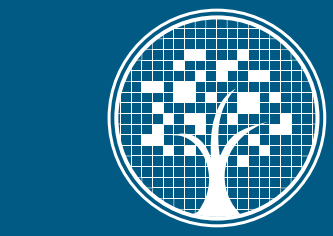

HCUP Methods Series

Methodological Issues when Studying Readmissions and Revisits using Hospital Administrative Data

Report # 2011-01

U.S. Department of Health and Human Services
Agency for Healthcare Research and Quality

Contact Information:
Healthcare Cost and Utilization Project (HCUP)
Agency for Healthcare Research and Quality
540 Gaither Road
Rockville, MD 20850
http://www.hcup-us.ahrq.gov

For Technical Assistance with HCUP Products:

Email: hcup@ahrq.gov

or

Phone: 1-866-290-HCUP

Recommended Citation: Barrett M, Steiner C, Andrews R, Kassed C, Nagamine M. *Methodological Issues when Studying Readmissions and Revisits Using Hospital Adminstrative Data.* 2011. HCUP Methods Series Report # 2011-01. ONLINE March 9, 2011. U.S. Agency for Healthcare Research and Quality. Available: http://www.hcup-us.ahrq.gov/reports/methods/methods.jsp.

TABLE OF CONTENTS

Introduction **1**

Terminology **1**

Analytic Considerations for Data Preparation **2**
Selecting the Appropriate Administrative Database 2
Consistency of Person-Specific Identifiers (PIDs) 2
Selecting the Hospital Settings for a Revisit Analysis 3
Deciding on the Number of Data Years to Include 3
Identifying the Time between Hospital Visits 3
Handling Multiple Records Representing Sequential Hospital Events on the Same Day 4
Reasons to Collapse Same-Day Hospital Records into One Combined Record 6
Reasons to Retain Same-Day Hospital Events as Separate Records 6
Categorizing Patients for a Revisit Analysis 6
Categorizing Patients by Patient Characteristics 6
Categorizing Patients by Hospital Characteristics 7
Categorizing Patients by Insurance Status 7

Analytic Considerations for Defining Revisits **8**
Defining the Starting Point 8
Specifying the Criteria for a Revisit 8
Selecting the Time Period for Revisits 9
Defining a “Clean Period” Prior to the Index Event 10

Analytic Considerations for Reporting Revisit rates **11**

Conclusion **11**

Appendix A. HCUP Data Partners **A-1**

Appendix B. Summary Counts of Reviewed Journal Articles **B-1**

Appendix C. Literature Review: Studies of Repeat Hospital Visits **C-1**
Goals of Literature Review 1
Review Methods 1
List of Relevant Articles 2
Studies Using HCUP Data 7

INTRODUCTION

Reducing repeat acute care hospital visits is a key strategy for improving the quality of health care, while reducing the cost of care. Depending on the severity and complexity of the underlying condition, a patient may be readmitted as an inpatient (IP) to the hospital, seen frequently in the emergency department (ED), or admitted to the hospital after an ambulatory surgery (AS) visit. Devising effective strategies to reduce the rate of multiple acute care hospital visits by the same person requires a thorough understanding of the factors that contribute to repeat visits. However, studying patients that repeatedly use or cross between the IP, ED, and AS settings is difficult for a myriad of reasons, including a lack of reliable patient identifiers that enable tracking of patients in hospital administrative data, as well as privacy concerns.

Sequential hospital visits may occur for any reason and can be separated by days, weeks, months or years. Multiple hospital visits by the same patient may, in fact, be unrelated. Studying related visits can be difficult as researchers must understand whether patients are seen in the hospital for expected follow-up treatment, or conversely, for unexpected complications. This Methods Series Report discusses the decisions that need to be addressed as an analyst designs a study of patients with sequential acute care hospital visits that is based on hospital administrative data. Topics include considerations in preparing the administrative database for the analysis, defining repeat hospital visits, and reporting results. This report provides specific examples using HCUP administrative data. However, the examples are illustrative and most are also applicable to other administrative data.

To examine variation in designing readmission analyses, we compiled list of 72 journal articles published between January 2000 and November 2010 that used U.S. hospital administrative data to study repeat hospital visits (see Appendix C). This information is supplemented by examples from the Healthcare Cost and Utilization Project (HCUP) databases, sponsored by the Agency for Healthcare Research and Quality (AHRQ). HCUP recently augmented its state-level databases with data elements that allow tracking a patient across time and hospital setting while adhering to strict privacy regulations. HCUP features the largest collection of multi-year hospital care data in the United States, containing a wealth of all-payer, encounter-level information beginning in 1988. Analyses of repeat hospital visits are possible on select HCUP State Inpatient Databases (SID), State Emergency Department Databases (SEDD), and State Ambulatory Surgery Databases (SASD) beginning with 2003 data. Appendix A contains the list of data organizations that participate in the HCUP state databases. Not all states that participate in HCUP collect the information necessary to track a patient across hospital settings and time.

TERMINOLOGY

Before discussing the issues involved in designing a study of repeat acute care hospital visits, common terminology is defined.

- Synthetic person-specific identifier (PID) – a unique string of characters (numbers and/or letters) that can be used to track patients across time and hospital settings. While a PID is often based on some combination of patient's social security number, date of birth, gender, or name, the actual synthetic PID cannot be directly linked back to the person.
- Index event – starting point for analyzing repeat hospital visits.
- Readmissions – repeat inpatient admissions within a specified time period.

- Revisits – repeat hospital visits within a specified time period. May include a mixture of inpatient, emergency department, and/or hospital-based ambulatory surgery visits.

ANALYTIC CONSIDERATIONS FOR DATA PREPARATION

Analytic considerations for preparing administrative data for an analysis of repeat hospitalizations include:

- Selecting the appropriate administrative database – This section includes a discussion on checking the consistency of person-specific identifiers, selecting the appropriate hospital-settings for a revisit analysis, deciding on the number of data years to include, and identifying the time between hospital visits.
- Handling sequential hospital events on the same day events – This section includes rationale for when to retain same day hospital events as separate records and when to collapse the information about the events into one combined record.
- Categorizing patients when characteristics can change over time – This section discusses categorizing patients by patient characteristics, hospital characteristics, and insurance status.

Each topic is discussed in turn.

