Published in final edited form as:

Infect Control Hosp Epidemiol. 2010 August ; 31(8): 872–875. doi:10.1086/655435.

Comparison of Costs of Surgical Site Infection and Endometritis after Cesarean Section Using Claims and Medical Record Data

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Abstract

We used administrative and clinical data from a case-control study to calculate the costs of surgical site infection and endometritis after cesarean section. Attributable costs determined by generalized least squares with the two data sources were similar, suggesting that administrative data can be used to calculate infection costs.

Calculation of the attributable costs due to hospital-acquired infections requires adjustment for factors associated both with infection and increased or decreased costs. In many reports attributable costs are determined using multivariate models or matching algorithms adjusted for demographic, comorbidity, and procedure data abstracted from medical records.^{1,2} Alternatively, we and others have used administrative data (primarily *International Classification of Diseases, 9th Edition, Clinical Modification* (ICD-9-CM) diagnosis and procedure codes) to define comorbidities and procedures.^{3,4} To our knowledge, no investigators have compared the use of medical record vs. claims data to determine the attributable costs of a hospital-acquired infection. We used the two sources of data to create covariates for regression models, in order to calculate costs attributable to surgical site infection (SSI) and endometritis among women who underwent cesarean delivery.

METHODS

We performed a case-control study on a subset of 491 women who underwent low transverse cesarean delivery at Barnes-Jewish Hospital (BJH), a 1250-bed tertiary care hospital affiliated with Washington University School of Medicine between July 1, 1999 and June 30, 2001. We previously reported independent risk factors for SSI and endometritis in this population.^{5,6} Endometritis was defined as fever beginning > 24 hours or continuing at least 24 hours after delivery plus fundal tenderness.⁶ SSI was defined using the National Nosocomial Infections Surveillance System (NNIS) criteria.^{5,7}

Electronic data were collected for all patients from the BJH Medical Informatics database for the original surgical admission, including demographic information, microbiology and laboratory results, and ICD-9-CM diagnosis and procedure codes. ICD-9-CM diagnosis codes were also collected for the 12 months preceding the cesarean delivery to identify

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The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

None of the authors have any conflicts of interest.

comorbidities. Comorbidity and procedure variables were created from the administrative data using the Clinical Classification diagnostic groupings (available at <http://www.hcup-us.ahrq.gov/>).

Clinical data were collected from the surgical admission hospital records, including obstetric history, relevant comorbidities thought to be associated with risk of SSI or endometritis, prophylactic and therapeutic antibiotics, and duration of rupture of membranes and labor, as described previously.^{5,6}

Total hospital cost data (direct, indirect, and fixed costs) were obtained from the BJH cost accounting database (Trendstar; McKesson Corp, Alpharetta, Georgia) for the surgical admission and any inpatient, outpatient surgery, and emergency readmission to the hospital within 30 days after surgery, excluding the costs before the day of the cesarean delivery, as described previously.⁸ All costs were inflation adjusted to 2008 US dollars using the medical care component of the Consumer Price Index.⁹

Attributable costs were determined as previously described using multivariate generalized least squares (GLS) regression.^{3,8,10} All variables with $p \leq 0.05$ in univariate analysis or with biologic plausibility were entered into the initial model; $p > 0.25$ was used for exclusion in the model. An intermediate regression was performed to predict costs in 2008 US dollars.¹⁰ Attributable costs were calculated from the coefficients in the GLS model, as described previously.^{3,8} All statistical analyses were performed using Stata version 9.2 (Stata Corp, College Station, TX). Approval for this study was obtained from the Washington University Human Research Protection Office.

RESULTS

The case-control population was restricted to women with complete cost data for the original surgical admission and any hospital readmission(s) within 30 days after low transverse cesarean delivery, and included 80 women with SSI, 121 women with endometritis, and 309 control patients without infection. Nineteen women had both SSI and endometritis.

Separate GLS models were created to determine the impact of SSI and endometritis on hospital costs using the two sources of data (administrative or medical record) to identify covariates. In the administrative data model, covariates associated with significantly increased costs were young age, severe complications of delivery, pneumonia, pulmonary collapse or insufficiencies, pre-eclampsia/eclampsia, chorioamnionitis, maternal cardiac conditions, sexually transmitted infection, obstetric laceration and/or trauma, ovarian procedures, and placement of a central venous catheter. In the alternative model using medical record data, covariates associated with significantly increased costs included age, non-Caucasian race, labor induction, use of drains, additional surgical procedure other than bilateral tubal ligation, transfusion and/or anemia, severe pre-eclampsia/eclampsia, general anesthesia, inhaled steroids, preoperative antibiotics for therapy of chorioamnionitis, and postoperative hematoma. The attributable costs of SSI and endometritis estimated by the two multivariate GLS regression models were very similar, regardless of the source of data used to specify covariates (Table).

