Administrative data based patient safety research: a critical review

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Administrative data are readily available, inexpensive, computer readable, and cover large populations. Despite coding irregularities and limited clinical details, administrative data supplemented by tools such as the Agency for Healthcare Research and Quality (AHRQ) patient safety indicators (PSIs) could serve as a screen for potential patient safety problems that merit further investigation, offer valuable insights into adverse impacts and risks of medical errors and, to some extent, provide benchmarks for tracking progress in patient safety efforts at local, state, or national levels.

The first and most critical obstacle in the patient safety campaign is the lack of a system that can reliably identify and report medical errors. Such a system is a prerequisite to study the magnitude of the problem, to identify risks and correlated factors, to find solutions, and to examine the effectiveness of any intervention aimed at reducing medical errors.

Medical records have so far been the primary source for researching medical errors. Over 90% of the original studies reviewed by the 1999 Institute of Medicine (IOM) report involve medical record abstractions. This system contains rich clinical details that allow identification of various medical injuries and near misses and analysis of circumstances and causes of errors. A significant limitation of this system is that medical records are mostly in paper format or electronic format that is not readily usable for research. Transforming medical records into research data is resource intensive and requires exceptional knowledge and skills in medical context and research. As a result, patient safety research with medical records is usually limited in scope and statistical power. Alternative systems for safety research include mandatory and voluntary reports of medical errors, drug safety surveillance, nosocomial infection surveillance, and medical malpractice data. All of these systems have limitations and/or access difficulties. For example, about 20 US states mandate reporting serious adverse events such as unanticipated death, brain or spinal cord damage but no published study has ever used the data, probably because they are strictly guarded from the public and researchers.

Administrative data are a viable source, and their potential in patient safety research is increasingly recognized. They are readily available, inexpensive, computer readable, typically continuous, and cover large populations. In the early 1970s administrative data were used to reveal startling small area variations in health care and practice patterns. In the 1980s many researchers started using the data for outcomes research. Since the early 1990s researchers have been exploring the potential of administrative data in assessing quality and patient safety. Notable examples are the complication screening programs (CSP) by Iezzoni and colleagues and the Agency for Healthcare Research and Quality (AHRQ)’s quality indicators. In 2002 AHRQ developed and released the patient safety indicators (PSIs), a tool specifically designed for screening administrative data for patient safety events and medical errors. This development opened a new stage and opportunities for patient safety research using administrative data.

This paper provides a critical review of the progress in administrative data based patient safety research, with a focus on the PSIs and initial analysis of applying the PSIs to hospital discharges in a sample of general hospitals in the US. The merits and limitations of claims based systems are reviewed and the potential applications and future challenges discussed.

ADMINISTRATIVE DATA BASED PATIENT SAFETY RESEARCH

We conducted an extensive literature review aimed at identifying all empirical research in patient safety or medical errors that used administrative data. Our review started with the IOM report, the review performed by the University of California at San Francisco-Stanford Evidence-Based Practice Center under contract with AHRQ, Iezzoni’s review of administrative data based research on quality of care, and our previous research. We then carried out a systematic search of Medline and AHRQ grant databases from 1966 to 2002 using the following search algorithm ((patient safety OR medical error* OR medical-errors* OR adverse event* OR complication* OR iatrogenic* OR nosocomial) AND (administrative data* OR insurance-claim-review* OR claims data or ICD-9-CM*)).

Use of administrative data in quality and safety assessment

Administrative data, also called claims data, are by-products of administering and reimbursing healthcare services. Government payers (such as Medicare, Medicaid and Veterans Affairs) and private insurance companies regularly maintain a large amount of administrative data concentrated primarily on acute hospital admissions and, increasingly, on outpatient care, nursing homes, home care, and hospice programs. The core data elements of an administrative data system are admission date, discharge date and
findings from other studies,\textsuperscript{51, 7 – 19} suggested that the CSP had colleagues\textsuperscript{20} at Harvard University and Kovner and colleagues\textsuperscript{21} at Stanford University to further expand, test, and refine these measures as well as to improve the evidence behind their use with extensive literature reviews and broad clinical consensus panels. The final product of this joint effort is the AHRQ patient safety indicators (PSIs).