Selecting the Appropriate Administrative Database

We reviewed journal articles that described studies in which different types of administrative databases were used: national databases such as Medicare claims data, state-level databases such as HCUP, local data on a group of hospitals or a single hospital, or other focused data for specific populations such as Veterans. Almost thirty percent of the studies used national databases, 26 percent used state-level databases, and 32 percent used local data. Appendix B presents summary counts of the reviewed articles by data source. One limitation of state-level databases is the inability to track residents that receive treatment in other states. In contrast, databases such as Medicare claims provide information for patients from all states, but only for one type of insurance (i.e., Medicare fee-for-service).

Additional considerations in selecting an appropriate database for a study of multiple hospital visits include:

- Consistency of PID coding across years
- Selection of the hospital setting
- Time span covered by available data
- Availability of sufficient information on the timing between hospital visits.

Consistency of Person-Specific Identifiers (PIDs)

The selected database used for an analysis of repeat hospitalizations needs to have consistently coded PIDs throughout study period and across hospital settings, if more than one setting is to be included in the analysis. For the HCUP state databases, PIDs (“termed VisitLink” for visit linkage number) are verified against gender and date of birth in the creation of a re-identified PID to ensure consistency across data years and hospital setting.[1]

[1] Overview of the HCUP Supplemental Files for Revisit Analyses available at http://www.hcup-us.ahrq.gov/toolssoftware/revisit/revisit.jsp

Inconsistencies in PIDs across calendar years of data still exist because HCUP data partners have changed their coding schemes. Between 2004 and 2007, four of the 17 states that have synthetic person identifiers in the HCUP state databases have refined their creation of synthetic PIDs because of differing interpretations of how to apply the Health Insurance Portability and Accountability Act (HIPAA) restrictions to the release of this type of person-related information.

Even if the PIDs are consistently coded across years and hospital settings, it is advisable to confirm that PIDs are consistently coded for the population of interest (e.g., age, insurance, hospital type, etc.). For example, in the HCUP state databases, there is limited availability in PIDs for pediatric patients in some states, but good availability (greater than 90 percent) for adult patients in all possible states. Availability of PIDs for patients covered by different types of insurance can also vary by state.[2]

Selecting the Hospital Settings for a Revisit Analysis

When studying repeat hospital care, careful consideration needs to be given to the choice of hospital settings. Many studies have focused on inpatient readmissions, but that may not always provide the most complete picture of hospital care. For example, if studying a chronic condition such as asthma it might be advantageous to include inpatient stays and emergency department visits that do not result in admission because treatment for asthma occurs in both settings. If studying inpatient treatment for an acute condition such as acute myocardial infarction (AMI), it might be interesting to look forward in time at inpatient readmissions or back in time for an emergency department visit in which the heart condition was misdiagnosed. In addition, complications of ambulatory or short-stay surgery may present in the emergency department and be stabilized and released home or admitted to the hospital.

The majority of the journal articles we reviewed (69 percent) studied only inpatient readmissions. Another 17 percent utilized both inpatient and outpatient data. Summary counts are shown in Appendix B.

Deciding on the Number of Data Years to Include

The number of data years to be included in a study period for an analysis of revisits depends on the time interval that will be allowed between multiple visits. For example, in a study of repeat hospital visits within three months that uses only one calendar year of data, events of interest can only be identified for the first nine months of the year (January through September). The last three months (October through December) are reserved for identifying the repeat visits for patients with a first event during the June to September period. If the event of interest is rare, a calendar year study period may be insufficient to obtain an adequate sample size. About half of the journal articles we reviewed (47 percent) used a time period of three or more years. Twenty-eight percent used a one year study period. The lengths of study periods used in studies we reviewed are detailed in Appendix B.

Identifying the Time between Hospital Visits

The final consideration in choosing an appropriate administrative database to study revisits is the availability of information on the time interval between hospital events. Because of HIPAA guidelines on protecting patient confidentiality, dates of admission, discharge, and treatment are

[2] Steiner, C. (AHRQ), Barrett, M. (M.L. Barrett, Inc.), and Hunter, K. (Thomson Reuters). *Hospital Readmissions and Multiple Emergency Department Visits, in Selected States, 2006–2007.*. HCUP Statistical Brief #90. May 2010. Agency for Healthcare Research and Quality, Rockville, MD. http://www.hcup-us.ahrq.gov/reports/statbriefs/sb90.pdf. (Accessed August 7, 2010).

not releasable on publicly available administrative databases. In the absence of actual dates, there needs to be alternative information on timing between hospital visits. Administrative databases often limit timing information to months (e.g. admit month or discharge month) which can hinder analyses of revisits within shorter time periods such as 7 or 14 days. To facilitate revisit analyses, HCUP has created a timing variable that can be used to identify the actual number of days between hospital visits while adhering to strict privacy guidelines.[3]

Handling Multiple Records Representing Sequential Hospital Events on the Same Day

Hospital administrative databases are often characterized as being "discharge-level" files, meaning that each record represents one discharge abstract from a hospital setting, which can be an IP, ED, or AS visit. If the same individual visits the hospital multiple times in a given year, the administrative database includes separate records for each visit. For example, if a patient is seen in the ED and sent home, then there is one ED record. If later in the year, the patient is admitted to the hospital, there is a separate IP record. If the inpatient stay resulted in being transferred to another hospital, there are two separate IP records.

Transfers are a specific type of same-day event in which there is a discharge disposition of transfer out on the first hospital record and an admission source that indicates a transfer into the hospital on the second hospital record. Same-day events that are not transfers are also possible. These are defined by multiple records in which the discharge date of one hospital record is the same as the admission date of a different hospital record, but the discharge status and admission source do not indicate a transfer. It is also possible that the multiple visits do occur on the same day because one event ends near midnight and the second event starts the next day in the early morning. When studying sequential hospital visits, one might argue that these multiple records represent one hospital event, even if that is not how they are represented in the administrative database. This section includes information on the frequency of these types of events based on HCUP data and rationale for when to retain same day hospital events as separate records and when to collapse the events into one combined record.

The 2007 HCUP state databases were used to examine the effect of different schemes for identifying transfers and same-day events and the variation in occurrence across states. We used the 2007 State Inpatient Databases (SID), State Emergency Department Databases (SEDD), and State Ambulatory Surgery Databases (SASD) to examine four types of events:

1. IP-to-IP events involving an inpatient record that ends on the same day another inpatient record starts.
2. ED-to-IP events involving an emergency department record that ends on the same day an inpatient record starts.
3. ED-to-ED events involving an emergency department record that ends on the same day another emergency department record starts.
4. AS-to-IP events involving an ambulatory surgery record that ends on the same day an inpatient record starts.

