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Medicare reimbursement attributable to catheter-associated urinary tract infection in the inpatient setting: a retrospective cohort analysis

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Abstract

Background: Most catheter-associated urinary tract infections (CAUTIs) are considered preventable and thus a potential target for healthcare quality improvement and cost savings.

Objectives: We sought to estimate excess Medicare reimbursement, length of stay, and inpatient death associated with CAUTI among hospitalized beneficiaries.

Research design: Using a retrospective cohort design with linked Medicare inpatient claims and National Healthcare Safety Network data from 2009, we compared Medicare reimbursement between Medicare beneficiaries with and without CAUTIs.

Subjects: Fee-for-Service Medicare beneficiaries aged ≥65 years with continuous coverage of Parts A (hospital insurance) and B (supplementary medical insurance).

Results: We found that beneficiaries with CAUTI had higher median Medicare reimbursement (Intensive care unit [ICU]: $8,548, non-ICU: $1,479) and length of stay (ICU: 8.1 days, non-ICU: 3.6 days) compared to those without CAUTI controlling for potential confounding factors. Odds of inpatient death were higher among beneficiaries with versus without CAUTI only among those with an ICU stay (ICU: odds ratio 1.37).

Conclusions: Beneficiaries with CAUTI had increased Medicare reimbursement and length of stay compared with those without CAUTI after adjusting for potential confounders.

Keywords

catheter-associated urinary tract infection; Medicare; reimbursement; healthcare-associated infection; claims data; elderly; health care costs; mortality; regression analysis

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Introduction

Recent estimates suggest that catheter-associated symptomatic urinary tract infections (SUTIs) pose a considerable source of disease burden among children and adults admitted to US hospitals.[1] With up to two-thirds of catheter-associated urinary tract infections (CAUTIs) thought to be preventable,[2] successful efforts to prevent CAUTI have the potential to improve healthcare outcomes and reduce healthcare costs.

Previous estimates of excess healthcare cost attributed to CAUTI include direct costs or charges expected to be incurred through diagnostic testing, treatment, and/or longer inpatient hospitalization.[3–9] These incremental estimates range between $791[10, 11] and $4700[2] per CAUTI in 2009 US dollars. A limitation of these estimates is their focus on cost solely from the perspective of the healthcare facility. As the primary payer of 37% of inpatient discharges in 2010,[12] the additional payments made by Medicare that could be attributable to having a CAUTI are also important to consider.

Objectives

The primary objective of this analysis was to determine Medicare reimbursement attributable to CAUTI among beneficiaries discharged from acute care hospitals in 2009. Secondary objectives were to estimate the additional length of stay and inpatient death associated with CAUTI in the same population.

Methods

Study design

Using a retrospective cohort design, we compared Medicare reimbursement for inpatient care between beneficiaries with and without a CAUTI reported to NHSN. The CDC Human Research Protection Office determined this work was exempt from the regulations governing the protection of human subjects in research under 45 CFR 46.101(b)(5). This work was conducted under a data use agreement with the Centers for Medicare and Medicaid Services.

Data sources

The Centers for Medicare and Medicaid Services (CMS) 2009 Medicare and Provider Analysis and Review (MedPAR) discharge claims data were utilized to obtain inpatient hospitalization stay characteristics, reimbursement amounts (i.e., total Medicare payment to the hospital for the hospitalization), length of stay, and death at discharge. The CMS 2009 Beneficiary Annual Summary File (BASF) data were used to obtain patient demographics, Medicare enrollment status, state Medicaid buy-in status, and status for 21 chronic conditions.

The 2008 BASF data were used to obtain the previous calendar year’s inpatient annual Medicare reimbursement amount; beneficiaries without 2008 BASF data (86 of 5294) were considered to have no inpatient Medicare reimbursement for that year. The BASF and MedPAR files were linked at the beneficiary level by a beneficiary identifier code. The MedPAR claims and BASF data were limited to beneficiaries residing in 8 states

(Colorado, Illinois, New Hampshire, New York, Pennsylvania, South Carolina, Tennessee, and Virginia).

CAUTI events were identified using Centers for Disease Control and Prevention-maintained National Healthcare Safety Network (NHSN) 2009 event data.[13]

Annual cost report data submitted to the CMS-maintained Healthcare Cost Report Information System (HCRIS) were used to identify facility-level details including facility identifiers (used to link NHSN and MedPAR records), hospital bed size, ICU bed size, teaching status, and disproportionate share hospital (DSH) indicator. The wage and case mix indices, intern and resident-to-bed ratio, and DSH patient percent by provider were obtained from the CMS impact file[14] for fiscal year 2009.

