**Supplemental Digital Content 2. Risk for Delirium Associated with ICD Procedure Codes**

The risk for delirium associated with various International Statistical Classification of Diseases and Related Health Problems (ICD) procedure codes were derived from a yet-unpublished retrospective study at the same institution. The primary aim of the study is to investigate a potential association between obstructive sleep apnea and postoperative delirium. The Human Research Protection Office at Washington University granted a waiver of informed consent. A total of 234,375 procedure codes from 102,154 unique patients were available.

The study period spanned the transition from ICD-9-CM to ICD-10. If ICD-10 codes were documented for a patient, then these were backward-mapped to ICD-9-CM codes using general equivalence mappings available through the Centers for Medicare & Medicaid Services (<https://www.cms.gov/Medicare/Coding/ICD10/index.html>).

Similar ICD-9-CM codes were grouped using Clinical Classification Software (CCS) lookup tables, which were developed by the Agency for Healthcare Research and Quality (<https://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp>). The CCS consists of a series of classification categories with increasing levels of detail. For example, the first-level category “7” corresponds to “Operations on the cardiovascular system,” the second-level category “7.2” corresponds to “Coronary artery bypass graft (CABG),” and the third-level category “7.2.3” corresponds to “Bypass of three coronary arteries.” Each ICD-9-CM code was mapped to one of the CCS classification categories.

CCS categories were combined into clusters to achieve a minimum number of patients per cluster. Third-level categories with 300 or more instances were treated as their own clusters. Third-level categories with fewer than 300 instances were nested into their parent second-level categories. Second-level categories with 300 or more instances were treated as their own clusters. Second-level categories with fewer than 300 instances were nested into the parent first-level categories. First-level categories with 100 or more instances were treated as their own clusters. First-level categories with fewer than 100 instances were grouped into an “Other” cluster.

Because each patient had multiple procedure codes and therefore could belong to more than one CCS cluster, a dummy variable was created for each cluster. A logistic regression for postoperative delirium was constructed, using each of the clusters as an input variable. The beta coefficient from this logistic regression was used as the “procedure risk for delirium” for each cluster of procedures. The beta coefficient for each cluster is shown in eTable 2.

To utilize these derived procedure risk coefficients in the current study, up to three ICD-9-CM or ICD-10 procedure codes per patient were retrieved from the hospital database. The general equivalence mappings from the Centers for Medicare & Medicaid Services were used to backward-map any ICD-10 codes to ICD-9-CM codes.

Each ICD-9-CM procedure code was mapped to one of the CCS clusters that were derived in the obstructive sleep apnea study. The procedure risk for that cluster was retrieved from the lookup table shown in the table below. The total procedure risk for each patient was computed as the sum of the procedure risk coefficients corresponding to the (up-to-three) CCS clusters for that patient.

**Table. Procedure Delirium Risk Coefficients for Clusters of Procedures**

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| --- | --- | --- | --- | --- |
| **Cluster** | **Cluster Label** | **Number of Patients** | **Delirium**  **N (%)** | **Delirium Risk Coefficient** |
| 1 | Operations on the nervous system | 109 | 58 (53%) | -0.06429 |
| 6 | Operations on the respiratory system | 342 | 225 (66%) | 0.65789 |
| 6.1 | Tracheostomy; temporary and permanent | 575 | 505 (88%) | 1.31793 |
| 7 | Operations on the cardiovascular system | 767 | 448 (58%) | -0.01593 |
| 7.1 | Heart valve procedures | 325 | 199 (61%) | -0.36215 |
| 7.19.2 | Other OR procedures on blood vessels | 364 | 235 (65%) | 0.19947 |
| 7.7 | Other OR heart procedures | 686 | 533 (78%) | 0.92349 |
| 7.8 | Extracorporeal circulation auxiliary to open heart procedures | 532 | 422 (79%) | 1.09610 |
| 8 | Operations on the hemic and lymphatic system | 111 | 55 (50%) | -0.25056 |
| 9 | Operations on the digestive system | 756 | 531 (70%) | 0.82988 |
| 10 | Operations on the urinary system | 103 | 46 (45%) | -0.27320 |
| 14 | Operations on the musculoskeletal system | 335 | 204 (61%) | 0.40292 |
| 14.11 | Spinal fusion | 106 | 55 (52%) | 0.06445 |
| 14.13.3 | Other muscle and tendon procedures | 207 | 148 (71%) | 0.80540 |
| 15 | Operations on the integumentary system | 181 | 115 (64%) | -0.03120 |
| 16 | Miscellaneous diagnostic and therapeutic procedures | 518 | 331 (64%) | 0.05378 |
| 16.27 | Respiratory intubation and mechanical ventilation | 324 | 237 (73%) | 0.13914 |
| 16.27.3 | Continuous mechanical ventilation 96 hours or more | 631 | 543 (86%) | 1.05497 |
| Other |  | 138 | 94 (68%) | 0.53722 |