The 2007 HCUP SID for 15 states combined were used to examine the change in the percentage of records identified as same-day events using different combinations of three possibly helpful data elements: discharge disposition, admission source, and timing (Table 1). It should be noted that sequential events that go through the night were not considered in the

[3] More information about the HCUP supplemental variables for revisit analyses is available on the HCUP User Support Web site (http://www.hcup-us.ahrq.gov/toolssoftware/revisit/revisit.jsp).

example because only a few HCUP databases include information on the hour the hospital visit started and stopped.

The strictest criteria for looking at same-day transfers required a discharge disposition of transfer out on the first hospital record and a second hospital record on the same day with an admission source that indicated a transfer into the hospital. In pooled data from the 2007 SID for 15 states, less than one percent of the inpatient discharges were identified as IP-to-IP same-day events. In the other data combinations, there were less than 0.1 percent of records identified as same-day events.

The next criteria excluded the use of admission source in identifying same-day events because this data element was often unavailable on ED and AS records. This increased the percentage of records identified as follows: IP-to-IP same-day events increased from 0.8 to 1.3 percent, ED-to-IP same-day events increased from 0.1 to 0.5 percent, ED-to-ED same-day events increased from 0.0 to 0.1 percent, and AS-to-IP same-day events remained near zero percent.

The last criteria used only timing to identify same-day events and disregarded the discharge disposition and admission source. The percentage of records identified as same-day events more than doubled: IP-to-IP same-day events increased from 1.3 to 3.1 percent, ED-to-IP same-day events increased from 0.5 to 1.0 percent, ED-to-ED same-day events increased from 0.1 to 1.5 percent, and AS-to-IP same-day events increased from 0.04 to 0.13 percent.

Table 1. Percentage of Records Identified as Same-Day Events

Scheme to identify same day events	IP-to-IP same-day events Percentage (15 States)	ED-to-IP same-day events Percentage (12 States)	ED-to-ED same-day events Percentage (12 States)	AS-to-IP same-day events Percentage (10 States)
Two records – the first record has a discharge disposition that indicates a transfer out and the second record includes an admission source of transferred into the hospital on the same day	0.8%	0.1%	0.0%	0.02%
Two records – the first record has a discharge disposition that indicates a transfer out and the second record starts on the day of discharge (No use of admission source)	1.3%	0.5%	0.1%	0.04%
Two records in which the first hospital record indicates a discharge on the same day as a second record shows an admission (No use of discharge disposition or admission source)	3.1%	1.0%	1.5%	0.13%

Source: Agency for Healthcare Research and Quality, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, State Inpatient Databases, State Emergency Department Databases, and State Ambulatory Surgery Databases, 2007.

There are two options for handling multiple records in an administrative database that represent a same-day event -- collapse to create one record or retain separate records. Selection of the best approach depends on the intent of the study.

Reasons to Collapse Same-Day Hospital Records into One Combined Record

If the multiple same-day event records are combined into a summary record, then a study of revisits will consider the care received in the hospital as one event. When combining the multiple hospital records that represent a same-day event, consider retaining the hospital identifier from latter record to credit this hospital with the care, summing the length of stay and total charges to capture the total utilization, retaining the diagnoses and procedure codes from both records, but assigning the principal diagnosis from latter record. If there is evidence of ED services reported on the first record, then it might be helpful to also retain that information. This approach gives more complete picture of resources to treat a certain medical condition.

Reasons to Retain Same-Day Hospital Events as Separate Records

If the multiple same-day event records are kept separate, a study of revisits will consider the second record a second event. Keeping the records separate, will allow the analysis to consider the initial severity at the first event as a predictor of future revisits. In addition, if the records are kept separate, the analysis can consider whether the care at the first or second hospital might have contributed to later hospital revisits.

Categorizing Patients for a Revisit Analysis

Revisit studies frequently report information by patient demographics, hospital characteristics, or insurance status. Because these characteristics can change over the study period, decisions need to be made on how to assign the reporting categories. This section discusses possible approaches to categorizing patients by different patient characteristics, hospital characteristics, and insurance status.

Categorizing Patients by Patient Characteristics

How to categorize a patient depends on how variable the information may be over the study period. When categorizing patients in a revisit study based on information that is constant over the study period, such as gender, any occurrence of a patient in the administrative database can be used. For computer programming, it is easiest to use the first occurrence.

When categorizing patients based on information for which change is predictable, such as age, the analyst needs to decide whether it is appropriate to use the earliest or latest event to categorize the patient.

When categorizing patients in a revisit study based on information for which change is possible, but not predictable, the expected frequency of change during the study period and the intent of the analysis should be considered. For example, when assigning the urban/rural location of the patient's residence, consider the length of the study period. If the period is short, such as one year, then using the location of the first occurrence of the patient is reasonable. If the study period is longer, with duration of 5 years, for example, then the location of the majority of the occurrences may be more appropriate. In the case of the race/ethnicity of the patient, then the racial group reported most frequently may be most representative, given that the collection of this information can be unreliable (though inconsistency in race/ethnicity coding could be a signal that the patient has a multi-racial background).

Categorizing Patients by Hospital Characteristics

Categorizing patients by hospital characteristics needs to be consistent with the purpose of the analysis. For example, when studying hospital care for patients treated for severe injuries, the hospital responsible for the initial treatment of the trauma is essential to the study. This assignment can be complex because severely injured patients are often transferred to a more advanced trauma center. Consider a possible two-step process to categorizing use of trauma hospitals for treating severe injuries:

- Did the initial treatment occur within a single hospital?
    - If yes, categorize the event by the trauma level of the single treatment facility.
    - If no, categorize the event by whether the transfer was to a higher, lower, or similar trauma level facility.

Categorizing Patients by Insurance Status

Categorizing patients by insurance status also needs to be consistent with the purpose of the analysis. The expected payer reported on administrative data is specific to one point in time. Over the course of a year or multiple years, a patient can be covered by different types of insurance. Options for categorizing patients by type of insurance over time include the following:

- Selecting the expected payer for the index event
- Choosing the expected payer for the revisit
- Using a hierarchical assignment that considers all events
- Opting for an “if ever” approach.