MedPAR – NHSN data linkage

To identify beneficiaries with CAUTI, CAUTI events occurring in 2009 and reported to NHSN were linked to corresponding MedPAR claims by the 4 linkage variables hospitalization admission date, date of birth, sex, and CMS provider number using a method developed by Baggs and colleagues.[15, 16] If missing or incorrect, the CMS provider number was added to each NHSN facility location using an algorithm which connected facility identifiers between the NHSN facility file and the 2004–2009 CMS Cost Reports. NHSN facility locations without a CMS provider identification number were excluded. Next, the frequency of all combinations of the 4 linkage variables was determined for both data sources. If a particular combination occurred more than once in either data source, observations with those non-unique linkage patterns were excluded. Finally, the two data sources were joined by the four linkage variables; only exact matches were included.

CAUTI definition

The criteria for defining an event as a CAUTI are described in the online CAUTI event module of the NHSN Patient Safety Manual and in Appendix 2.[13]

Participants

Beneficiaries eligible for inclusion were at least 65 years of age at admission; with or without end stage renal disease; and, covered continuously by Medicare parts A and B, discharged from an inpatient facility, and not enrolled in managed care during 2009. Claims were limited to those for which the primary payer was Medicare and length of stay greater than two days. Providers were limited to inpatient hospitals participating in Medicare's Inpatient Prospective Payment System (IPPS). CAUTI events reported from inpatient dialysis specialty care areas, rehabilitation wards, mixed acuity units, and long-term care (chronic care) units, and locations designated on MedPAR claims as swing-beds or exempt from the IPPS were excluded. Only one claim was utilized per beneficiary: the first claim of the calendar year for potential controls and the first claim of the calendar year with a linked CAUTI for potential cases.

Beneficiaries were considered to be diagnosed with a CAUTI if linked to a CAUTI event reported to NHSN. Beneficiaries not linked to an NHSN-reported CAUTI event but who had

a discharge diagnosis code indicative of CAUTI (i.e., ICD-9-CM: 996.64) were excluded. The remaining beneficiaries were classified as potential controls.

Controlling for potential confounders

Three steps were taken to control for potential confounding. First, potential controls were limited to the CMS provider number, age, race, primary ICD-9-CM diagnosis code, and DRG values observed among the pool of eligible cases. Second, up to five beneficiaries without CAUTI were frequency matched to each beneficiary with CAUTI by ICU status (whether or not the stay included admission to the ICU) and the Agency for Healthcare Research and Quality Clinical Classifications Software (CCS)[17] single-level procedure category of the primary International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure code.[15, 16]

Third, multivariable regression was used to control for potential confounding to the relationship between CAUTI status and healthcare reimbursement at the beneficiary and facility levels. Beneficiary-level admission covariates included age,[18] sex,[18] race,[19] socioeconomic status using the state Medicaid buy-in variable,[19, 20] comorbidities identified before admission[18] represented by 19 chronic condition indicators,[21] and previous healthcare utilization[18] represented by the inpatient annual Medicare reimbursement amount during the previous calendar year.

Beneficiary-level hospitalization covariates included conditions, comorbidities, and procedures conducted during the hospitalization noted by the discharging physician. Discharge diagnoses were used to calculate a hospitalization Gagne comorbidity score for each beneficiary.[22] To represent procedures, the number of secondary procedure codes per beneficiary was utilized. For beneficiaries with CAUTI, only procedures performed prior to the CAUTI event date were counted since the primary procedure code was used in the frequency matching process.

Facility-level covariates included hospital[23] and ICU size, represented by number of hospital and ICU beds, and factors used to adjust IPPS rates[14, 24] including wage index,[14] case mix index,[14] teaching status indicator, intern and resident-to-bed ratio, DSH indicator, and DSH patient percentage.

Analytic and statistical methods

To assess the similarity of beneficiaries with and without CAUTI during hospitalization, we compared expected length of stay for each stratified by ICU status. The 2009 Healthcare Cost and Utilization Project Nationwide Inpatient Sample[12] estimates of mean length of stay by CCS principal procedure category and age group were used to represent expected length of stay. Actual, expected, and beneficiary-level differences between actual and expected length of stay were summarized for beneficiaries with and without CAUTI. In addition, length of stay prior to CAUTI among cases was compared with length of stay among controls.

Univariate comparisons of characteristics between beneficiaries with and without CAUTI were assessed using the Wilcoxon-Mann-Whitney test, if continuous, or the chi-square test, if categorical.

Because the data violated assumptions of ordinary least squares, multivariable quantile (median) models were used to assess reimbursement and length of stay attributable to CAUTI. The odds ratio of inpatient death for those with versus without CAUTI was estimated using multivariable logistic regression. The models included the previously described variables, and were stratified by ICU status. The breast, colorectal, endometrial, lung, and prostate cancer chronic conditions were collapsed into one group, and hip/pelvic fracture and osteoporosis into another. To assess the robustness of the results, the analysis was repeated for two subsets: (1) beneficiaries who were discharged alive, since healthcare utilization may differ depending on survival during hospitalization; and (2) hospitals located in Pennsylvania, the only state mandating CAUTI surveillance reporting to NHSN in 2009 and to whose hospitals the large majority of included beneficiaries were admitted.