**AHRQ PATIENT SAFETY INDICATORS (PSIS)**
The UCSF-Stanford team developed AHRQ PSIs by a five step process\textsuperscript{22}:

- they reviewed the literature to develop a list of candidate indicators in addition to the initial PSIs developed at AHRQ and collected information about their performance;
- they formed several panels of clinician experts to solicit their judgment of clinical sensibility and suggest revisions to the candidate indicators;
- they consulted ICD-9-CM coding experts to ensure that the definition of each indicator reflected the intended clinical situation;
- they conducted empirical analysis of the promising indicators using HCUP data; and
- they produced the software and documentation for public release at AHRQ.

The PSIs include 20 indicators with reasonable face and construct validity, specificity, and potential for fostering quality improvement. Seven of the PSIs are recommended to be area based PSIs to capture complications/adverse events occurring in an area as opposed to within an institution. The PSI software calculates raw rates, risk adjusted rates derived by applying the average case mix of a baseline file that reflects a large proportion of the US hospitalized population in patient age, sex, diagnosis related groups (DRGs) and comorbidities, and smoothed rates that dampen random fluctuations over time.\textsuperscript{7} Thirty co-morbidity categories\textsuperscript{2} are automatically generated by the software and used as risk adjusters together with variables available in most administrative data systems. Table 1 describes the definitions of the numerators, denominators, and key exclusions for the 20 PSIS, and table 2 provides the findings from applying the PSI to the 7.45 million discharges in the HCUP Nationwide Inpatient Sample for the year 2000. Note that each PSI has a unique risk pool determined by its denominator definition and exclusion criteria. Table 3 presents unadjusted length of stay, charges, and in-hospital mortality for patients with and without PSI events. Tables 2 and 3 show substantial numbers of patient safety events with tangible impacts on patient outcomes in terms of increased length of stay, increased likelihood of in-hospital death, and increased charges for patients experiencing a PSI event as opposed to those that do not. Taken together, these tables clearly point to a significant potential role for administrative data in patient safety efforts.

**CHALLENGES OF ADMINISTRATIVE DATA BASED PATIENT SAFETY RESEARCH**
Any discussion of patient safety research using administrative data should recognize some data limitations and understand how such limitations play in their analysis. In particular, we focus on how these issues relate to the PSI and/ or are addressed by the PSI.
Problems with ICD-9-CM coding

There are many concerns over ICD-9-CM coding with regard to patient safety research. First, we can only find events for which there are corresponding ICD-9-CM codes. A small number of standard codes and E codes appear to identify medical errors. For example, ICD-9-CM codes 9984, 9987, and E8710-E8719 can be used to record a foreign body left after a procedure. A coder should in theory code both the standard ICD-9-CM code and the E code. These codes, including E codes that are specifically designed to record injuries, in no way capture any significant percentage of the entire universe of medical errors that can occur. Secondly, there may be a substantial amount of coding errors due to misunderstanding of codes, or errors by physicians and coders, or miscommunications between them. An IOM study in 1977 found that agreement on the principal diagnosis between hospital reports and IOM reabstraction was only 65.2%. Thirdly, coding is very likely to be incomplete because of limited slots for coding secondary diagnoses and other reasons. Fourthly, assignment of ICD-9-CM codes is variable because of the absence of precise clinical definitions and context. Iezzoni and colleagues found that the mean number of diagnoses coded in 441 California hospitals ranged from 2.5 to 11.7, and this variation explained part of the differences between high and low mortality hospitals. Some of the variation may be driven by financial reasons, such as in “DRG creep” where hospitals choose codes with higher Medicare pay schedules. Finally, diagnoses are not dated in current administrative data systems, making it difficult to determine whether a secondary diagnosis occurred before admission from long term care, principal diagnosis of deep vein thrombosis.

