Using Healthcare Cost and Utilization Project (HCUP) Data for Emergency Medicine Research

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Hospital billing data have been used by researchers and policymakers for decades to monitor trends in hospital stays, emergency department (ED) visits, and ambulatory surgery care. One important source for these data is the Healthcare Cost and Utilization Project (HCUP), which is sponsored by the Agency for Healthcare Research and Quality (AHRQ), part of the US Department of Health and Human Services. In this issue, Kocher et al[1] use the HCUP Nationwide Inpatient Sample to examine the association between the volume of ED encounters that result in admission and inpatient mortality.[1]

HCUP produces multiple health care databases, including the State Emergency Department Databases (SEDD), State Inpatient Databases (SID), the Nationwide Emergency Department Sample (NEDS), and the Nationwide Inpatient Sample annually, along with related software tools and information products. In 2012, 47 state data organizations, hospital associations, and private data organizations participated in the HCUP partnership, all of which contribute inpatient data and 31 of which contribute treat-and-release ED data. A subset of the HCUP Partners elects to make their data available to the public through the HCUP Central Distributor. Price information for HCUP Central Distributor data, including student discounts, online training, and the data use agreement that must be signed, are available on the HCUP User Support Web site.[2]

HCUP began releasing SEDD files through the Central Distributor in 1999. The SEDD capture encounters at hospital-affiliated EDs that do not result in hospitalization at the same facility. The SEDD data can be combined with data on admissions from the ED found in the SID to yield the census of ED encounters in acute care community hospitals in a state. HCUP also creates the NEDS by using ED encounters from the SEDD and SID as a sampling frame to yield national estimates of ED encounters. With nearly 30 million unweighted records representing more than 130 million ED visits, the NEDS, a stratified 20% probability sample of hospital-based EDs, is the largest all-payer ED database in the United States. The stratification variables for the NEDS are US census region, trauma center designation, urban-rural location of the hospital, ownership, and teaching status. The NEDS has been available through the Central Distributor since 2006. Observation services encounters are also captured on some HCUP inpatient and outpatient files, and the data have been used in a small number of research articles.[3,4]

As with all collections of data, HCUP ED data have both strengths and weaknesses.

HCUP STRENGTHS

One of the most important strengths of the HCUP data lies in its very large size. This extensive capture of ED encounters makes analysis of small area variations, such as differences in county-level ED admission rates, possible.[5] It facilitates emergency care system analyses, such as the effect of H1N1 on hospitals and EDs,[6,7] as well as analyses of less frequently occurring conditions that may not be well captured in smaller data collection efforts.[8-10]

Another important strength of HCUP data is their capture of charges. Inpatient charges can be converted to estimated costs with the Cost-to-Charge Ratio Files, which can be downloaded from the HCUP User Support Web site.[11] Inpatient charges—and the associated estimated costs—include resources used in the ED. Charges incurred in the ED for both treat-and-release ED encounters and ED encounters that result in subsequent admission to the same hospital are available on many files. For example, the 2011 NEDS has ED charge information for 87% of treat-and-release ED records and 76% of records in which the patient was subsequently admitted to the hospital.[12] HCUP does not produce ED Cost-to-Charge Ratio Files.

HCUP captures encounters by the uninsured, a population not usually included in Medicare or Medicaid claims data. Data on the uninsured make HCUP a valuable resource for examining variations in ED use and treatment patterns across insurance categories[13] and for analyzing effects of health reform.[14,15] HCUP also captures data across all age groups, which is important for ED research. Although Medicare claims data can provide a wealth of information and are rich resources for many health services researchers, Medicare encounters are a minority of ED visits (approximately 22%), and they may lack generalizability to other age groups treated in EDs.

Administrative hospital data used for the HCUP databases have been collected annually for more than 25 years in many states. HCUP's longitudinal data permit analysis of ED-related trends such as changes over time in the treatment of children for bronchiolitis.[16] Another advantage is that HCUP data have been used for thousands of peer-reviewed journal articles by researchers who offer detailed feedback on how to improve the data.

HCUP data include many variables of interest to researchers, including *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) diagnosis codes, *ICD-9-CM* and Current Procedure Terminology procedure codes, patient demographic characteristics (eg, sex, age, urban/rural designation of residence, national quartile of median household income for patient's zip code), and expected payment source. HCUP data have external cause-of-injury codes (E-codes), and the HCUP User Support page has an evaluation of the reporting of those codes on discharge records.[17] HCUP uses *ICD-9-CM* codes and E-codes to create injury severity, mechanism, and intent variables, which are available on the HCUP NEDS, SEDD, and SID. The Nationwide Inpatient Sample and NEDS have hospital characteristics, including ownership, teaching status, and urban or rural location. The NEDS has hospital trauma level from the Trauma Information Exchange Program.