Data management and analysis were conducted using SAS Version 9.3 (SAS Institute Inc., Cary, NC). *P*-values less than .05 were considered statistically significant. In accordance with the CMS data use agreement, actual number and corresponding percent of total were not displayed when cell sizes ≤10.

Results

Participants

Of 3923 eligible CAUTI events, 23% linked to MedPAR claims (Figure 1); 884 and 4,410 beneficiaries with and without CAUTI were selected in the frequency matching process, respectively.

Descriptive data

Of the matched beneficiaries with CAUTI, ≤10 with an ICU stay and ≤10 without an ICU stay were classified as having asymptomatic bacteremic urinary tract infection (ABUTI); the remaining cases were classified as having SUTI. Fifty-five and 26 ICU and non-ICU CAUTIs, respectively, reported as having a secondary bloodstream infection.

Baseline characteristics of matched beneficiaries with and without CAUTI, stratified by ICU status, were largely similar (Table 1). Greater proportions of those with CAUTI had histories of chronic kidney disease (ICU: $P \leq .003$, not ICU: $P \leq .01$) and heart failure (ICU: $P = .02$, not ICU: $P = .001$). Cases were more likely to be admitted to a facility in Pennsylvania (ICU: $P \leq .0001$, not ICU: $P \leq .0001$; Table 2).

Outcome data

Beneficiaries with CAUTI had a higher proportion of DRGs with major comorbidities and complications (MCCs), higher average DRG weights, and a higher proportion of outlier payments than those without CAUTI (Table 2). Expected length of stay was similar for cases and controls within ICU strata (ICU: $P = .97$, not ICU: $P = .96$). In addition, actual length of stay prior to CAUTI among cases did not differ from length of stay among controls (ICU:

P=.11, not ICU: *P*=.48). On average, cases had longer lengths of stay than controls (ICU: *P*=<.0001, not ICU: *P*=<.0001), and differed in distribution of discharge destination (ICU: *P*=<.0001, not ICU: *P*=<.0001).

Respiratory intubation and mechanical ventilation was the most common CCS principal procedure category among beneficiaries with a stay in the ICU; following no procedure, treatment for fracture or dislocation of hip and femur was the most common procedure category among beneficiaries without an ICU stay (Table 3).

Main results and other analyses

Beneficiaries with an ICU-stay who were diagnosed with a CAUTI had an $8,548 (95% CL: $6,062-$11,035) higher modeled median Medicare reimbursement. The length of stay was a median extra 8.1 (7.0–9.1) days, and those with a CAUTI had 1.37 (1.04–1.80) times the odds of death during the index hospitalization compared with beneficiaries without a CAUTI. Beneficiaries without an ICU-stay who were diagnosed with a CAUTI had a $1,479 ($909-$2,050) higher median Medicare reimbursement. The length of stay was a median additional 3.6 (2.9–4.3) days, and those with a CAUTI had 1.17 (0.62–2.23) times the odds of death during the index hospitalization compared with beneficiaries without a CAUTI. The modeled outcomes attributable to CAUTI and stratified by ICU status are also shown in Table 4 for all matched beneficiaries and beneficiaries admitted to hospitals located in Pennsylvania and Appendix Table 1 (Supplemental Digital Content 1) for beneficiaries discharged alive.

Discussion

Key results

In this analysis, beneficiaries with CAUTI had higher median Medicare reimbursement and length of stay during the index hospitalization compared with those without CAUTI. Overall, beneficiaries with a CAUTI and an ICU stay had a higher odds of death compared with controls; no difference was observed when restricted to claims without an ICU stay or from Pennsylvania hospitals.

The non-ICU attributable reimbursement using median regression fell within the aforementioned range of $791 to $4700 per CAUTI, while the ICU estimate exceeded this range. Differences may, in part, be explained by the differing objective and methods of this analysis. Our objective was to estimate the reimbursement attributable to CAUTI from the perspective of Medicare, not the facility as was the objective of other studies. The methods of several previous studies utilized expected cost associated with CAUTI; in contrast, this analysis used actual reimbursement from Medicare claims and compared against a similar control group of beneficiaries without CAUTI.

Length of stay was significantly longer among beneficiaries with CAUTI compared with controls. This positive association was consistent across ICU strata and data subsets. However, the odds of death were increased only in beneficiaries with an ICU stay. Both length of stay and mortality have been inconsistently associated with CAUTI in previous studies. While previous studies have differed in the treatment of potential confounding

factors to the relationship between CAUTI and length of stay or mortality,[25] reasons for the inconsistent findings remain unclear.

One reason for differences in our findings from previous estimates may be the variation in CAUTI definitions across studies. Many studies, particularly those prior to the 2009 NHSN definition change, defined cases based on urine microbiology criteria, but varied in the requirement of specific signs or symptoms. In contrast to symptomatic CAUTI and asymptomatic CAUTI with bacteremia, which comprise the current CAUTI definition, asymptomatic bacteriuria has been postulated not to incur additional healthcare costs.[4] Since catheter-associated asymptomatic bacteriuria comprised 51% of CAUTIs reported to NHSN between 2006 and 2008,[26] inclusive, increased estimates of reimbursement attributable to CAUTI following the definition change, as seen in our analysis, may be reasonable.

