**Supplemental Digital Content (SDC)**

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**Appendix 1- Codes to identify shoulder surgeries**

Shoulder arthroplasty or joint repair: 1.TA.80; 1.TA.87; 1.TA.93

Rotator cuff repair: 1.TC.70; 1.TC.71; 1.TC.57; 1.TC.59; 1.TC.72; 1.TC.80

Other shoulder repair: 1.TF.04; 1.TF.72; 1.TF.80; 1.TF.87

**Appendix 2-Validation Study**

*Data source and population*

The Ottawa Hospital Data Warehouse (OHDW) stores administrative and clinical data for patients cared for at The Ottawa Hospital (TOH), a multi-site Academic Health Sciences Centre with two inpatient campuses and one free standing ambulatory surgery center. In October 2011, TOH adopted an electronic anesthesia record, which is the medicolegal reference standard for documentation of intraoperative care for all surgical patients at TOH. In other words, all clinical anesthesia records at TOH are completed electronically by anesthesiologists in our perioperative electronic health record (Perioperative Manager, OPTUM, Eden Prairie, MN), and these data are stored in the OHDW in standard formats that can be deterministically linked to other hospital data using unique patient identifiers.

Our validation study population consisted of all adults having shoulder surgery at TOH from January 2013 to December 2016. Our start date was chosen to account for initial implementation and changes in software and fields after implementation of our electronic anesthesia record, as well as to allow time for clinicians to get used to electronic charting over the first year. December 2016 was the latest date that complete data were available when linkage was performed. Data were linked deterministically to provincial health records at ICES based on each person’s health insurance number, which was transformed into a unique encrypted identifier. Once data were linked to ICES we could create an analytic dataset combining the clinical data from TOH with administrative data at ICES. In total, 364 TOH shoulder surgery patients with the known anesthesia type based specifically on the clinical medical record were linked.

*Reference standard*

Documentation of placement of a nerve block was identified from OHDW for each patient. For each anesthesia record an anesthesia type is required (general, neuraxial, general plus neuraxial, regional, general plus regional). There are also standard fields to document the technical aspects of peripheral nerve block placement, including the anatomical location and specific type of block. Data from each of these fields were included in our reference standards data set. For any patient where there was documentation of a peripheral nerve block being placed in the clinical record, the presence of a nerve blocks was coded as ‘1’ (i.e., block present); where no nerve block was documented the presence of a nerve block was code as ‘0’ (i.e., block not present). No manual chart review was performed as the electronic record is the medico-legal standard (i.e., it is the chart) and blocks were all documented in using standardized data fields that were directly extracted (i.e., no new information would be available through manual review of these same fields). This electronic clinical record was considered the reference standard.

*Diagnostic algorithms*

We used the presence of an Ontario Health Insurance Plan (OHIP) physician billing code (G260-plexus nerve block, G060-major nerve block, G061-minor nerve block, and G279-percutaneous peripheral nerve catheter), billed +/- 1 day from surgery as the diagnostic algorithm. These codes were identified through regularly held ICES data.

*Analysis*

We used concepts of diagnostic test accuracy to determine whether OHIP physician billing codes could be used to validly identify the presence of absence of nerve blocks.

For each patient we coded the presence or absence of a nerve block and the presence of absence of a physician billing code as binary variables. Each patient was then classified as being a true positive (code positive/nerve block positive), true negative (code negative/nerve block negative), false positive (code positive/nerve block negative), or false negative (code negative/nerve block positive).

Our primary measures of accuracy were the positive and negative likelihood ratios (LR+/LR-), which are less influenced by prevalence than positive and negative predictive values.1 Confidence intervals were calculated using the methods of Simel et al.2 Based on recommended cut points, a high level of accuracy would be present if a +LR of >10, and a -LR <0.2 were found.3 We also calculated the sensitivity and specificities for each code, including confidence intervals using the binomial distribution.

*Results*

Of the 364 linked patients, 312 had a nerve block (86%). The 2x2 table correlating true presence or absence of a nerve block with physician billing codes is provided in Appendix Table 1. The OHIP physician billing codes had a sensitivity of 97% and a specificity of 94%. This corresponded to a positive likelihood ratio (+LR) = 16.8 and a negative likelihood ratio (-LR) = 0.03 (see full results and confidence intervals in Appendix Table 2).