### Table 1 Definitions of AHRQ patient safety indicators

<table>
<thead>
<tr>
<th>Patient safety indicator</th>
<th>Numerator definition</th>
<th>Denominator definition</th>
<th>Key exclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anesthesia reactions and complications</td>
<td>Adverse effects of or poisoning by anesthetic, endotracheal tube wrongly placed</td>
<td>All surgical discharges</td>
<td>Poisoning due to drug dependence or abuse, self-inflicted injury</td>
</tr>
<tr>
<td>Death in low mortality DRGs</td>
<td>In-hospital death</td>
<td>DRGs with less than 0.5% mortality</td>
<td>Trauma, cancer, immune compromise</td>
</tr>
<tr>
<td>Decubitus ulcer</td>
<td>Pressure ulcer</td>
<td>All medical and surgical discharges with &gt;4 day stay</td>
<td>MDC 9, admission from long term care, paralysis</td>
</tr>
<tr>
<td>Failure to rescue</td>
<td>In-hospital death</td>
<td>Acute renal failure, deep vein thrombosis, pulmonary embolus, pneumonia (including aspiration), shock, cardiac arrest, gastrointestinal hemorrhage/acute ulcer</td>
<td>Transfer to or from acute care hospital, admission from long term care, principal diagnosis related to the denominator condition</td>
</tr>
<tr>
<td>Foreign body left during procedure</td>
<td>Foreign body accidentally left during procedure</td>
<td>All medical and surgical discharges</td>
<td>None</td>
</tr>
<tr>
<td>Iatrogenic pneumothorax</td>
<td>Iatrogenic pneumothorax</td>
<td>All medical and surgical discharges</td>
<td>Trauma, cardiothoracic surgery, lung or pleural biopsy</td>
</tr>
<tr>
<td>Infection due to medical care</td>
<td>Infection following infusion, injection, or transfusion, or due to vascular device or graft</td>
<td>All medical and surgical discharges</td>
<td>Cancer, immune compromise</td>
</tr>
<tr>
<td>Postoperative hip fracture</td>
<td>Postoperative hip fracture</td>
<td>All surgical discharges</td>
<td>MDC 8, self-inflicted injury, cancers possibly metastatic to bone, children, principal diagnosis that could cause syncope or falls</td>
</tr>
<tr>
<td>Postoperative hemorrhage/ hematoma</td>
<td>Postoperative hemorrhage/ hematoma with surgical drainage or evacuation</td>
<td>All surgical discharges</td>
<td>Obstetric discharges</td>
</tr>
<tr>
<td>Postoperative physiological or metabolic derangement</td>
<td>Postoperative acute renal failure requiring dialysis or diabetic ketoacidosis, hyperosmolarity, or hypoglycemic coma</td>
<td>All elective surgical discharges</td>
<td>Obstetric discharges, principal diagnosis causally related to the numerator condition</td>
</tr>
<tr>
<td>Postoperative respiratory failure</td>
<td>Postoperative acute or acute on chronic respiratory failure</td>
<td>All elective surgical discharges</td>
<td>MDC 4, MDC 5, obstetric discharges</td>
</tr>
<tr>
<td>Postoperative thromboembolism</td>
<td>Postoperative deep vein thrombosis or pulmonary embolus</td>
<td>All surgical discharges</td>
<td>Obstetric discharges, principal diagnosis of deep vein thrombosis</td>
</tr>
<tr>
<td>Postoperative sepsis</td>
<td>Postoperative sepsis</td>
<td>All elective surgical discharges</td>
<td>Cancer, infection, immune compromise, obstetric discharges, Obstetric discharges</td>
</tr>
<tr>
<td>Postoperative abdominopelvic wound dehiscence</td>
<td>Secondary procedure to close postoperative disruption of abdominal wall</td>
<td>All abdominal surgical discharges</td>
<td>Obstetric discharges</td>
</tr>
<tr>
<td>Accidental puncture or laceration</td>
<td>Accidental puncture or laceration during procedure</td>
<td>All medical and surgical discharges</td>
<td>Obstetric discharges</td>
</tr>
<tr>
<td>Transfusion reaction</td>
<td>ABO or Rh transfusion reaction</td>
<td>All medical and surgical discharges</td>
<td>None</td>
</tr>
<tr>
<td>Birth trauma</td>
<td>Intracranial hemorrhage, extracerebral fracture, spinal injury, nerve injury (other than facial and brachial plexus), other birth trauma</td>
<td>All live births</td>
<td>Preterm infants (for intracranial hemorrhage), osteogenesis imperfecta (for fracture)</td>
</tr>
<tr>
<td>Obstetric trauma (vaginal with instrumentation)</td>
<td>Principal or secondary diagnosis of fourth degree perineal, high vaginal, or cervical laceration; or procedure to repair any of these lacerations</td>
<td>All vaginal deliveries with forceps or vacuum</td>
<td>None</td>
</tr>
<tr>
<td>Obstetric trauma (vaginal without instrumentation)</td>
<td>Same</td>
<td>All vaginal deliveries with forceps or vacuum</td>
<td>None</td>
</tr>
<tr>
<td>Obstetric trauma (cesarean)</td>
<td>Same + uterine or urinary tract laceration; or procedure to repair any of these lacerations</td>
<td>All cesarean deliveries</td>
<td>None</td>
</tr>
</tbody>
</table>

All diagnosis based numerator definitions are based on secondary diagnoses unless otherwise noted.