The use of NHSN data to identify patients with CAUTI strengthened this analysis. Previous studies of Medicare and all-payer claims of patients with CAUTI reveal only a paucity actually list the ICD-9-CM diagnosis code relevant to CAUTI (996.64).[27, 28] Correspondingly, only 15 of 550 and 18 of 334 ICU and non-ICU cases, respectively, had 996.64 listed as a discharge diagnosis code.

As described in the results, only 894 of 3923 events were linked with a corresponding MedPAR claim; however, not all 3923 events were expected to link for 2 reasons. First, in the US in 2009, only 65.4% of individuals at least 65 years of age were enrolled in Medicare parts A and B, non-managed care, fee-for-service (FFS)[29, 30]; in addition, only 88.2% of hospitalizations among this age group listed Medicare as the primary payer.[12] Second, to maximize potential linkage, eligible NHSN events reported by all US hospitals were included even though MedPAR claims were limited to beneficiaries from 8 states. Facilities in the 8 states reported 2508 eligible events, and 884 events linked to MedPAR claims. Applying the aforementioned proportions to the events reported by hospitals in the 8 states, 1447 events would have been expected to link to a corresponding MedPAR claim and the adjusted proportion linked would have been 61%. To help explain the remaining 39% of non-linking NHSN events, potential reasons include (1) lower proportion of FFS beneficiaries in Pennsylvania than the national estimate (61.5% vs. 76.3% in 2009),[31] (2) interstate healthcare utilization in which events occurred in non-residents of the eight states, (3) potential errors in the mapping of NHSN facility identifiers to CMS provider identifiers, and (4) data errors disallowing linkage of the datasets.

Aggregated reimbursement estimate

On average the development of a CAUTI during inpatient hospitalization was associated with increased cost to Medicare. To estimate an overall increased amount reimbursed by Medicare in 2009, we multiplied the point estimate from the median regression model by the number of CAUTIs for which Medicare was the primary payer in 2009. Using the new CAUTI definition, Wise and colleagues[1] estimated 30,000 (95% CL: 26,000–34,000) and 43,000 (37,000–50,000) SUTIs occurred in ICU and non-ICU hospitalizations, respectively, among adults and children in the US in 2009. Assuming Medicare was the primary payer for 37%[12] of the hospitalizations, an estimated 11,186 (9,694–12,677) and 16,033 (13,796–18,643) CAUTIs occurred for which Medicare was the primary payer. Using the point

estimates from the median regression models, Medicare would have paid institutional providers approximately $95.6 million and $23.7 million for beneficiaries with and without an ICU stay, respectively, totaling $119.3 million attributable to CAUTI in 2009. This aggregated estimate is limited in that the estimated number of CAUTIs did not include ABUTIs, but did include children and adults under the age of 65 years. These limitations are likely minor since less than 2% of CAUTIs in this analysis were ABUTIs and the burden estimate was adjusted by the proportion for which Medicare was expected to be the primary payer.

Potential mechanism

Because the hospitals included in this analysis were paid under CMS's IPPS,[14] there are a limited number of ways CAUTI might increase costs. We propose the three most likely potential mechanisms are: (1) DRG upcoding due to a CC or MCC; (2) a change to a higher-weighted base DRG; or, (3) an outlier payment due to a high cost hospitalization. Our observations lend support to these potential mechanisms; as summarized in Table 2, excess cost appears to have been acquired by Medicare through both higher DRG weights and outlier payments among beneficiaries with CAUTI compared with those without CAUTI.

Limitations

This analysis was limited, first, by the inability to identify a comparison group consisting of patients with an indwelling urinary catheter during the index hospitalization using either MedPAR or NHSN data. Two ICD-9-CM procedure codes (57.94 and 57.95) exist relevant to the placement of indwelling urinary catheter; however, their sensitivity has been shown to be low (1.47%).[28] This low sensitivity was confirmed in our analysis: although the cases all had indwelling urinary catheters by definition, only 1–2% had a corresponding procedure code listed in the MedPAR claims data (Table 1). NHSN data could not be used to identify potential controls since the denominator data are reported in aggregate at the facility unit-level, not at the patient-level. Despite this obstacle, the case and control groups were similar by strata in most assessed admission and discharge characteristics, highlighted by the similar expected and pre-CAUTI actual lengths of stays.

Second, while we eliminated controls with a discharge diagnosis code of 996.64 and claims from hospitals not reporting at least 1 CAUTI to NHSN during 2009, the potential for misclassification of controls remained. As discussed previously, less specific diagnosis codes are more commonly used on claims in the event of a CAUTI.[27, 28] However, due to the relatively rare nature of CAUTI, with reported pooled mean rates no greater than 4.7 across ICUs and 3.2 CAUTI per 1000 urinary catheter days across inpatient wards,[32] the magnitude of misclassification was likely small. Ultimately, by not excluding all controls with a potential CAUTI, the estimates may have had a small bias toward the null (i.e., smaller estimated attributable reimbursement, length of stay, and odds ratio of death).