If the payer of the index event is used, then the analysis might focus on the effect of insurance on quality of care. In contrast, in a study of how insurance affects other reasons for seeking a readmission (e.g., unavailable care or financial issues in management of care outside the hospital), the insurance group at readmission might be more relevant. Consider a family that lost their insurance and then had “self-pay” at a revisit.

A hierarchical approach assigns a preference in the assignment of payer. Consider the following example that assigns priority to Medicare, then Medicaid, then private insurance, and lastly uninsured:

- If any hospital visit is coded with Medicare as the expected payer, then assign the patient to Medicare.
- If no hospital visit is covered by Medicare, then assign the patient to Medicaid if any hospital visit is coded with Medicaid as the expected payer.
- If no hospital visit is covered by Medicare or Medicaid then assign patient to private insurance if any hospital visit is coded with private insurance as the expected payer.
- If no hospital visit is covered by Medicare, private insurance, or Medicaid, then assign patient to other insurance if any hospital visit is coded with another type of government or local payer.
- If no hospital visit is covered by insurance (Medicare, private insurance, Medicaid, or other) then assign patient to uninsured.

Medicare and Medicaid are considered before private insurance because Medicare and Medicaid programs are sometimes reported under a private insurance group contracted to cover Medicare or Medicaid patients. This can especially be true for Medicare HMO programs.

The "if ever" approach to categorizing a patient by type of insurance, considers all hospital visits for a patient. A simple dichotomous scheme divides patients into two groups: uninsured (at least one hospital visit is uninsured) versus insured (all hospital visits in the study period are covered by some type of insurance). A more detailed categorization of the insured would separate patient for which all hospital visits were covered by Medicare, Medicaid, private, or some combination of insurance.

ANALYTIC CONSIDERATIONS FOR DEFINING REVISITS

Analytic considerations for defining revisits include the following:

- Defining the starting point of the study
- Specifying the criteria for a revisit
- Selecting the appropriate time period for revisits,
- Determining a clean period, if necessary, prior to the starting point.

Each topic is discussed in turn.

Defining the Starting Point

The starting point of a revisit study is often called the "index event" and refers to the first occurrence of the event of interest. The event of interest is typically defined by a combination of clinical criteria and hospital setting. Clinical criteria can include, but are not limited to, diagnoses, procedures and a discharge disposition of alive. The index event can occur during an inpatient stay, emergency department visit, or ambulatory surgery.

Possible exclusion criteria include the following:

- Index events in which the patient died in the hospital because there is no risk of readmission.
- Same day events that were combined into a single record during the data preparation because it represents a more complex situation.

The exclusion of certain types of patients may also be appropriate for certain revisit analyses. For example, if using a state-specific database, then patients that reside in another state should be excluded. In addition, it might be appropriate to exclude patients with cancer or in an immunocompromised state because these conditions would greatly increase the risk of repeat hospital care.

Specifying the Criteria for a Revisit

Revisit analyses tend to consider one of the following: any subsequent event regardless of cause, any subsequent event that does not involve trauma, or any subsequent event only if the event is "related" to the index event. The selection of criteria can dramatically change results.

HCUP SID for 2007 from 15 states combined were used to examine the difference in 30-day readmission rates for two conditions, congestive heart failure (CHF) and asthma, by different

criteria (Table 2). The index event was defined by an adult inpatient admission with a specific principal diagnosis in which the patient is discharged alive. The Clinical Classification Software (CCS)[4] was used to identify the conditions: CCS 108 for a diagnosis of CHF and CCS 128 for a diagnosis of asthma. The three criteria for a readmission within 30 days include an inpatient stay with a principal diagnosis of the condition, a stay with a principal or secondary diagnosis of the condition, or any admission regardless of diagnosis. The percentage of patients with a 30-day readmission doubled when the criteria were broadened from a subsequent stay with a principal diagnosis of interest to a principal or secondary diagnosis of interest (9.8 to 22.1 percent for CHF patients and 4.8 to 9.5 percent for asthma). For asthma, the percentage of patients with a 30-day readmission tripled when the criteria were further broadened to any admission (4.8 to 14.3 percent).

Table 2. Percentage of Patients Identified as Having a 30-Day Readmission using Three Different Criteria

Scheme to identify 30-day readmission	Congestive Heart Failure	Asthma
Percentage of patients with a readmission within 30 days with the same principal diagnosis	9.8%	4.8%
Percentage of patients with a readmission within 30 days with the same diagnosis as a principal or secondary	22.1%	9.5%
Percentage of patients with a readmission within 30 days with any diagnosis	25.4%	14.3%

Source: Agency for Healthcare Research and Quality, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, State Inpatient Databases, 15 States, 2007.

Selecting the Time Period for Revisits

In the above example, a readmission was identified as occurring within 30 days of the index event. A different time after the index event (e.g., 7 days, 14 days, 3 months, 1 year etc.) may be appropriate depending on the analysis.

When selecting an appropriate time period for the revisits, consider selecting a time that allows for the same risk of exposure of all patients, seasonality of the disease, and possible external factors. Shorter time frames (7 or 14 days) are often used to make events attributable to hospital acute care (IP, ED or AS) while longer time frames may reflect differences in ambulatory care and/or coordination of care.

HCUP SID and SEDD for 2007 from 13 states combined were used to examine the difference in any-cause revisit rates using different time frames for adult patients who were treated in the ED for nonspecific chest pain (CCS 102) but not admitted at that time (Table 3). Within one week of the initial ED visit for chest pain, 93.1 percent of the patients had not been seen back in an ED or admitted; within two weeks, 89.8 percent of the patients had not been seen back in a hospital; and in one month, the percentage of patients not seen back at a hospital drops to 84.6 percent. Within one week, 2.3 percent of the patients were admitted to the hospital for any

[4] Overview of the Clinical Classification Software available at http://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp

cause. Within one month, the percentage of patients admitted more than doubled to 5.3 percent. The percentage of patients seen again in the ED (for any cause) more than doubled from one week to one month, increasing from 4.8 to 11.5 percent respectively.