DRG = diagnosis related group; MDC = major diagnostic category.
admission (a co-morbid disease) or during the stay in hospital (a complication or medical error). Overall, these limitations were not amenable to be proactively addressed in developing the PSIs.

**Inadequate reliability and validity in identifying medical errors**

Administrative data have been shown to have low sensitivity but fair specificity in identifying quality gaps. Bates and colleagues found that, while medical record review results in many false positives, administrative data were able to identify only half of patients with adverse events but had a fair specificity of 74%. Iezzoni and colleagues conducted several validity studies on CSP. One study reported that physician reviewers confirmed CSP flagged complications in 68.4% of surgical and 27.2% of medical cases. Another study found that 89% of surgical cases and 84% of medical cases had their CSP trigger codes corroborated by review of the medical records. A third one indicates that objective clinical criteria or physicians’ notes supported the coded diagnosis in 70% to over 90% of most CSP flagged conditions. Focusing on specific adverse events for a specific patient population, as is built into the PSIs, improves specificity appreciably. Romano et al. showed that specificity for postoperative complications after diskectomy can be as high as 98%. No attempts have been made to identify the validity and reliability of AHRQ PSIs.

**Lack of clinical details for risk analysis and risk adjustment**

Lack of clinical details is a major limitation of claims data. Of special concern is severity of illness that affects patient outcomes and conceivably affects the likelihood of medical errors. Analysis of outcomes and risk factors associated with medical errors are limited to variables available from administrative data.

AHRQ PSIs and other similar tools usually identify a relatively homogeneous risk pool for each PSI which not only reduces misclassification but also alleviates variation in risk factors. Coding co-morbidities using ICD-9-CM codes represents another major effort built into the PSI for risk adjustment. Iezzoni provided an excellent review of several claims based systems measuring severity. The performance of these systems depends substantially on complete coding of diagnoses.

**Analytical issues**

The large size of the administrative data and the relative rarity of safety events requires special consideration in statistical analysis. The sheer size of the administrative data can give the illusion of great precision and power. Given the standard errors for cases with obstetric trauma without instrumentation and their risk pool (table 3), as an example, a difference of 0.014 days in length of stay in hospital between the two groups is statistically significant (p<0.05). Such differences are often of little clinical significance. Coupled with missing important confounding variables and difficulty in choosing correct statistical models that fit the data, clinically insignificant but statistically significant results could lead to biased inferences and erroneous conclusions.

Matched case-control analysis appears to be a method particularly applicable to administrative data based analysis where cases are rare and controls are plenty. Classen et al. and Bates et al. matched cases of adverse drug reactions (ADR) with controls without ADR on DRG, co-morbidity, severity, and demographic characteristics to estimate the excess costs, mortality, and length of stay attributable to ADR. Jensen et al. matched cases of hospital acquired Staphylococcus aureus infections in Denmark hospitals to patients with the same primary diagnosis at admission to identify risk factors among unmatched factors such as age, anemia, etc. Bates et al. matched patients with ADR with patients from the same hospital unit and similar pre-event length of stay to study risk factors for ADR. Matching retains only cases and controls with similar covariates. By matching cases and controls to the same hospitals, researchers could focus on patient level factors without concerns over hospital coding practices and hospital effects.

**Potential applications of administrative data in patient safety research**

**Patient safety indicators as a screening tool**

First and foremost, PSIs are considered indicators, not definitive measures, of patient safety concerns. As with the CSP, the intention of these indicators is to provide a
useful screening tool to highlight areas in which quality should be investigated in greater depth. PSIs enable institutions to quickly and easily identify a manageable number of medical records for closer scrutiny. Using administrative data to screen cases for chart review has also been proposed by Roos and Brazauskas in 1990 and by Silber and colleagues more recently. For example, in cases with a foreign body left in after surgery (table 2), 7.45 million medical records were to be extracted to uncover 536 cases. Screening the claims with PSIs would quickly identify such rare events and associated medical records could be abstracted for in-depth analysis. This approach has great potential in enhancing the design of medical record based patient safety research, but its use has yet to be widely adopted.

