleeding	GIB
K51.411	Inflammatory polyps of colon with rectal bleeding	GIB
K51.511	Left sided colitis with rectal bleeding	GIB
K51.811	Other ulcerative colitis with rectal bleeding	GIB
K51.911	Ulcerative colitis, unspecified with rectal bleeding	GIB
K55.21	Angiodysplasia of colon with hemorrhage	GIB
K55.8	Other vascular disorders of intestine	GIB
K57.01	Dvtrcli of sm int w perforation and abscess w bleeding	GIB
K57.11	Dvrtclos of sm int w/o perforation or abscess w bleeding	GIB
K57.13	Dvtrcli of sm int w/o perforation or abscess w bleeding	GIB
K57.21	Dvtrcli of lg int w perforation and abscess w bleeding	GIB
K57.31	Dvrtclos of lg int w/o perforation or abscess w bleeding	GIB
K57.33	Dvtrcli of lg int w/o perforation or abscess w bleeding	GIB
K57.41	Dvtrcli of both small and lg int w perf and abscess w bleed	GIB
K57.51	Dvrtclos of both small and lg int w/o perf or abscs w bleed	GIB
K57.53	Dvtrcli of both small and lg int w/o perf or abscess w bleed	GIB
K57.81	Dvtrcli of intest, part unsp, w perf and abscess w bleeding	GIB
K57.91	Dvrtclos of intest, part unsp, w/o perf or abscess w bleed	GIB
K57.93	Dvtrcli of intest, part unsp, w/o perf or abscess w bleeding	GIB
K62.5	Hemorrhage of anus and rectum	GIB
K63.1	Perforation of intestine (nontraumatic)	GIB
K63.81	Dieulafoy lesion of intestine	GIB
K76.2	Central hemorrhagic necrosis of liver	GIB
K92.0	Hematemesis	GIB
K92.1	Melena	GIB
K92.2	GI hemorrhage, unspecified	GIB
I60.00	Ntrm subarach hemorrhage from unsp carotid siphon and bifurc	ICH
I60.01	Ntrm subarach hemor from right carotid siphon and bifurc	ICH
I60.02	Ntrm subarach hemorrhage from left carotid siphon and bifurc	ICH
I60.10	Ntrm subarach hemorrhage from unsp middle cerebral artery	ICH
I60.11	Ntrm subarach hemorrhage from right middle cerebral artery	ICH
I60.12	Ntrm subarach hemorrhage from left middle cerebral artery	ICH
I60.20	Ntrm subarach hemor from unsp anterior communicating artery	ICH
I60.21	Ntrm subarach hemor from right anterior communicating artery	ICH
I60.22	Ntrm subarach hemor from left anterior communicating artery	ICH

