Guide to Statistics and Methods

Practical Guide to Surgical Data Sets: Healthcare Cost and Utilization Project National Inpatient Sample (NIS)

Jonah J. Stulberg, MD, PhD, MPH; Elliott R. Haut, MD, PhD

Introduction to the Healthcare Cost and Utilization Project

Managed by the Agency for Healthcare Research and Quality, the Healthcare Cost and Utilization Project (HCUP, pronounced *H-Cup*) is a collection of data sets that represent the largest collection of administrative, longitudinal health care data in the United States. The data represent all-payer encounter-level information beginning in 1988 and is a collaborative effort between state data organizations, hospital associations, private data organizations, and the federal government. The stated objective of the project is to "conduct and translate research to inform decision making and improve health care delivery." Because an extensive description of all HCUP data sets is beyond the scope of this review, we will focus on the National Inpatient Sample (NIS, formerly *Nationwide Inpatient Sample*) as it relates to surgical research. This guide is an introduction; interested readers can explore the resources available on the HCUP website (http://www.hcup-us.ahrq.gov/). Many of the ideas we discuss will be applicable to the entire HCUP suite (**Table**).

Strengths of Administrative Data

The HCUP databases are considered administrative data sets because they capture the administrative components (eg, diagnosis codes, procedure codes, and costs) of a hospital encounter and not the clinical components (eg, vital signs and laboratory values). They differ from clinical registries (eg, the National Surgical Quality Improvement Project) because they represent an aggregation of existing claims files rather than data prospectively collected by trained data abstractors for research or quality improvement. Although they are not clinical data sets, these administrative databases have been used to help shape policy decisions, assess the effectiveness of surgical techniques, examine disparities in surgical care, perform comparative effectiveness research, and drive quality-improvement efforts.[1-3]

The NIS is a 20% representative sampling of all inpatient hospital encounters in the United States. It is designed to be representative of health care use overall, making it ideal for performing basic descriptive studies, deriving national estimates, studying costs, studying rare disease, and understanding trends over time.

Limitations of Administrative Data and the HCUP Databases

Regardless of what data source a researcher chooses to use for a given project, the data will have important limitations that could potentially affect the conclusions reached. Researchers should be transparent, acknowledge the limitations inherent in the data they are using, and discuss how the limitations may affect their findings. Researchers must always carefully select a data set that will allow them to reliably answer their research question or test their research hypothesis with a minimal amount of limitations.

Table. Available Healthcare Cost and Utilization Project Data Resources

Full Name	Acronym	Year Begun	New Records/y	Key Strengths	Key Limitations	Ideal Use
National Data						
National Inpatient Sample (formerly *Nationwide Inpatient Sample*)	NIS	1988	7 Million	Large size, long history, and inclusion of all inpatient hospital encounters	Lack of longitudinal data	Researching national prevalence/incidence, changes over time, and associations between diagnoses, procedures, and outcomes
Kids' Inpatient Database	KID	1997	2 Million–3 million	Large size and use of national estimates	Lack of state-specific granularity	Researching national prevalence/incidence, changes over time, and associations between diagnoses, procedures, and outcomes in the pediatric population
Nationwide Emergency Department Sample	NEDS	2006	30 Million	Large size and focus on emergency care	Inability to observe patients through system of care	Understanding patient use of emergency department services
Nationwide Readmissions Database	NRD	2013	15 Million	Readmissions and longitudinal data	Unsuitability for regional, state, or hospital-specific analysis	Studying readmissions following surgical procedures
State Data						
State Inpatient Database	SID	1995	Varies by state	All-payer state-specific data	Inconsistency of state participation over time	Studying state-level policy on surgical services
State Ambulatory Surgery and Services Databases	SASD	1997	Varies by state	All-payer ambulatory facility data	Inclusion of only 20 states	Understanding state-specific trends in inpatient vs ambulatory surgery
State Emergency Department Databases	SEDD	1999	Varies by state	All-payer emergency care data	Inability to observe patients through system of care	Understanding state-specific emergency surgery

Administrative Data Limitations

Although the size and scope of the HCUP databases affords wonderful research latitude, the data were originally collected for billing purposes and therefore have inherent limitations.[4] The most obvious limitation is the lack of clinical data. Additionally, the *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) system changes over time. As of October 2015, hospitals in the United States converted to using *International Statistical Classification of Diseases, Tenth Revision, Clinical Modification* codes, which will have consequences for those attempting longitudinal trend analyses. The specification of diagnoses is also limited by the inherent limitations of the coding system used. For example, in trauma research, the Injury Severity Score is not directly available. Instead, the International Classification of Diseases Programs for Injury Categorization can be used to estimate the Injury Severity Score based on *ICD-9-CM* codes. Another important limitation is surveillance bias, the phenomenon of "the more you look, the more you find," which may make examination of certain diagnoses or complications (eg, venous thromboembolism) invalid.[5] Finally, the systematic undercoding of certain low-cost diagnostic procedures can lead to inaccurate estimations of procedural use.