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| **Appendix Table 1 - Contingency Table** |   |   |
|   | **Nerve block in clinical record** |
|   | **Present** | **Absent** |
| **OHIP billing code G260, G060, G061 or G279 Present** | 303 | 3 |
| **OHIP billing code G260, G060, G061 or G279 Absent** | 9 | 49 |

|  |  |
| --- | --- |
| **Appendix Table 2 - Accuracy Statistics** |   |
|   | **Point Estimate** | **95% CI** |
| **Positive Likelihood Ratio** | 16.83 | 5.61-50.50 |
| **Negative Likelihood Ratio** | 0.031 | 0.016-0.059 |
| **Sensitivity** | 97.12 | 94.59-98.67 |
| **Specificity** | 94.23 | 84.05-98.79 |
| CI: confidence interval |   |   |

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3. Jaeschke R, Guyatt GH, Sackett DL: Users’ guides to the medical literature. III. How to use an article about a diagnostic test. B. What are the results and will they help me in caring for my patients? The Evidence-Based Medicine Working Group. JAMA 1994; 201:703–7

**Appendix 3 -** Adjusted regression model for composite outcome (i.e., unplanned admissions, readmissions within 7 days, ED visit within 7 days or death within 7 days (note: no deaths occurred in either group))

|  |  |  |
| --- | --- | --- |
| **Covariate** | **OR\*** | **95% CI** |
| Peripheral nerve block (vs none) | 0.96 | 0.89 to 1.03 |
| Female (vs male) | 1.09 | 1.03 to 1.16 |
| Year (restricted cubic spline with 3 knots) Year (linear) | 1.11 | 1.04 to 1.16 |
|  Year (spline segment) | 0.88 | 0.84 to 0.92 |
| Age (restricted cubic spline with 5 knots) Age (linear) | 1.00 | 0.99 to 1.01 |
| Age (spline segment 1) | 0.99 | 0.97 to 1.02 |
| Age (spline segment 2) | 1.07 | 0.82 to 1.39 |
| Age (spline segment 3) | 1.02 | 0.56 to 1.86 |
| *Neighborhood income*  Quintile 1 (lowest) Quintile 2 Quintile 3 Quintile 4 Quintile 5 | 1.00.930.920.870.83 | 0.84 – 1.020.83 – 1.010.79 – 0.950.76 – 0.91 |
| Rural (vs not) | 1.21 | 1.11 – 1.31 |
| *Resource Utilization Band* Band 1 Band 2 Band 3 Band 4 Band 5 | 1.000.700.680.670.67 | 0.41 – 1.200.41 – 1.150.40 – 1.140.39 – 1.15 |
| *Surgery Type* Shoulder arthroplasty or joint repair Rotator cuff repair Other shoulder repair | 1.001.091.06 | 1.01 – 1.170.78 – 1.44 |
| *Surgical approach* Open (vs Arthroscopic) | 1.90 | 1.77 – 2.05 |
| *Healthcare resource use* Hospitalization in the last year (yes vs no) Emergency department visit in last year 0 (ref) 1 >1 | 0.951.001.311.65 | 0.85 – 1.071.22 – 1.401.53 – 1.79 |
| *Comorbidities* ASA score, >2 Cerebrovascular disease Chronic Renal disease Dialysis Primary malignancy Metastatic solid tumor Peripheral vascular disease Liver Disease History of Peptic ulcer disease Rheumatologic disease Hemiplegia or paraplegia Atrial arrhythmia History of venous thromboembolism History of heart failure History of hypertension History of diabetes mellitus Chronic obstructive pulmonary disease Asthma Myocardia Infarction Cardiac valvular disease Disease of the pulmonary circulation Coagulopathy Obesity Weight loss Blood loss anemia Deficiency anemia Alcohol Abuse Drug Abuse Psychosis Depression | 1.310.711.150.590.960.431.260.430.710.742.471.131.281.021.021.070.991.0340.901.591.360.951.851.031.371.401.421.441.471.49 | 1.23 – 1.410.45 - 1.120.62 - 2.120.21 - 1.660.70 - 1.320.12 - 1.480.75- 2.130.18 - 1.000.36 - 1.390.37 - 1.461.12 - 5.490.80 - 1.580.51 - 3.190.83- 1.270.95 - 1.090.99 - 1.160.91 - 1.080.96 - 1.120.73 - 1.110.88 - 2.880.75 - 2.460.47 - 1.931.40 - 2.440.29 - 3.630.88 - 1.600.30 - 3.74 0.97 - 2.060.48 - 1.701.54 - 14.940.83 - 1.75 |