I60.30	Ntrm subarach hemor from unsp posterior communicating artery	ICH
I60.31	Ntrm subarach hemor from right post communicating artery	ICH
I60.32	Ntrm subarach hemor from left posterior communicating artery	ICH
I60.4	Nontraumatic subarachnoid hemorrhage from basilar artery	ICH
I60.50	Nontraumatic subarachnoid hemorrhage from unsp verteb art	ICH
I60.51	Nontraumatic subarachnoid hemorrhage from r verteb art	ICH
I60.52	Nontraumatic subarachnoid hemorrhage from l verteb art	ICH
I60.6	Nontraumatic subarachnoid hemorrhage from oth intracran art	ICH
I60.7	Nontraumatic subarachnoid hemorrhage from unsp intracran art	ICH
I60.8	Other nontraumatic subarachnoid hemorrhage	ICH
I60.9	Nontraumatic subarachnoid hemorrhage, unspecified	ICH
I61.0	Nontraumatic intcrbl hemorrhage in hemisphere, subcortical	ICH
I61.1	Nontraumatic intcrbl hemorrhage in hemisphere, cortical	ICH
I61.2	Nontraumatic intracerebral hemorrhage in hemisphere, unsp	ICH
I61.3	Nontraumatic intracerebral hemorrhage in brain stem	ICH
I61.4	Nontraumatic intracerebral hemorrhage in cerebellum	ICH
I61.5	Nontraumatic intracerebral hemorrhage, intraventricular	ICH
I61.6	Nontraumatic intracerebral hemorrhage, multiple localized	ICH
I61.8	Other nontraumatic intracerebral hemorrhage	ICH
I61.9	Nontraumatic intracerebral hemorrhage, unspecified	ICH
I62.00	Nontraumatic subdural hemorrhage, unspecified	ICH
I62.01	Nontraumatic acute subdural hemorrhage	ICH
I62.02	Nontraumatic subacute subdural hemorrhage	ICH
I62.03	Nontraumatic chronic subdural hemorrhage	ICH
I62.1	Nontraumatic extradural hemorrhage	ICH
I62.9	Nontraumatic ICH, unspecified	ICH
S06.340A	Traum hemor right cerebrum w/o loss of consciousness, init	ICH
S06.341A	Traum hemor right cerebrum w LOC of 30 min or less, init	ICH
S06.342A	Traum hemor right cerebrum w LOC of 31–59 min, init	ICH
S06.343A	Traum hemor right cerebrum w LOC of 1–5 h 59 min, init	ICH
S06.344A	Traum hemor right cerebrum w LOC of 6–24 h, init	ICH
S06.345A	Traum hemor r cereb w LOC > 24 h w ret. consc lev, init	ICH
S06.346A	Traum hemor r cereb w LOC > 24 h w/o ret. consc w surv, init	ICH
S06.347A	Traum hemor r cereb w LOC w dth d/t brain inj bf consc, init	ICH
S06.348A	Traum hemor r cereb w LOC w dth d/t oth cause bf consc, init	ICH
S06.349A	Traum hemor right cerebrum w LOC of unsp duration, init	ICH
S06.350A	Traum hemor left cerebrum w/o loss of consciousness, init	ICH
S06.351A	Traum hemor left cerebrum w LOC of 30 min or less, init	ICH
S06.352A	Traum hemor left cerebrum w LOC of 31–59 min, init	ICH
S06.353A	Traum hemor left cerebrum w LOC of 1–5 h 59 min, init	ICH
S06.354A	Traum hemor left cerebrum w LOC of 6 h to 24 h, init	ICH
S06.355A	Traum hemor left cerebrum w LOC > 24 h w ret. consc lev, init	ICH
S06.356A	Traum hemor l cereb w LOC > 24 h w/o ret. consc w surv, init	ICH
S06.357A	Traum hemor l cereb w LOC w dth d/t brain inj bf consc, init	ICH
S06.358A	Traum hemor l cereb w LOC w dth d/t oth cause bf consc, init	ICH
S06.359A	Traum hemor left cerebrum w LOC of unsp duration, init	ICH
S06.360A	Traum hemor cereb, w/o loss of consciousness, init	ICH
S06.361A	Traum hemor cereb, w LOC of 30 min or less, init	ICH
S06.362A	Traum hemor cereb, w LOC of 31–59 min, init	ICH
S06.363A	Traum hemor cereb, w LOC of 1–5 h 59 min, init	ICH
S06.364A	Traum hemor cereb, w LOC of 6 h to 24 h, init	ICH
S06.365A	Traum hemor cereb, w LOC > 24 h w ret. consc lev, init	ICH
S06.366A	Traum hemor cereb, w LOC > 24 h w/o ret. consc w surv, init	ICH
S06.367A	Traum hemor cereb, w LOC w dth d/t brain inj bf consc, init	ICH
S06.368A	Traum hemor cereb, w LOC w dth d/t oth cause bf consc, init	ICH
S06.369A	Traum hemor cereb, w LOC of unsp duration, init	ICH
S06.4X0A	Epidural hemorrhage w/o loss of consciousness, init encntr	ICH
S06.4X1A	Epidural hemorrhage w LOC of 30 min or less, init	ICH
S06.4X2A	Epidural hemorrhage w LOC of 31–59 min, init	ICH
S06.4X3A	Epidural hemorrhage w LOC of 1–5 h 59 min, init	ICH
S06.4X4A	Epidural hemorrhage w LOC of 6 h to 24 h, init	ICH
S06.4X5A	Epidural hemorrhage w LOC > 24 h w ret. consc lev, init	ICH
S06.4X6A	Epidural hemorrhage w LOC > 24 h w/o ret. consc w surv, init	ICH
S06.4X7A	Epidur hemor w LOC w death d/t brain injury bf consc, init	ICH
S06.4X8A	Epidur hemor w LOC w death due to oth causes bf consc, init	ICH
S06.4X9A	Epidural hemorrhage w LOC of unsp duration, init	ICH
S06.5X0A	Traum subdr hem w/o loss of consciousness, init	ICH
S06.5X1A	Traum subdr hem w LOC of 30 min or less, init	ICH
S06.5X2A	Traum subdr hem w loss of consciousness of 31–59 min, init	ICH
S06.5X3A	Traum subdr hem w LOC of 1–5 h 59 min, init	ICH
S06.5X4A	Traum subdr hem w LOC of 6 h to 24 h, init	ICH
S06.5X5A	Traum subdr hem w LOC > 24 h w ret. consc lev, init	ICH
S06.5X6A	Traum subdr hem w LOC > 24 h w/o ret. consc w surv, init	ICH
S06.5X7A	Traum subdr hem w LOC w dth d/t brain inj bef reg consc,init	ICH
S06.5X8A	Traum subdr hem w LOC w dth d/t oth cause bef reg consc,init	ICH
S06.5X9A	Traum subdr hem w LOC of unsp duration, init	ICH
S06.6X0A	Traum subrac hem w/o loss of consciousness, init	ICH
S06.6X1A	Traum subrac hem w LOC of 30 min or less, init	ICH

S06.6X2A	Traum subrac hem w loss of consciousness of 31–59 min, init	ICH
S06.6X3A	Traum subrac hem w LOC of 1–5 h 59 min, init	ICH
S06.6X4A	Traum subrac hem w LOC of 6 h to 24 h, init	ICH
S06.6X5A	Traum subrac hem w LOC > 24 h w ret. consc lev, init	ICH
S06.6X6A	Traum subrac hem w LOC > 24 h w/o ret. consc w surv, init	ICH
S06.6X7A	Traum subrac hem w LOC w death d/t brain inj bf consc, init	ICH
S06.6X8A	Traum subrac hem w LOC w death d/t oth cause bf consc, init	ICH
S06.6X9A	Traum subrac hem w LOC of unsp duration, init	ICH

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