NIS Limitations

The most significant limitations involve the redesign (and associated renaming) of the NIS in 2012. There were several changes, including removing long-term acute care hospitals and using state hospital identifiers rather than the American Hospital Association hospital identifiers. The most dramatic change was the switch from using all discharges from a sample of hospitals to using a sample of discharges from all hospitals. These changes have important implications for researchers interested in studying trends over time, and anyone performing this type of analysis should refer to the NIS redesign report (http://www.hcup-us.ahrq.gov/reports/methods/methods.jsp) for further details.

Critical Methodologic Considerations

With sample sizes in the millions, *P* values for statistical significance frequently far exceed the typical cutoff of less than .05. Therefore, we urge caution when interpreting *P* values from NIS studies and recommend considering clinical significance in the context of statistical significance. By starting with a clearly thought-out research question and understanding the limitations of asking this

---

Box. Best Practices When Using the National Inpatient Sample for Research

1. Ensure the National Inpatient Sample is the appropriate data set to address the question of interest.
2. Consult the HCUP website (http://www.hcup-us.ahrq.gov) to guide the project through the nuances and common pitfalls of the data set.
3. Map out variables of interest to your research question and write out the benefits and disadvantages of that variable generated from administrative records. Assure these do not undermine your primary hypothesis.
4. Focus the research question on the strengths of the HCUP data sets (Table).
5. Review the HCUP website to determine which code sets and downloadable files pertain to your research.

---

question using the data available, findings can be appropriately interpreted to improve surgical practice. These data should not be used for causal inference; instead, they are best suited for hypothesis generation or evaluation of trends. Recent articles note the lack of rigor in published manuscripts using the NIS and make suggestions for best practices in research using the NIS (**Box**).[6,7]

Unique Capabilities of HCUP

The HCUP is working to develop solutions for known limitations within their suite of databases. One shining example is the development of variables that track an individual over time (eg, VisitLink and DaysToEvent). All HCUP databases are deidentified, making the study of an individual patient over time impossible. The solution: developing a linking variable that would allow researchers to track an individual over time within the data without compromising the individual's identity by exposing protected health information. The combination of these variables allows researchers to track an individual from an initial visit, eg, a surgical encounter, over time, which will allow studies of readmissions, cancer recurrence, and others.

The HCUP also provides user support features, such as downloadable statistical programming codes that help with risk adjustment using Elixhauser comorbidities, clinical classifications software tools, and chronic condition indicators. With improved computing power and a well-established base of surgeon-researchers capable of using these resources, the HCUP suite will be increasingly valuable.

REFERENCES

1. Stulberg JJ, Delaney CP, Neuhauser DV, Aron DC, Fu P, Koroukian SM. Adherence to surgical care improvement project measures and the association with postoperative infections. *JAMA*. 2010;303(24):2479-2485.

2. Schwartz DA, Hui X, Schneider EB, et al. Worse outcomes among uninsured general surgery patients. *Surgery*. 2014;156(2):345-351.

3. Zafar SN, Shah AA, Hashmi ZG, et al. Outcomes after emergency general surgery at teaching versus nonteaching hospitals. *J Trauma Acute Care Surg*. 2015;78(1):69-76, 76-77.

4. Haut ER, Pronovost PJ, Schneider EB. Limitations of administrative databases. *JAMA*. 2012;307(24):2589.

5. Haut ER, Pronovost PJ. Surveillance bias in outcomes reporting. *JAMA*. 2011;305(23):2462-2463.

6. Khera R, Angraal S, Couch T, et al. Adherence to methodological standards in research using the national inpatient sample. *JAMA*. 2017;318(20):2011-2018.

7. Khera R, Krumholz HM. With great power comes great responsibility. *Circ Cardiovasc Qual Outcomes*. 2017;10(7):e003846.