**Epidemiological study in patient safety**

Administrative data are valuable in epidemiological studies of the incidence and consequences and factors associated with medical injuries. Our earlier studies and those of Romano et al. revealed substantial incidence rates and provided some insights into the outcomes and risk factors associated with medical errors. Our ongoing analysis of the 2000 data suggests that medical errors identified in table 2, excluding death in low mortality DRGs and failure to rescue where patients with errors all died during hospitalization, account for a total of 2.4 million extra days in hospital, $9263 million extra charges, and 32 591 attributable deaths in the US per year. It is also possible to identify certain risk factors such as nurse staffing.

**Public reporting**

At a time when no reliable reporting system exists, applying PSIs to administrative data could reveal the overall incidences and trends and provide useful benchmarks at the local, state, regional, and national levels for tracking progress. However, such use must be made with care. Coding differences across institutions, lack of robust risk adjustment, relative rarity of safety events, and many other reasons make it uncertain that differences between PSI rates reflect true differences in quality. Because of these limitations, public reporting of PSI rates for institutions and regions may raise contentions over technicalities rather than facilitate quality improvement. Developers of PSIs and similar administrative data based systems in general express caution with regard to the use of the indicators for public reporting at an institutional level.

**CONCLUSION**

We have highlighted generic and specific concerns regarding administrative data and their use, in particular, for patient safety research. Despite the known limitations, the lack of tools for patient safety today makes administrative data based tools like the AHRQ PSIs appealing. AHRQ PSIs could be useful to identify potential patient safety problems that merit further investigation. With proper methodology, administrative data can provide valuable insights into the incidences, adverse impacts, and risks of medical errors. In addition, PSI rates could serve as useful monitors at local, state and national levels and as benchmarks for tracking progress in patient safety. Further research will be needed to establish whether, and under what circumstances, these indicators are valid measures of safety related hospital performance for comparative purposes. Most paramount in this effort is work at explicitly examining cases flagged by PSIs using chart review. Some of this work is already ongoing.

Future growth in electronic health data will make tools like the PSI more useful. Ongoing refinement of ICD-9-CM and, eventually, ICD-10-CM should introduce more data elements and may allow clearer distinction of complications from conditions present at admission and increase the specificity of codes.

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**Table 3** Means (SE) length of stay (LOS), charges, and mortality rates for discharges experiencing a patient safety indicator (PSI) event compared with those not experiencing a PSI event (unadjusted)