Table 3. Percentage of Patients Rehospitalized after Treatment in the ED for Chest Pain in Three Different Time Periods

	Number of Patients	Percent of Total
Adult patients with an ED visit for chest pain in January to November 2007 that were not admitted to the hospital at that time	493,293	100.0%
Within one week of the initial ED visit		
Patients with no hospital visits (IP or ED)	459,080	93.1%
Patients admitted to a hospital for any cause	11,559	2.3%
Patients seen in the ED for any cause and not admitted	23,786	4.8%
Within two weeks of the initial ED visit		
Patients with no hospital visits (IP or ED)	443,026	89.8%
Patients admitted to a hospital for any cause	17,205	3.5%
Patients seen in the ED for any cause and not admitted	35,934	7.3%
Within one month of the initial ED visit		
Patients with no hospital visits (IP or ED)	417,534	84.6%
Patients admitted to a hospital for any cause	26,291	5.3%
Patients seen in the ED for any cause and not admitted	56,507	11.5%

Source: Agency for Healthcare Research and Quality, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, State Emergency Department Databases and State Inpatient Databases, 13 States, 2007.

Defining a "Clean Period" Prior to the Index Event

In some revisit studies it may be appropriate to define a "clean" period of time at the beginning of the study period for which no event, either index or subsequent hospitalization, will be identified.

Consider two separate studies of 30-day readmissions for diabetes in a calendar year. In both studies, the index event is an adult admission with a principal diagnosis of diabetes in which the patient is discharged alive. The readmission criteria are subsequent admissions with a principal diagnosis of diabetes within a month (30 days). One option is to count patients from the beginning of the year. Programming code would look for the first index event for a person from January to November. This allows an equal 30-day window from each index event to search for a readmission. Patients with an index event in November can be followed into December. The readmission rate would be the number of patients with at least one readmission for diabetes within 30 days divided by the number of patients with an admission for diabetes in 11 months. This approach possibly counts a true readmission in January as an index event, because data was not available in December of the previous year. A second option is to define a "clean period" prior to selecting the index event that is the same length as the readmission time period. This would mean modifying the approach described above by excluding patients with an event in January. This guarantees that all index events had no prior admission for diabetes within 30 days. The readmission rate would then be the number of patients with a readmission for diabetes within 30 days divided by all patients with an admission for diabetes in 10 months.

Clean periods can also be used when allowing a patient to be counted multiple times in the study period. Consider a study of multiple ED visits for pediatric asthma within a month over a five-year study period. Given the long study period and the chronic nature of asthma, it is reasonable to count a patient multiple times. In this case, an ED visit would be considered an index event only if the child had a diagnosis of asthma and there is no ED visit for asthma in the prior 30 days. The revisit rate in this study would be the number of times pediatric asthma patients revisited the ED for asthma treatment within 30 days divided by the number of times in the five-year period that pediatric patients visited the ED for asthma treatment without a prior asthma ED event in 30 days. A child with an ED visit on February 20, March 2, March 15, and November 10, would be counted once in the numerator for the March 2nd revisit and twice in the denominator for the two index events (February 20 and November 10).

Studies that count all patient revisits regardless of cause do not typically include a clean period. In this case, each visit for a patient is considered an index event. A subsequent visit within a specified time period, such as 30 days, is counted as a revisit. Using the example above of a child with an ED visit on February 20, March 2, March 15, and November 10, all four visits would be considered an index events (the denominator of the revisit rate) and two visits (March 2 and March 15) would be counted as revisits (the numerator of the revisit rate) because they fall within 30 days of an index event.

ANALYTIC CONSIDERATIONS FOR REPORTING REVISIT RATES

When reporting utilization of services such as IP stays or ED visits, it is beneficial to include both patient-level and event-level counts. The comparison of event and patient counts allows the analyst to judge if the change (i.e., increase or decrease) in utilization is driven by a change in the number of patients or the overuse of services by a small number of patients. Consider the following example of ED visits for abdominal pain in two hospitals. In hospital A, there are 10,000 ED visits each year, and the number of patients is about 8,000 annually. In hospital B, there are also 10,000 ED visits for abdominal pain each year, but the number of patients changes from 8,000 in year 1 to 6,000 in year 2. In hospital B, the revisit rate of patients being treated for abdominal pain is actually increasing.

Stratification of revisit rates may also be beneficial. Pediatric cases may have different revisit rates than adults with the same condition. If looking at all-cause inpatient readmissions, obstetric and newborn discharges may have very different readmission rtes than non-obstetric and non-newborn discharges.

Severity or risk adjustment may also be beneficial when comparing revisit rates across geographical regions, hospital, or different patient populations. A simple risk adjustment would include age and gender. A more complex adjustment might also include comorbidites, severity classified by the 3M All Patient Refined DRG (APR DRG) severity score, patient income, or any other factor that could considerably increase or decrease the risk of subsequent hospital care.

CONCLUSION

Designing a study of repeat acute care hospital visits deserves careful consideration in preparing the data and defining the criteria for an index event and subsequent hospital visit. Analytic considerations for preparing administrative data for a revisit analysis include selecting the appropriate databases, handling same day events, and categorizing patients when

characteristics can change over time. Analytic considerations for defining repeat hospitalizations include defining the starting point of the study, determining a clean period, if necessary, prior to the starting point, and specifying the criteria for a repeat hospitalization including the appropriate time period and cause. Presented results need to carefully explain the methods so that comparable studies can be identified.

APPENDICES

APPENDIX A. HCUP DATA PARTNERS

Only some of the following HCUP data partners provide synthetic patient identifiers to HCUP and availability varies by data year. Please refer to the HCUP User Support Web site for specific details (http://www.hcup-us.ahrq.gov/toolssoftware/revisit/revisit.jsp)

Arizona Department of Health Services
Arkansas Department of Health
California Office of Statewide Health Planning and Development
Colorado Hospital Association
Connecticut Hospital Association
Florida Agency for Health Care Administration
Georgia Hospital Association
Hawaii Health Information Corporation
Illinois Department of Public Health
Indiana Hospital Association
Iowa Hospital Association
Kansas Hospital Association
Kentucky Cabinet for Health and Family Services
Louisiana Department of Health and Hospitals
Maine Health Data Organization
Maryland Health Services Cost Review Commission
Massachusetts Division of Health Care Finance and Policy
Michigan Health & Hospital Association
Minnesota Hospital Association
Missouri Hospital Industry Data Institute
Nebraska Hospital Association
Nevada Department of Health and Human Services
New Hampshire Department of Health & Human Services
New Jersey Department of Health and Senior Services
New Mexico Health Policy Commission
New York State Department of Health
North Carolina Department of Health and Human Services
Ohio Hospital Association
Oklahoma State Department of Health
Oregon Association of Hospitals and Health Systems
Pennsylvania Health Care Cost Containment Council
Rhode Island Department of Health
South Carolina State Budget & Control Board
South Dakota Association of Healthcare Organizations
Tennessee Hospital Association
Texas Department of State Health Services
Utah Department of Health
Vermont Association of Hospitals and Health Systems
Virginia Health Information
Washington State Department of Health
West Virginia Health Care Authority
Wisconsin Department of Health Services
Wyoming Hospital Association

