Systemic inaccuracies in the National Surgical Quality Improvement Program database: Implications for accuracy and validity for neurosurgery outcomes research

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A R T I C L E   I N F O

A B S T R A C T

The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) provides a rich database of North American surgical procedures and their complications. Yet no external source has validated the accuracy of the information within this database. Using records from the 2006 to 2013 NSQIP database, we used two methods to identify errors: (1) mismatches between the Current Procedural Terminology (CPT) code that was used to identify the surgical procedure, and the International Classification of Diseases (ICD-9) post-operative diagnosis: i.e., a diagnosis that is incompatible with a certain procedure. (2) Primary anesthetic and CPT code mismatching: i.e., anesthesia not indicated for a particular procedure. Analyzing data for movement disorders, epilepsy, and tumor resection, we found evidence of CPT code and postoperative diagnosis mismatches in 0.4–100% of cases, depending on the CPT code examined. When analyzing anesthetic data from brain tumor, epilepsy, trauma, and spine surgery, we found evidence of miscoded anesthesia in 0.1–0.8% of cases. National databases like NSQIP are an important tool for quality improvement. Yet all databases are subject to errors, and measures of internal consistency show that errors affect up to 100% of case records for certain procedures in NSQIP. Steps should be taken to improve data collection on the frontend of NSQIP, and also to ensure that future studies with NSQIP take steps to exclude erroneous cases from analysis.

1. Introduction

The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) provides a rich database of North American surgical procedures and their complications [1–4]. Running since 2005, it currently contains nearly 3 million procedures and incorporates data from over 600 hospitals. Numerous papers have been published which utilize this database, and have uncovered useful predictors and trends in complications for various procedures, particularly in neurosurgery [1,5,6] and spine surgery [7–11].

Yet no external source has validated the accuracy of the information within this database, and all databases are subject to some degree of error during data entry or processing. While we have no means of externally validating the data within NSQIP, we are nevertheless able to use metrics of internal consistency to check the certain aspects of the data's integrity.

2. Methods

We devised and applied novel internal consistency metrics to validate the 2006–2013 NSQIP data. Each record in NSQIP documents a single operating room visit, utilizing up to 21 Current Procedural Terminology (CPT) codes per case to describe the primary, additional, and concurrent procedures performed. Each record also has a post-operative International Classification of Diseases (ICD-9) code that describes the diagnosis. Demographic information is also reported, along with perioperative complications, preoperative morbidity, and aspects of the operative visit (e.g., type of primary anesthesia, presence of resident physicians, length of case, etc.).

Using these records, we devised two methods of validating the data:

1. CPT code and ICD-9 diagnosis mismatching (i.e., a diagnosis that is incompatible with a certain procedure). An example would be cortical neurostimulation for Parkinson's disease, when only subcortical stimulation is indicated.
2. Primary anesthetic and CPT code mismatching (i.e., anesthesia that would not be indicated for a particular procedure). An example would using epidural or spinal anesthesia for a craniotomy.

Statistical analysis was conducted in SPSS version 23 (IBM Corp.; Armonk, NJ, USA). Means are reported ± standard deviation (SD) unless otherwise specified.

2.1. Ethics, consent and permissions

Because all data used herein was obtained from a publicly available, anonymized database, its use is exempt from institutional review board approval.

3. Results

Using data from the ACS NSQIP database, we conducted two primary tests of internal consistency to validate the integrity of the data: (1) procedure CPT code and diagnosis ICD-9 code mismatch and (2) procedure CPT code and anesthesia type mismatch.

3.1. CPT code and postoperative diagnosis mismatch

Each record in the NSQIP dataset provides a primary CPT code and a postoperative ICD-9 diagnosis. There are some *a priori* combinations that should not occur. For example, there are CPT codes for brain tumor resection and separate codes for the treatment of

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Table 1
Examples of mismatches between CPT procedure codes and postoperative diagnosis ICD-9 codes.