\*Note that OR >1 represents increased risk of outcome. ACG: The Johns Hopkins Adjusted Clinical Groups (ACG®) score; ASA: American Society of Anesthesiologists

**Appendix 4** – Reviewer requested sensitivity analyses

1. Excluding data from 2009 when utilization of PNBs was substantially lower: To perform these analyses, data from patients who had surgery in 2009 were excluded and our adjusted analysis of the primary composite outcome at 7-days and 2-day cost outcomes were re-run
	1. Composite 7-day result: Adjusted odds ratio (OR) 0.99, 95%CI 0.92-1.09, *P*=0.962
	2. Health system costs at 7-days: Adjusted ratio of means 1.07, 95%CI 1.07-1.08, *P*<0.001
2. Adjusting for procedural risk using the full CCI code: To perform this analysis we re-ran our primary and 7-day cost analyses, but replaced our original procedural variables (first 3 digits of the CCI code plus a binary indicator for open vs arthroscopic) with the full CCI code as a categorical variable
	1. Composite 7-day result: Adjusted OR 0.99, 95%CI 0.92-1.07, *P*=0.780
	2. Health system costs at 7-days: Adjusted ratio of means 1.06, 95%CI 1.06-1.06, *P*<0.001
3. Adjusting for hospital-level variation by adjusting for each hospital as a categorical fixed effect: To perform this analysis we replaced our multilevel random intercept models (initially run in PROC GLIMMIX) with standard regression models (PROC LOGISTIC for binary, PROC GENMOD for log-gamma). In each of these new models a categorical variable representing each of the 118 hospitals was added as a fixed effect to the other patient-level covariates included in all other adjusted models
	1. Composite 7-day result: Adjusted OR 0.99, 95%CI 0.92-1.07, *P*=0.990
	2. Health system costs at 7-days: Adjusted ratio of means 1.06, 95%CI 1.0-1.07, *P*<0.001
4. Adjusting for the ACG® as a 5-knot restricted cubic spline: To perform this analysis we removed the linear term for the ACG® score from our adjusted multilevel models and replaced it with the ACG® score represented as a 5-knot restricted cubic spline
	1. Composite 7-day result: Adjusted OR 0.96, 95%CI 0.89-1.03, *P*=0.247
	2. Health system costs at 7-days: Adjusted ratio of means 1.07, 95%CI 1.07-1.08, *P*<0.001
5. Re-running our cost analysis after subtracting the physician billing cost of the block: To perform this analysis, the cost from the OHIP fee schedule for each block procedure performed was subtracted from the total 7-day health system cost for each patient. We also subtracted 4 units of anesthesia time-billing ($60) as an estimate of each block placement taking an estimated 30-45 minutes of physician anesthesiologist time (we could not directly extricate the time fee paid vs the procedure code paid). The new cost outcome was then placed as the dependent variable in our multilevel adjusted log-gamma model
	1. Health system costs at 7-days (minus physician billing for PNB placement): Adjusted ratio of mean 1.03, 95%CI 1.03-1.04, *P*<0.001

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1. Terza J V: Two-Stage Residual Inclusion Estimation in Health Services Research and Health Economics. Health Serv Res 2018; 53:1890–9

2. Terza J V, Bradford WD, Dismuke CE: The use of linear instrumental variables methods in health services research and health economics: a cautionary note. Health Serv Res 2008; 43:1102--20