Third, a larger proportion of matched cases than matched controls were admitted to and reported by hospitals located in Pennsylvania. In 2009, only the state of Pennsylvania mandated acute care hospitals report CAUTI surveillance data to NHSN.[33, 34] When restricted to hospitals within Pennsylvania, the point estimates for reimbursement and

length of stay attributable to CAUTI were lower, but remained significantly higher in cases compared with controls and were consistent with the overall results.

A fourth limitation was the restriction of outcome data to the institutional claims associated with the index hospitalization. The focus on index inpatient claims was primarily due to data availability. Non-institutional claims (such as those submitted by physicians not employed by the facility) may have contributed further to the attributable reimbursement. Other outcomes and additional healthcare utilization attributable to CAUTI may continue beyond the index hospitalization. The exclusion of healthcare utilization data after the index hospitalization suggests our findings may represent an underestimate of reimbursement attributable to CAUTI.

Use of administrative claims data are limited at least by their primary purpose as a means for obtaining payment. It is possible that not all chronic and comorbid conditions have been included on claims, particularly if payment is not affected by the presence of a condition.

Generalizability

These results may be generalizable to the subset of the Medicare population represented by our study; this subset includes beneficiaries who were at least 65 years of age, enrolled in Medicare Parts A and B FFS, and not enrolled in the managed care option. In 2010, approximately 93%[35] of Americans aged 65 years and older were enrolled in Medicare with 26%[30] of beneficiaries enrolled in managed care. While a recent analysis found no major differences in a limited number of demographic and health characteristics between Medicare FFS and managed care enrollees[36], reimbursement, length of stay, and discharge death may differ due to healthcare plan coverage characteristics and, therefore, the results of this analysis may not be generalizable to managed care enrollees in the same age group. Finally, since the data are limited to residents of eight states, Pennsylvania in particular, we recommend caution when extrapolating conclusions nationally.

Conclusions and implications

Beneficiaries who develop CAUTI during hospitalization had higher Medicare reimbursement and length of stay than those without CAUTI after adjusting for potential confounders. If CAUTI is a source of excess healthcare utilization, as these results suggest, prevention of CAUTI in the hospital may result in both improved health outcomes for patients, but healthcare cost savings to the Medicare program.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Source of support:

Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention, Atlanta, GA

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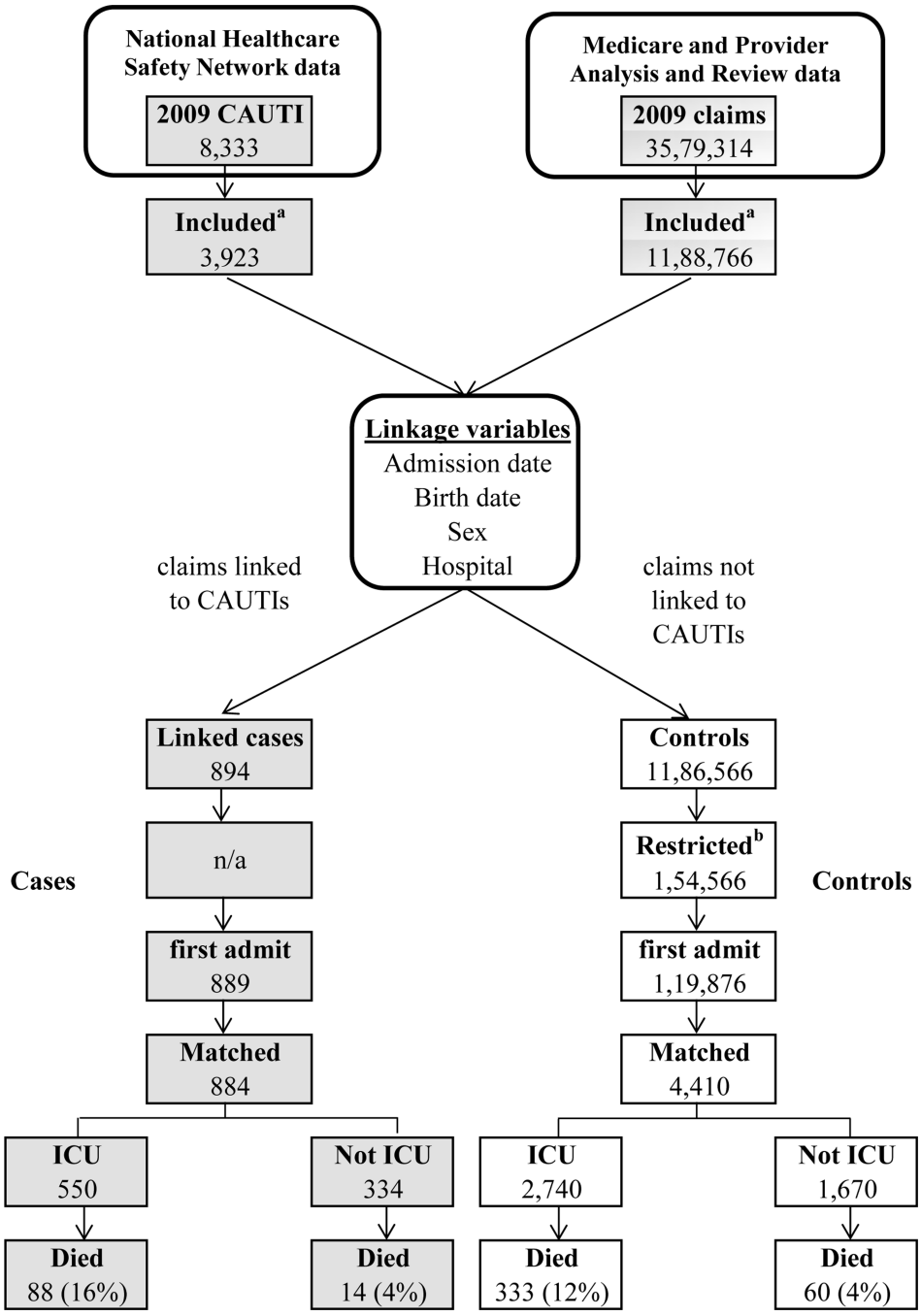