APPENDIX B. SUMMARY COUNTS OF REVIEWED JOURNAL ARTICLES

Type of article	Number (Percent of total)
Articles published between January 2000 and November 2010 that used U.S. administrative hospital data to study repeat hospital visits	72 (100%)
Regional representation of administrative data*	
National databases (Medicare claims data, National Managed Care Benchmark Database, Perspective Rx Comparative Database)	21 (29.2%)
State-level databases (HCUP or other state data)	19 (26.4%)
Local data on a group of hospitals or a single hospital.	23 (31.9%)
Other types of focused data (University Health System Consortium data, workers compensation data, Veterans Health Administration data)	6 (8.3%)
Could not be determined from abstract	3 (4.2%)
Type of administrative data	
Studies using inpatient data only	50 (69.4%)
Studies using outpatient data only	3 (4.2%)
Studies using inpatient and outpatient data	12 (16.7%)
Could not be determined from abstract	7 (9.7%)
Length of study period	
Less than 1 year	1 (1.4%)
1 year	20 (27.8%)
1-2 years	2 (2.8%)
2 years	7 (9.7%)
3 or more years	34 (47.2%)
Could not be determined from abstract	8 (11.1%)

.

APPENDIX C. LITERATURE REVIEW: STUDIES OF REPEAT HOSPITAL VISITS

Goals of Literature Review

Identify journal articles published between January 2001 and November 2010 that use U.S. administrative data to study readmissions.

Review Methods

- Google scholar
  Search terms: readmission administrative data
  Limited to U.S. studies published between January 2007 and June 2010
  22 articles reviewed
  18 relevant articles

- PubMed
  Search terms: hospital readmission, administrative data
  Limited to U.S. studies published between January 2007 and June 2010
  15 articles reviewed
  12 relevant articles

- PubMed
  Search terms: readmission AND administrative data
  Limited to US studies published between 2001 and November 2010
  30 articles reviewed
  27 relevant articles

- PubMed
  Search terms: readmission AND claim data
  Limited to US studies published between 2001 and November 2010
  12 articles reviewed
  12 relevant articles

- HCUP-US Search of HCUP publications
  Search term: readmission AND readmissions
  10 articles reviewed
  9 relevant articles

List of Relevant Articles

Ahmed A, Thornton P, Perry GJ, Allman RM, DeLong JF. Impact of atrial fibrillation on mortality and readmission in older adults hospitalized with heart failure. *Eur J Heart Fail*. 2004 Jun;6(4):421-6.

Arbaje AI, Wolff JL, Yu Q, et al. Postdischarge environmental and socioeconomic factors and the likelihood of early hospital readmission among community-dwelling Medicare beneficiaries. *The Gerontologist.* 2008 Aug;48(4):495-504.

Aujesky D, Mor MK, Geng M, et al. Predictors of early hospital readmission after acute pulmonary embolism. *Archives of Internal Medicine.* 2009 Feb 9;169(3):287-93.

Becker DJ. Do hospitals provide lower quality care on weekends? *Health Services Research*. 2007 Aug;42(4):1589-612.

Bharmal M, Gemmen E, Zyczynski T, Linnstaedt A, Kenny D, Marelli C. Resource utilisation, charges and mortality following hospital inpatient admission for congestive heart failure among the elderly in the US. *J Med Econ*. 2008;11(3):397-414.

Bohannon RW, Lee N. Association of physical functioning with same-hospital readmission after stroke. *Am J Phys Med Rehabil*. 2004 Jun;83(6):434-8.

Bohannon RW, Lee N. Hospital readmissions and deaths during the first year after hospitalization for stroke. *Conn Med*. 2003 Oct;67(9):535-9.

Bohannon RW, Maljanian RD. Hospital readmissions of elderly patients hospitalized with pneumonia. *Conn Med*. 2003 Nov-Dec;67(10):599-603.

Breakey WR, Dunn GJ. Racial disparity in the use of ECT for affective disorders. *Am J Psychiatry*. 2004 Sep;161(9):1635-41.

Brousseau DC, Owens PL, Mosso AL, Panepinto JA, Steiner CA. Acute are utilization and rehospitalizations for sickle cell disease. *JAMA.* April 2010;303(13):1288-1294.

Chen YT, Wang Y, Radford MJ, Krumholz HM. Angiotensin-converting enzyme inhibitor dosages in elderly patients with heart failure. *Am Heart J.* 2001 Mar;141(3):410-7.

Claassen CA, Michael Kashner T, Gilfillan SK, Larkin GL, John Rush A. Psychiatric emergency service use after implementation of managed care in a public mental health system. *Psychiatr Serv*. 2005 Jun;56(6):691-8.

Cramer S, Chapa G, Kotsos T, Jenich H. Assessing multiple hospitalizations for health-plan -managed Medicaid diabetic members. *J Healthc Qual*. 2010 May-Jun;32(3):7-14.

Delaney CP, Chang E, Senagore A, et al. Clinical outcomes and resource utilization associated with laparoscopic and open colectomy using a large national database. *Annals of Surgery.* 2008 May;247(5):819-24.

de Lissovoy G, Zodet M, Coyne K, O'Connell JB. Treatment charges and resource use among patients with heart failure enrolled in an MCO. *Manag Care Interface*. 2002 May;15(5):46-52.

Encinosa WE, Bernard DM, Du D, Steiner CA. Recent improvements in bariatric surgery outcomes. *Med Care*. 2009 May;47(5):531-5.

Encinosa WE, Bernard DM, Chen CC, Steiner CA. Healthcare utilization and outcomes after bariatric surgery. *Med Care*. 2006 Aug;44(8):706-12.

Encinosa WE, Hellinger FJ. The Impact of Medical Errors on Ninety-Day Costs and Outcomes: An Examination of Surgical Patients. *Health Serv Res*. 2008 Jul 25.