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| **Appendix 5 :** Characteristics of the propensity score matched cohort |
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|  | **No PNB (n=28571)** | **PNB (n=31073)** | **ASD** |
|  |  |  |  |
| *Demographics* |   |   |   |
|  Age, mean (SD) | 51 (14) | 52 (14) | 0.07 |
|  Female, % | 32.7 | 33.4 | 0.01 |
|  Rural, % | 12.6 | 13.5 | 0.03 |
|  Neighborhood income quintile, median (IQR)  | 3 (2-4) | 3 (2-4) | 0.00 |
| *Surgery type* (%) |   |   |   |
|  Shoulder arthroplasty or joint repair | 41.1 | 37.2 | 0.08 |
|  Rotator cuff repair | 58.1 | 62.1 | 0.08 |
|  Other shoulder repair | 0.7 | 0.6 | 0.01 |
| *Surgical approach* (%) |   |   |   |
|  Arthroscopic | 24.4 | 26.8 | 0.06 |
| *Healthcare resource use* (%) |   |   |   |
|  Hospitalization in the last year | 5.3 | 5 | 0.01 |
|  Emergency department visit in the last year | 40.7 | 40.2 | 0.01 |
| *Comorbidities* |   |   |   |
|  ACG score (mean, SD) | 8 (3) | 8 (3) | 0.00 |
|  ASA score, < 3 | 67.8 | 65.2 | 0.06 |
|  Cerebrovascular disease, % | 0.3 | 0.3 | 0.00 |
|  Chronic Renal disease, % | 0.2 | 0.1 | 0.00 |
|  Dialysis, % | 0.1 | 0.1 | 0.00 |
|  Dementia, % | 0.0 | 0.0 | 0.00 |
|  Primary malignancy, % | 0.6 | 0.7 | 0.01 |
|  Metastatic solid tumor, % | 0.0 | 0.0 | 0.00 |
|  Peripheral vascular disease, % | 0.2 | 0.2 | 0.00 |
|  History of Peptic Ulcer disease, % | 0.2 | 0.2 | 0.00 |
|  Liver Disease, % | 0.1 | 0.1 | 0.00 |
|  Rheumatologic disease, % | 0.1 | 0.2 | 0.03 |
|  Hemiplegia or paraplegia, % | 0.1 | 0.1 | 0.00 |
|  Atrial arrhythmia, % | 0.4 | 0.5 | 0.01 |
|  History of venous thromboembolism, % | 0.1 | 0.1 | 0.00 |
|  History of heart failure, % | 1.1 | 1.2 | 0.01 |
|  History of hypertension, % | 34.2 | 36.2 | 0.04 |
|  History of diabetes mellitus, % | 15.0 | 15.4 | 0.01 |
|  Chronic obstructive pulmonary disease, %  | 11.5 | 12.6 | 0.03 |
|  Asthma, % | 18.6 | 18.3 | 0.01 |
|  Myocardia Infarction, % | 1.3 | 1.6 | 0.03 |
|  Cardiac valvular disease, % | 0.1 | 0.1 | 0.00 |
|  Disease of the pulmonary circulation, % | 0.2 | 0.2 | 0.00 |
|  Coagulopathy, % | 0.1 | 0.1 | 0.00 |
|  Obesity, % | 0.5 | 0.6 | 0.01 |
|  Weight loss, % | 0.0 | 0.0 | 0.00 |
|  Blood loss anemia, % | 0.5 | 0.5 | 0.00 |
|  Deficiency anemia, % | 0.0 | 0.0 | 0.00 |
|  Alcohol Abuse, % | 0.3 | 0.2 | 0.02 |
|  Drug Abuse, % | 0.2 | 0.2 | 0.00 |
|  Psychosis, % | 0.0 | 0.0 | 0.00 |
|  Depression, % | 0.3 | 0.3 | 0.00 |
| ACG: The Johns Hopkins Adjusted Clinical Groups (ACG®) score; ASA: American Society of Anesthesiologists; IQR: interquartile range; SD: standard deviation; PNB: Peripheral Nerve Block; ASD: Adjusted Standardized Difference |