Figure 1.

Flow diagram of eligibility and inclusion in analysis of CAUTI cases and controls who were Medicare beneficiaries and discharged from an inpatient hospitalization in 2009.

Abbreviations: CAUTI, catheter-associated urinary tract infection; ICU, intensive care unit; BSI, bloodstream infection; ABUTI, asymptomatic bacteremic urinary tract infection.

[a]Included hospitalizations met inclusion criteria and had unique linkage patterns.

[b]The control pool was restricted to specific case characteristics.

Table 1.

Admission characteristics of Medicare beneficiaries with and without CAUTI who were discharged from a hospitalization in 2009.

Characteristic	ICU[a]		non-ICU	
	Cases *n*= 550	Controls *n*= 2740	Cases *n*= 334	Controls *n*= 1670
Admission type, n (%)				
Emergency	368 (67)	1691 (62)	226 (68)	1083 (65)
Urgent	104 (19)	506 (18)	53 (16)	231 (14)
Elective	71 (13)	507 (19)	54 (16)	352 (21)
Age at admission, n (%)				
65–69 years	81 (15)	481 (18)	45 (13)	273 (16)
70–74	98 (18)	533 (19)	46 (14)	280 (17)
75–79	107 (19)	551 (20)	62 (19)	301 (18)
80–84	138 (25)	578 (21)	70 (21)	362 (22)
≥85	126 (23)	597 (22)	111 (33)	454 (27)
Sex, n (%)				
Male	256 (47)	1501 (55)	134 (40)	748 (45)
Female	294 (53)	1239 (45)	200 (60)	922 (55)
Race, n (%)				
White	478 (87)	2411 (88)	309 (93)	1492 (89)
Other	72 (13)	329 (12)	25 (7)	178 (11)
2008 reimbursement, $, mean (SD)	10,279 (20,627)	8,751 (21,131)	9,448 (24,538)	8,811 (22,946)
median	0	0	0	0
Chronic condition, n (%)				
Ischemic heart disease	371 (67)	1757 (64)	214 (64)	979 (59)
Heart failure	281 (51)	1253 (46)	172 (51)	699 (42)
Diabetes	242 (44)	1096 (40)	141 (42)	628 (38)
Chronic kidney disease	216 (39)	894 (33)	128 (38)	525 (31)
Chronic obstructive pulmonary disease and bronchiectasis	170 (31)	718 (26)	87 (26)	370 (22)
Rheumatoid arthritis/osteoarthritis	161 (29)	702 (26)	138 (41)	590 (35)

Abbreviations: CAUTI, catheter-associated urinary tract infection; ICU, intensive care unit; SD, standard deviation.

[a]ICU: Beneficiaries admitted to the ICU any time during the hospital stay.

Table 2.

Hospitalization characteristics of Medicare beneficiaries with and without CAUTI who were discharged from a hospitalization in 2009.