<table>
<thead>
<tr>
<th>Medical error</th>
<th>LOS with PSI event</th>
<th>LOS without PSI event</th>
<th>Charge with PSI event</th>
<th>Charge without PSI event</th>
<th>Mortality (%) with PSI event</th>
<th>Mortality (%) without PSI event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complications of anesthesia</td>
<td>50.40 (0.17)</td>
<td>50.51 (0.006)</td>
<td>24572 (838)</td>
<td>25093 (29)</td>
<td>10.10 (0.28)</td>
<td>10.83 (0.01)</td>
</tr>
<tr>
<td>Death in low mortality DRGs</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Decubitus ulcer</td>
<td>160.32 (0.09)</td>
<td>100.79 (0.006)</td>
<td>5987 (375)</td>
<td>28100 (29)</td>
<td>130.85 (0.17)</td>
<td>40.01 (0.01)</td>
</tr>
<tr>
<td>Failure to rescue</td>
<td>110.24 (0.06)</td>
<td>100.20 (0.02)</td>
<td>52879 (364)</td>
<td>3468 (111)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Foreign body left in during procedure</td>
<td>90.30 (0.75)</td>
<td>40.78 (0.002)</td>
<td>41882 (2938)</td>
<td>14882 (12)</td>
<td>40.09 (0.008)</td>
<td>20.63 (0.00)</td>
</tr>
<tr>
<td>Iatrogenic pneumothorax</td>
<td>130.78 (0.25)</td>
<td>40.59 (0.003)</td>
<td>55286 (1454)</td>
<td>13384 (11)</td>
<td>160.11 (0.59)</td>
<td>20.56 (0.006)</td>
</tr>
<tr>
<td>Infection due to medical care</td>
<td>200.75 (0.22)</td>
<td>40.54 (0.003)</td>
<td>84751 (1096)</td>
<td>13975 (12)</td>
<td>100.31 (0.003)</td>
<td>20.11 (0.0006)</td>
</tr>
<tr>
<td>Postoperative hip fracture</td>
<td>160.37 (0.58)</td>
<td>50.39 (0.007)</td>
<td>52224 (1784)</td>
<td>24594 (35)</td>
<td>90.93 (0.92)</td>
<td>10.70 (0.01)</td>
</tr>
<tr>
<td>Postoperative hemorrhage or hematoma</td>
<td>110.74 (0.27)</td>
<td>50.77 (0.006)</td>
<td>57040 (1334)</td>
<td>27200 (33)</td>
<td>60.27 (0.41)</td>
<td>20.07 (0.01)</td>
</tr>
<tr>
<td>Postoperative physiologic and metabolic derangements</td>
<td>210.35 (0.78)</td>
<td>40.13 (0.006)</td>
<td>114847 (4261)</td>
<td>20528 (33)</td>
<td>280.16 (10.59)</td>
<td>0.75 (0.01)</td>
</tr>
<tr>
<td>Postoperative respiratory failure</td>
<td>220.39 (0.47)</td>
<td>30.75 (0.006)</td>
<td>110397 (2554)</td>
<td>16602 (22)</td>
<td>290.39 (0.96)</td>
<td>39.00 (0.07)</td>
</tr>
<tr>
<td>Postoperative thromboembolism</td>
<td>160.03 (0.14)</td>
<td>50.66 (0.006)</td>
<td>66805 (736)</td>
<td>26777 (32)</td>
<td>310.56 (0.25)</td>
<td>130.94 (0.01)</td>
</tr>
<tr>
<td>Postoperative sepsicaemia</td>
<td>250.10 (0.48)</td>
<td>70.20 (0.01)</td>
<td>113708 (2486)</td>
<td>32328 (72)</td>
<td>240.87 (0.85)</td>
<td>10.12 (0.02)</td>
</tr>
<tr>
<td>Accidental puncture or laceration</td>
<td>80.34 (0.08)</td>
<td>60.62 (0.003)</td>
<td>38788 (427)</td>
<td>16212 (13)</td>
<td>40.77 (0.16)</td>
<td>30.06 (0.007)</td>
</tr>
<tr>
<td>Transfusion reaction</td>
<td>130.40 (20.20)</td>
<td>40.78 (0.003)</td>
<td>68372 (20193)</td>
<td>14884 (12)</td>
<td>60.67 (40.64)</td>
<td>20.63 (0.002)</td>
</tr>
<tr>
<td>Postoperative wound dehiscence</td>
<td>220.32 (0.61)</td>
<td>60.72 (0.014)</td>
<td>93022 (3336)</td>
<td>26623 (75)</td>
<td>330.66 (10.16)</td>
<td>160.53 (0.026)</td>
</tr>
<tr>
<td>Birth trauma - injury to neonate</td>
<td>30.38 (0.10)</td>
<td>30.03 (0.008)</td>
<td>5111 (372)</td>
<td>4226 (33)</td>
<td>65.65 (0.12)</td>
<td>33.07 (0.00)</td>
</tr>
<tr>
<td>Obstetric trauma (vaginal with instrument)</td>
<td>20.42 (0.016)</td>
<td>20.28 (0.008)</td>
<td>5664 (92)</td>
<td>5976 (115)</td>
<td>0.016 (0.011)</td>
<td>0.003 (0.003)</td>
</tr>
<tr>
<td>Obstetric trauma (vaginal without instrument)</td>
<td>20.17 (0.003)</td>
<td>20.09 (0.002)</td>
<td>5110 (43)</td>
<td>5206 (23)</td>
<td>0.002 (0.002)</td>
<td>0.003 (0.001)</td>
</tr>
<tr>
<td>Obstetric trauma (cesarean section)</td>
<td>40.56 (0.13)</td>
<td>30.76 (0.007)</td>
<td>12614 (496)</td>
<td>9461 (36)</td>
<td>0 (0)</td>
<td>0.02 (10.47)</td>
</tr>
</tbody>
</table>
**Pointers for future research**

- Understanding the clinical sensitivity and specificity of the AHRQ PSIs.
- Understanding the interplay between administrative data and self-reports or chart abstraction for research on patient safety.
- Development of multifaceted error reporting systems which make maximal use of all data available.

**Key messages**

- Administrative data are readily available, inexpensive, and cover large populations.
- Tools such as the AHRQ PSI are available to begin identifying, tracking, and improving healthcare processes in the interest of patient safety.
- Researchers need to understand the issues and limitations of administrative data as they relate to studying patient safety events.

regularity—should be fully harvested in our campaign against medical errors.

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