Mismatch	Explanation	Involved CPT codes	Involved ICD-9 codes	Number of errors (% of cases with affected CPT code)
Cortical stimulation instead of subcortical stimulation for Parkinson's disease	Codes for cortical neurostimulation were used with a diagnosis of Parkinson's (PD) disease. Cortical stimulation is not indicated for PD. Subcortical stimulation is (e.g., globus pallidus or subthalamic nucleus). This is likely a miscoding where the distinction between subcortical and cortical stimulation was not appreciated during data entry	61850, twist drill or burr hole for implantation of neurostimulator electrodes, *cortical*	332.0, paralysis agitans (Parkinson's disease)	8 (100)
		61860, craniectomy or craniotomy for implantation of neurostimulator electrodes, *cortical*	Same	19 (41.3)
Seizure monitoring for diseases other than epilepsy	There are CPT codes specifically for placing electrodes for seizure-monitoring. When these are used diseases other than epilepsy, they are likely erroneous. The intended code was likely for placement of a neurostimulator electrode (e.g., for Parkinson's disease) or for cranial nerve mapping (e.g., for microvascular decompression of the trigeminal nerve)	61531 (Subdural implantation of strip electrodes through one or more burr or trephine hole(s) for long term seizure monitoring), 61533 (Craniotomy with elevation of bone flap; for subdural implantation of an electrode array, for long-term seizure monitoring), and 61535 (Craniotomy with elevation of bone flap; for removal of epidural or subdural electrode array, without excision of cerebral tissue (separate procedure))	332.0, paralysis agitans (PD); 350.2, atypical facial pain; 350.9, trigeminal nerve disorder	4 (2.3)
Tumor resection for diseases other than brain tumors	There are CPT codes for supra- and infra-tentorial tumor resection, which exclude meningiomas (meningiomas have their own CPT code). When the diagnosis is for meningioma, these are likely erroneous	61510 (Craniectomy, trephination, bone flap craniotomy; for excision of brain tumor, supratentorial, except meningioma), 61518 (Craniectomy for excision of brain tumor, infratentorial or posterior fossa; except meningioma cerebellopotine angle tumor, or midline tumor at skull base)	192.1, 225.2, 225.4, 237.6, 349.2	254 (2.9)
	In the same grouping, many abscesses or infections were coded erroneously for brain tumor resection. Likely, the intended code was for removal of abscess, which again is a separate CPT code		006.5, 013.25, 013.9, 038.10, 039.8, 049.0, 117.3,123.1, 130.0, 130.7, 136.9, 323.9, 324, 348, 730.28	35 (0.4)

brain abscesses. If an abscess is listed as the postoperative diagnosis, the CPT code for brain tumor resection should not be used. Presence of such mismatches indicates miscoding.

Analyzing data for surgery for movement disorders, epilepsy, and tumor resection, we found evidence of CPT code and postoperative diagnosis mismatches affecting from 0.4% to 100% of all occurrences of CPT categories (Table 1). The most frequently affected surgery was cortical neurostimulator electrode placement using burr holes. All (100%) of these cortical neurostimulation procedures listed Parkinson's disease (PD) as the postoperative diagnosis. However, there is no accepted cortical stimulation treatment for PD. These entries likely intended *subcortical* placement of neurostimulator electrodes, which is a different CPT code.

3.2. Anesthesia modality

Each record in the NSQIP dataset lists the primary anesthesia modality used, such as general, local, regional, spinal, epidural, etc. Some anesthetics should not be used for certain procedures, such as epidural anesthesia for brain tumor resection. When these are listed, it again implies miscoding.

Again analyzing data from multiple domains (brain tumor, epilepsy, trauma, and spine surgery), we found evidence of miscoded anesthesia occurring in 0.1–0.8% of cases (Table 2). The most commonly affected subgroup that we studied was epilepsy surgery (0.8%), where spinal, epidural, and no anesthetic were listed instead of general, monitored anesthesia care (MAC), or even regional/local anesthetic (which might be used during awake cases).

Table 2
Examples of erroneous anesthesia: spinal, epidural, or no anesthesia for cases where this would not be indicated.

Type of procedure (CPT codes)	# Cases with spinal, epidural, or No anesthesia (%)
Brain tumor resection (61510, 61518)	29 (0.3)
Epilepsy surgery (61534, 61536, 61537, 61538, 61541, 61543, 61567)	3 (0.8)
Hemicraniectomy (61322, 61323)	1 (0.4)
Anterior cervical fusion (22551, 22552, 22845, 22846, 22847)	17 (0.1)
Cervical laminoplasty (63050, 63051)	1 (0.2)

4. Discussion

Dozens of papers in the neurosurgical literature have used the ACS NSQIP database to better understand issues like venous thrombosis [5], returns to the operating room [6], mortality [12], and even the effect of resident duty hours on outcomes [13]. All of these rely on accurate CPT coding to identify procedures of interest. But, like any database, NSQIP contains errors.

It would be impractical to review the original charts for neurosurgical cases within NSQIP, and thus verify items like the index procedure, demographic information, diagnosis, etc. But we can use some measures of internal consistency to identify a subset of errors.

Above, we looked for evidence of improper CPT coding (which is the primary method by which studies are extracting neurosurgical