Characteristic	ICU[a]		non-ICU	
	Cases *n*= 550	Controls *n*= 2740	Cases *n*= 334	Controls *n*= 1670
Region of facility, n (%)				
Northeast	462 (84)	1912 (70)	309 (93)	1307 (78)
South	55 (10)	451 (16)	11 (3)	164 (10)
Midwest or West	33 (6)	377 (14)	14 (4)	199 (12)
Admitted to facility in PA, n (%)	420 (76)	1693 (62)	301 (90)	1125 (68)
Hospital size, n (%)				
0–250 beds	184 (33)	821 (30)	147 (44)	581 (35)
251–500 beds	179 (33)	948 (35)	116 (35)	587 (35)
≥501 beds	187 (34)	971 (35)	71 (21)	502 (30)
ICU size, n (%)				
0–32 beds	218 (40)	1107 (40)	183 (55)	796 (48)
≥33 beds	332 (60)	1633 (60)	151 (45)	874 (52)
Teaching hospital, n (%)	420 (76)	2153 (79)	226 (68)	1205 (72)
Intern/resident to bed ratio, mean (SD)	0.29 (0.31)	0.27 (0.29)	0.17 (0.23)	0.21 (0.26)
median	0.18	0.17	0.06	0.10
Disproportionate share hospital, n (%)	452 (82)	2291 (84)	256 (77)	1356 (81)
Wage index, mean (SD)	1.00 (0.12)	1.00 (0.11)	0.95 (0.12)	1.00 (0.13)
median	0.98	0.97	0.96	0.97
Case mix index, mean (SD)	1.62 (0.29)	1.62 (0.28)	1.51 (0.25)	1.54 (0.24)
median	1.58	1.58	1.49	1.52
Urinary catheter code, n (%)	≤10[b] (≤2[b])	42 (1.5)	≤10[b] (≤3[b])	26 (1.6)
Index reimbursement, $, mean (SD)	50,512 55,047	31,533 (35,991)	18,429 (28,152)	14,148 (15,802)
median	30,992	19,276	10,359	10,029
Length of stay (LOS), days, mean (SD)	21.7 (16.8)	12.0 (11.0)	12.3 (9.7)	7.2 (7.9)
median	17	8	9	5
Days to CAUTI onset, mean (SD)	11.5 (10.8)		7.3 (5.9)	

Characteristic	ICU[a]		non-ICU	
	Cases *n*= 550	Controls *n*= 2740	Cases *n*= 334	Controls *n*= 1670
median	8		6	
Expected LOS[c], mean (SD)	9.6 (6.1)	9.6 (6.1)	7.1 (3.7)	7.1 (3.6)
median	8.4	8.4	5.9	5.9
Gagne Score, n (%)				
≤0	105 (19)	596 (22)	72 (22)	520 (31)
1	114 (21)	496 (18)	60 (18)	290 (17)
2	97 (18)	517 (19)	63 (19)	277 (17)
3	107 (19)	466 (17)	54 (16)	232 (14)
≥4	127 (23)	665 (24)	85 (25)	351 (21)
Discharge destination, n (%)[d]				
Home	35 (6)	566 (21)	30 (9)	461 (28)
Home + home healthcare	68 (12)	522 (19)	51 (15)	376 (23)
Healthcare facility	356 (65)	1313 (48)	239 (72)	769 (46)
Died	88 (16)	333 (12)	14 (4)	60 (4)
DRG code				
with MCC	312 (57)	1400 (51)	144 (43)	607 (36)
with CC	78 (14)	553 (20)	95 (28)	467 (28)
without CC or unspecified	160 (29)	787 (29)	95 (28)	596 (36)
DRG weight				
0-<1.5	82 (15)	493 (18)	121 (36)	678 (41)
1.5-<2.0	105 (19)	544 (20)	85 (25)	371 (22)
2.0-<5.0	123 (22)	785 (29)	93 (28)	486 (29)
>5.0	240 (44)	918 (34)	35 (10)	135 (8)
DRG weight				
Median	3.69	2.84	1.82	1.82
Mean	5.81	4.28	2.63	2.21
Outlier payment (>$0)	173 (31)	352 (13)	28 (8)	49 (3)

Abbreviations: CAUTI, catheter-associated urinary tract infection; ICU, intensive care unit; SD, standard deviation; LOS, length of stay.

[a] ICU: Beneficiaries admitted to the ICU any time during the hospital stay.

[b] In accordance with the CMS data use agreement, actual number and corresponding percent of total were not displayed when cell sizes ≤10.

[c] ICU (cases, controls): n=517, n=2574; not ICU (cases, controls): n=259, n=1295.

[d] Discharge destination of “Other”: n≤10.

Table 3.

Five most frequent CCS principal procedure categories[a] and DRG codes of Medicare beneficiaries with and without CAUTI who were discharged from a hospitalization in 2009.