An increasing number of SID and SEDD have unique encrypted patient identifiers, which permit the tracking of patients over time and across hospital-based settings of care with the revisit files. The revisit files make it possible to analyze frequent users of the ED,[18] episodes of care (eg, ED visit for injury, ambulatory surgery, subsequent hospitalization), and ED encounters that occur between admissions, which are missed by inpatient-only 30-day readmission rates.[19] The HCUP User Support Web site provides documentation on using the revisit variables and identifies the states, years, and data types for which they are available.[20]

The analytic capacity of some HCUP files can be increased by linking them to other data sources. HCUP files with an American Hospital Association identification number on them can be linked to the Association's Annual Survey of Hospitals. HCUP files can also be linked to the county-level information on the Area Health Resources File.

AHRQ provides a number of software tools that increase the analytic capacity of HCUP data, and these tools can be used on other types of administrative data as well. The Clinical Classification Software collapses *ICD-9-CM* diagnosis and procedure codes into a smaller number of clinically meaningful categories that are sometimes more useful for presentation and analyses than individual codes.[21] The Comorbidity Software assigns variables that identify 29 comorbidities that are associated with greater hospital charges, inpatient length of stay, and patient mortality.[22] These variables are included on recent years of the SID and Nationwide Inpatient Sample. The AHRQ Quality Indicators are free software tools that are available online. They measure various aspects of health care quality, using inpatient data, including admissions that began in the ED.[23]

AHRQ supports the accurate analysis of HCUP data by producing methods reports, which are available on the HCUP User Support Web site. The topics covered include hierarchic modeling with HCUP data[24] and the meaning of the first-listed diagnosis on outpatient ED and ambulatory surgery records.[25] The "Introduction to the NEDS" report for the 2011 data year found that the number of ED encounters, number of hospital-based EDs by ED visit volume, and number of injury-related ED visits by mechanism and intent of injury estimated by the NEDS were similar to estimates generated from other national data sources,[12] a finding that has also been reported with previous years of data.[26]

HCUP WEAKNESSES

One of the weaknesses of all administrative data, including HCUP, is that they are originally generated for billing, not research, purposes. On the other hand, using administrative data costs much less than original collection and allows access to a much broader range of users.

There are some potentially important data elements that are not captured in HCUP. For example, HCUP data do not have patient preferences, triage level, physiologic information, medications, and test results. It is not possible to tell whether a patient was boarded, and information on specialist availability, ED volume by hour, regionalization, and treatments provided by emergency medical services is not available. The duration of treat-and-release ED encounters is captured by a few states[27]; however, information on the timeliness of treatments is not available.

Some HCUP data elements do not capture information completely. There is concern that certain procedures, such as noninvasive diagnostic services, are underreported in HCUP.[28,29] Researchers are encouraged to examine the distribution of data elements, the frequency of missing values, and the relationship of variables of interest to other variables to ensure that what has been captured reflects their clinical or policy experience. AHRQ is continually engaged in the process of evaluating data elements and seeking to improve the accuracy of their capture and coding. Current areas of focus for evaluation include observation services and ED disposition, and methods reports on these topics are forthcoming.

For several reasons, analysts need to be thoughtful in designing studies with HCUP data and in interpreting the results. The number of observations can be so large and the standard errors so low that statistical significance at standard levels is easily achieved. Analysts need to examine results for clinical and policy significance. Another potential pitfall in the use of large databases, such as HCUP, lies in the sampling design of the nationwide databases. The HCUP NEDS is created to be nationally representative of all US EDs through the use of a complex sampling design. In some cases, the use of NEDS data without weights as a convenience sample could lead to bias. Researchers using the nationwide databases should also be careful in conducting studies of subpopulations that might result in the exclusion of sampled hospitals from the analysis (eg, a study of encounters for a rare condition treated in only 200 hospitals). Eliminating sampled hospitals from the nationwide databases can lead to production of incorrect standard errors. HCUP identifies strategies and provides sample programming code that analysts can use if their study design will cause hospitals to be excluded from their analysis.[30]

THE FUTURE OF HCUP

HCUP has expanded and evolved during the course of its history, and it will continue to do so. HCUP has plans to conduct a feasibility study on redesign of the NEDS so that it includes encounters from a greater number of hospitals. The AHRQ Quality Indicators program is developing measures of

community health from a general and behavioral health perspective that will run on ED data. Those measures, known as the ED Prevention Quality Indicators, will not measure the quality of care in the ED per se but will use the ED as a window into the health care system at the community level.

HCUP has benefited from formal and informal input from the emergency medicine community over the years. As it seeks to improve the ways in which it provides information about emergency medicine, it will continue to value the insights of the research community.

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