DISCUSSION

We compared attributable costs of SSI and endometritis after cesarean delivery calculated using electronically available administrative and demographic data with costs calculated using manually collected medical record data to specify model covariates. The estimated attributable costs calculated using GLS regression models for both SSI and endometritis were similar, regardless of the source of data used to specify covariates. This finding

suggests that administrative data can be used to estimate costs of these hospital-acquired infections. Administrative data are available from many institutions with diverse patient populations through the Healthcare Cost and Utilization Project. Our results suggest that these data can be used to determine variation in costs of infection by institution and by type of surgery.

We determined the costs of SSI to equal \$3,400–\$3,700 and the costs of endometritis to equal \$3,800–\$4,000. These costs differ slightly from those reported in our previous study of infection costs after cesarean delivery,⁸ because of the use of a case-control subset in this report vs. the entire cohort of 1,597 women in the previous study. Our finding that administrative data could be used instead of clinical medical record data in our tertiary care institution to specify covariates in regression models must be confirmed with data from other facilities representing the great variety of U.S. acute care hospitals. Use of administrative data will facilitate comparison of costs of infection across facilities and can be used in the future to determine the economic impact of infection control prevention activities within institutions and at state and national levels.

Acknowledgments

Financial Support: This work was supported in part by grants from the Centers for Disease Control and Prevention (Prevention Epicenter Program, UR8/CCU715087), and the National Institutes of Health (K01AI065808 to M.A.O. and K24AI06779401 to V.J.F.).

We thank Preetishma Devkota, Zohair Karmally, Cherie Hill and Stacy Leimbach for assistance with data collection and management.

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Table

Results of the Two Generalized Least-Squares Models Using Administrative and Medical Record Data to Determine Attributable Costs of Surgical Site Infection and Endometritis

Variables	Administrative Data			Medical Record Data		
	Estimated β Coefficient	SE	p	Estimated β Coefficient	SE	p
Surgical site infection	.36	.04	<.001	.36	.04	<.001
Endometritis	.40	.03	<.001	.35	.03	<.001
Age <18 years	.10	.05	.053	.12	.05	.022
Age >35 years	.07	.04	.113	.12	.04	.004
Non-private health insurance ^a	.03	.03	.256			
Non-Caucasian race				.10	.03	.002
Sexually transmitted disease	.38	.15	.013			
Diabetes mellitus or gestational diabetes	.07	.05	.142			
Maternal heart disease	.18	.07	.011			
Labor induction				.06	.03	.039
Drains				.23	.05	<.001
Ovarian surgical procedure	.46	.14	.001			
Surgical procedure other than bilateral tubal ligation				.23	.07	.001
Obstetric laceration	.28	.11	.013			
Severe complication of delivery	.52	.11	<.001			
Central venous catheter ^b	.54	.11	<.001			
Mild pre-eclampsia	.12	.05	.017	.06	.05	.203
Severe pre-eclampsia or eclampsia	.27	.05	<.001	.16	.05	.001
General anesthesia				.22	.05	<.001
Clinical diagnosis of chorioamnionitis	.20	.04	<.001			
Group B Streptococcus antibiotic prophylaxis (ampicillin, penicillin, or clindamycin)				.06	.03	.092
Preoperative antibiotic therapy for chorioamnionitis (gentamicin, tobramycin, or ampicillin/sulbactam)				.18	.04	<.001
Pneumonia	.31	.10	.002			
Pulmonary collapse or insufficiencies	.30	.12	.015			
Transfusion and/or anemia				.20	.03	<.001

Variables	Administrative Data			Medical Record Data		
	Estimated β Coefficient	SE	<i>p</i>	Estimated β Coefficient	SE	<i>p</i>
Post-operative hematoma				.20	.07	.006
Inhaled steroids				.30	.10	.003
Model results	Administrative Data			Medical Record Data		
R ² of Model <i>c</i>	.31			.30		
Attributable Cost in US \$2008 – Surgical Site Infection (95% Confidence Interval)	\$3,418 (\$2,863–\$4,081)			\$3,684 (\$2,867–\$4,734)		
Attributable Cost in US \$2008 – Endometritis (95% Confidence Interval)	\$3,794 (\$3,177–\$4,530)			\$4,015 (\$3,075–\$5,243)		

^aPublic Aid, Medicaid, Medicare, or no health insurance

^binserted before the onset of SSI and/or endometritis in case patients

^cAdjusted R² after accounting for the natural log transformation of costs.