			ICU[b]				non-ICU			
			Cases		Controls		Cases		Controls	
			n= 550		*n*= 2740		*n*= 334		*n*= 1670	
Code	**Procedure category**	**DRG weight (FY09)**	**n**	**rank**	**n**	**rank**	**n**	**rank**	**n**	**rank**
216	Respiratory intubation and mechanical ventilation		51	1	255	1	11	5	55	5
34	Tracheostomy; temporary and permanent		45	2	225	2	≤10[c]		20	18
.	No procedure		33	3	165	3	75	1	375	1
1	Incision and excision of CNS		24	4	120	4	≤10[c]		≤10[c]	
43	Heart valve procedures		21	5	105	5	≤10[c]		35	9
54	Other vascular catheterization; not heart		15	10	75	10	14	4	70	4
146	Treatment; fracture or dislocation of hip and femur		14	11	70	11	27	2	135	2
153	Hip replacement; total and partial		≤10[c]		40	20	26	3	130	3
	DRG title									
3	ECMO or trach w MV 96+ hrs or PDX exc face, mouth & neck w maj O.R.	18.4	72	1	116	3	≤10[c]		≤10[c]	
4	Trach w MV 96+ hrs or PDX exc face, mouth & neck w/o maj O.R.	11.1	34	2	187	1	≤10[c]		17	26
64	Intracranial hemorrhage or cerebral infarction w MCC	1.8	17	3	73	5	≤10[c]		17	26
329	Major small & large bowel procedures w MCC	5.2	16	4	100	4	≤10[c]		12	41
291	Heart failure & shock w MCC	1.5	14	5	46	11	16	3	33	6
280	Acute myocardial infarction, discharged alive w MCC	1.9	14	5	38	18	≤10[c]		13	38
682	Renal failure w MCC	1.6	11	8	34	20	≤10[c]		15	33
377	G.I. hemorrhage w MCC	1.6	≤10[c]		43	13	≤10[c]		≤10[c]	
871	Septicemia or severe sepsis w/o MV 96+ hours w MCC	1.8	≤10[c]		118	2	≤10[c]		52	3
65	Intracranial hemorrhage or cerebral infarction w CC	1.2	≤10[c]		42	15	≤10[c]		≤10[c]	58
481	Hip & femur procedures except major joint w CC	1.8	≤10[c]		26	31	20	2	76	2
470	Major joint replacement or reattachment of lower extremity w/o MCC	2.0	≤10[c]		27	28	23	1	156	1

			ICU[b]				non-ICU			
			Cases		Controls		Cases		Controls	
			n= 550		*n*= 2740		*n*= 334		*n*= 1670	
Code	**Procedure category**	**DRG weight (FY09)**	**n**	**rank**	**n**	**rank**	**n**	**rank**	**n**	**rank**
683	Renal failure w CC	1.1	≤10[c]		19	41	≤10[c]		20	22
482	Hip & femur procedures except major joint w/o CC/MCC	1.5	≤10[c]		≤10		≤10[c]		37	4
690	Kidney & urinary tract infections w/o MCC	0.8	≤10[c]		≤10		≤10[c]		36	5

Abbreviations: CAUTI, catheter-associated urinary tract infection; ICU, intensive care unit; CCS, Clinical Classifications Software; DRG, Diagnosis Related Group.

[a] Agency for Healthcare Research and Quality Clinical Classifications Software[17] single-level procedure category of the primary International Classification of Diseases, Ninth Revision, Clinical Modification procedure code.

[b] ICU: Beneficiaries admitted to the ICU any time during the hospital stay.

[c] In accordance with the CMS data use agreement, actual number and corresponding rank were not displayed when cell sizes ≤10.

Table 4.

Estimates of outcomes attributable to CAUTI reported to NHSN among Medicare beneficiaries who were discharged from a hospitalization in 2009.

	All		PA Facilities only	
	ICU[a]	non-ICU	ICU[a]	non-ICU
Sample size, n				
Cases	550	334	420	301
Controls	2740	1670	1693	1125
Medicare reimbursement, $ (95% CL)[b,c]	$8,548[d]	$1,479[d]	$4,540[d]	$1,264[d]
	($6,062 - $11,035)	($909 - $2,050)	($2,393 - $6,687)	($583 - $1,945)
Length of stay, days (95% CL)[b,c]	8.1[d]	3.6[d]	7.1[d]	3.2[d]
	(7.0 - 9.1)	(2.9 - 4.3)	(6.2 - 8.0)	(2.5 - 4.0)
Hospitalization death, OR (95% CL)[c]	1.37[e]	1.17	1.05	0.89
	(1.04 - 1.80)	(0.62 - 2.23)	(0.73 - 1.50)	(0.41 - 1.95)

Abbreviations: CAUTI, catheter-associated urinary tract infection; CL, confidence limits; ICU, intensive care unit; NHSN, National Healthcare Safety Network; OR, odds ratio; PA, Pennsylvania.

[a] ICU: Beneficiaries admitted to the ICU any time during the hospital stay.

[b] Quantile regression estimates of the conditional median of the outcome adjusted for predictor variables.

[c] Models adjusted for age, race, sex, state Medicaid buy-in status, chronic conditions, Gagne comorbidity score, number of secondary procedure codes prior to infection, Centers for Medicare & Medicaid Services (CMS) wage index, CMS case mix index, number of hospital and intensive care unit beds, teaching status and intensity, disproportionate share hospital status and patient proportion, intern and resident-to-bed ratio, and the beneficiary's 2008 inpatient annual Medicare reimbursement amount.

[d] $P<.0001$.

[e] $P<.03$.