Feudtner C, Levin JE, Srivastava R, et al. How well can hospital readmission be predicted in a cohort of hospitalized children? A retrospective, multicenter study. *Pediatrics.* 2009 Jan;123(1):286-93.

Figueroa R, Harman J, Engberg J. Use of claims data to examine the impact of length of inpatient psychiatric stay on readmission rate. *Psychiatr Serv*. 2004 May;55(5):560-5.

French DD, Bass E, Bradham DD, Campbell RR, Rubenstein LZ. Rehospitalization After Hip Fracture: Predictors and Prognosis from a National Veterans Study. *Journal of the American Geriatrics Society*, 2007 Nov 15.

Friedman B, Basu J. The rate and cost of hospital readmissions for preventable conditions *Medical care research and review : MCRR*, 2004 Jun;61(2):225-240

Friedman B, Encinosa W, Jiang, HJ, Mutter R. Do patient safety events increase readmissions? *Medical Care.* 2009 May;47(5):583-90.

Friedman B, Jiang HJ, Elixhauser A. Costly hospital readmissions and complex chronic illness. *Inquiry.* 2008-2009 Winter;45(4):408-21.

Greenberg GA, Rosenheck RA, Charns MP. From profession-based leadership to service line management in the Veterans Health Administration: impact on mental health care. *Med Care*. 2003 Sep;41(9):1013-23.

Hallerbach M, Francoeur A, Pomerantz SC, Oliner C, Morris DL, Eiger G, Cohn J, Goldfinger M. Patterns and predictors of early hospital readmission in patients with congestive heart failure. *Am J Med Qual*. 2008 Jan-Feb;23(1):18-23.

Hasan O, Meltzer DO, Shaykevich SA, Bell CM, Kaboli PJ, Auerbach AD, Wetterneck TB, Arora VM, Zhang J, Schnipper JL. Hospital readmission in general medicine patients: a prediction model. *J Gen Intern Med*. 2010 Mar;25(3):211-9. Epub 2009 Dec 15.

Hendryx MS, Russo JE, Stegner B, Dyck DG, Ries RK, Roy-Byrne P. Predicting rehospitalization and outpatient services from administration and clinical databases. *J Behav Health Serv Res.* 2003 Jul-Sep;30(3):342-51.

Hinojosa MW, Konyalian VR, Murrell ZA, et al. Outcomes of right and left colectomy at academic centers. *The American Surgeon*. 2007 Oct;73(10):945-8.

Jen HC, Shew SB. Laparoscopic versus open appendectomy in children: outcomes comparison based on a statewide analysis. *The Journal of Surgical Research.* 2010 Jun 1;161(1):13-7.

Jiang HJ, Andrews R, Stryer D, Friedman B. Racial/Ethnic disparities in potentially preventable readmissions: the case of diabetes. *American Journal of Public Health* 2005 Sep;95(9):1561-1567.

Jiang HJ, Friedman B, Andrews R. Changes in hospital readmissions for diabetes-related conditions. Differences by payer. *Managed Care Interface* 2008 Jul;21(1):24-30.

Jiang HJ, Stryer D, Friedman B, Andrews R. Multiple hospitalizations for patients with diabetes. *Diabetes Care*. 2003 May;26(5):1421-6.

Keenan PS, Normand SL, Lin Z, et al. An administrative claims measure suitable for profiling hospital performance on the basis of 30-day all-cause readmission rates among patients with heart failure. *Circulation: Cardiovascular Quality and Outcomes*. 2008 Sep;1(1):29-37.

Kennedy BS, Fortmann SP, Stafford RS. Elective and isolated carotid endarterectomy: health disparities in utilization and outcomes, but not readmission. *Journal of the National Medical Association.* 2007 May; 99(5):480-8.

Nasir K, Lin Z, Bueno H, et al. Is same-hospital readmission rate a good surrogate for all-hospital readmission rate? *Medical Care.* 2010 May;48(5):477-81.

Nguyen NT, Zainabadi K, Mavandadi S, Paya M, Stevens CM, Root J, Wilson SE. Trends in utilization and outcomes of laparoscopic versus open appendectomy. *Am J Surg*. 2004 Dec;188(6):813-20.

Kima MH, Lin J, Hussein M, et al. Incidence and temporal pattern of hospital readmissions for patients with atrial fibrillation. *Current Medical Research and Opinion.* 2009 May;25(5):1215-20.

Kind AJ, Smith MA, Pandhi N, Frytak JR, Finch MD. Bouncing-back: rehospitalization in patients with complicated transitions in the first thirty days after hospital discharge for acute stroke. *Home Health Care Serv Q*. 2007;26(4):37-55.

Kotagal UR, Robbins JM, Kini NM, Schoettker PJ, Atherton HD, Kirschbaum MS. Impact of a bronchiolitis guideline: a multisite demonstration project. *Chest.* 2002 Jun;121(6):1789-97.

Krumholz HM, Merrill AR, Schone EM, et al. Patterns of hospital performance in acute myocardial infarction and heart failure 30-day mortality and readmission. *Circulation: Cardiovascular Quality and Outcomes.* 2009 Sep;2(5):407-13.

Lee WC, Joshi AV, Wang Q, Pashos CL, Christensen MC. Morbidity and mortality among elderly Americans with different stroke subtypes. *Adv Ther.* 2007 Mar-Apr;24(2):258-68.

Lichtman JH, Jones SB, Watanabe E, et al. Elderly women have lower rates of stroke, cardiovascular events, and mortality after hospitalization for transient ischemic attack. *Stroke.* 2009 Jun;40(6):2116-22.

Lyman S, Koulouvaris P, Sherman S, et al. Epidemiology of anterior cruciate ligament reconstruction: trends, readmissions, and subsequent knee surgery. *The Journal of Bone and Joint Surgery. American Volume.* 2009 Oct;91(10):2321-8.

Mathews CA, Glidden D, Murray S, Forster P, Hargreaves WA. The effect on treatment outcomes of assigning patients to ethnically focused inpatient psychiatric units. *Psychiatr Serv*. 2002 Jul;53(7):830-5.

McDonald KM, Hlatky MA, Saynina O, Geppert J, Garber AM, McClellan MB. Trends in hospital treatment of ventricular arrhythmias among Medicare beneficiaries, 1985 to 1995. *Am Heart J.* 2002 Sep;144(3):413-21.

Menzin J, Wygant G, Hauch O, et al. One-year costs of ischemic heart disease among patients with acute coronary syndromes: findings from a multi-employer claims database. *Current Medical Research and Opinion*. 2008 Feb;24(2):461-8.

Mulvey GK, Wang Y, Lin Z, et al. Mortality and readmission for patients with heart failure among U.S. News & World Report's top heart hospitals. *Circulation: Cardiovascular Quality and Outcomes.* 2009 Nov;2(6):558-65.

Patterson ME, Hernandez AF, Hammill BG, Fonarow GC, Peterson ED, Schulman KA, Curtis LH. Process of care performance measures and long-term outcomes in patients hospitalized with heart failure. *Med Care*. 2010 Mar;48(3):210-6.

Philbin EF, Dec GW, Jenkins PL, DiSalvo TG. Socioeconomic status as an independent risk factor for hospital readmission for heart failure. *Am J Cardiol*. 2001 Jun 15;87(12):1367-71.

Piontek F, Kohli R, Conlon P, Ellis JJ, Jablonski J, Kini N. Effects of an adverse-drug-event alert system on cost and quality outcomes in community hospitals. *Am J Health Syst Pharm*. 2010 Apr 15;67(8):613-20.

Rifkin WD, Conner D, Silver A, Eichorn A. Comparison of processes and outcomes of pneumonia care between hospitalists and community-based primary care physicians. *Mayo Clin Proc*. 2002 Oct;77(10):1053-8.

Ross JS, Chen J, Lin Z, et al. "Recent national trends in readmission rates after heart failure hospitalization." *Circulation: Heart Failure*. November 2009. http://circheartfailure.ahajournals.org/cgi/content/short/CIRCHEARTFAILURE.109.885210v1 (Accessed July 1, 2010.)

Setoguchi S, Nohria A, Rassen JA, et al. Maximum potential benefit of implantable defibrillators in preventing sudden death after hospital admission because of heart failure. *CMAJ: Canadian Medical Association Journal*. 2009 Mar 17;180(6):611-6.

Sheikh K, Bullock CM, Jiang Y, Ketner SD. Adherence to guidelines for and disparities in diabetes care utilization in Medicaid children. *J Pediatr Endocrinol Metab*. 2008 Apr;21(4):349-58.

Sherman SL, Lyman S, Koulouvaris P, et al. Risk factors for readmission and revision surgery following rotator cuff repair. *Clinical Orthopaedics and Related Research*. 2008 Mar;466(3):608-13.

Silverstein MD, Qin H, Mercer SQ, Fong J, Haydar Z. Risk factors for 30-day hospital readmission in patients >/=65 years of age. *Proc (Bayl Univ Med Cent).* 2008 Oct;21(4):363-72.

Smith MA, Frytak JR, Liou JI, Finch MD. Rehospitalization and survival for stroke patients in managed care and traditional Medicare plans. *Med Care*. 2005 Sep;43(9):902-10.

SooHoo NF, Krenek L, Eagan MJ, Gurbani B, Ko CY, Zingmond DS. Complication rates following open reduction and internal fixation of ankle fractures. *J Bone Joint Surg Am.* 2009 May;91(5):1042-9.

Spyropoulos AC, Lin J. Direct medical costs of venous thromboembolism and subsequent hospital readmission rates: an administrative claims analysis from 30 managed care organizations. *Journal of Managed Care Pharmacy*. 2007 Jul-Aug;13(6):475-86.

Sterling S, Chi F, Campbell C, Weisner C. Three-year chemical dependency and mental health treatment outcomes among adolescents: the role of continuing care. *Alcoholism, Clinical and Experimental Research*. 2009 Aug;33(8):1417-29.

Tai-Seale M, LoSasso AT, Freund DA, Gerber SE. The long-term effects of Medicaid managed care on obstetrics care in three California counties. *Health Serv Res*. 2001 Aug;36(4):751-71.

Varela JE, Hinojosa MW, Nguyen NT. Perioperative outcomes of bariatric surgery in adolescents compared with adults at academic medical centers. *Surg Obes Relat Dis*. 2007 Sep-Oct;3(5):537-40; discussion 541-2.

Vogel TR, Symons RG, Flum DR. A population-level analysis: the influence of hospital type on trends in use and outcomes of lower extremity angioplasty. *Vasc Endovascular Surg*. 2008 Feb-Mar;42(1):12-8.

Weller WE, Gallagher BK, Cen L, Hannan EL. Readmissions for venous thromboembolism: expanding the definition of patient safety indicators. *Jt Comm J Qual Saf*. 2004 Sep;30(9):497-504.

Welle WE, Rosati C, Hannan EL. Relationship between surgeon and hospital volume and readmission after bariatric operation. *Journal of the American College of Surgeons.* 2007 Mar;204(3):383-91.

Wexler DJ, Chen J, Smith GL, Radford MJ, Yaari S, Bradford WD, Krumholz HM. Predictors of costs of caring for elderly patients discharged with heart failure. *Am Heart J*. 2001 Aug;142(2):350-7.

Whelan CT, Chen C, Kaboli P, Siddique J, Prochaska M, Meltzer DO. Upper versus lower gastrointestinal bleeding: a direct comparison of clinical presentation, outcomes, and resource utilization. *J Hosp Med*. 2010 Mar;5(3):141-7.

Yermilov I, Bentrem D, Sekeris E, et al. Readmissions following pancreaticoduodenectomy for pancreas cancer: a population-based appraisal. *Annals of Surgical Oncology.* 2009 Mar;16(3):554-61.

Young AE, Webster B, Giunti G, Pransky G, Nesathurai S. Services provided following compensable work-related tetraplegia. *Spinal Cord*. 2004 Apr;42(4):248-60.

Yu W, Ravelo A, Wagner TH, Phibbs CS, Bhandari A, Chen S, Barnett PG. Prevalence and costs of chronic conditions in the VA health care system. *Med Care Res Rev*. 2003 Sep;60(3 Suppl):146S-167S.

Zhan C, Kaczmarek R, Loyo-Berrios N, et al. Incidence and short-term outcomes of primary and revision hip replacement in the United States. *The Journal of Bone and Joint Surgery. American Volume.* 2007 Mar;89(3):526-33.

Studies Using HCUP Data

Brousseau DC, Owens PL, Mosso AL, Panepinto JA, Steiner CA. Acute care utilization and rehospitalizations for sickle cell disease. JAMA. April 2010;303(13):1288-1294.

Context: Published rates of health care utilization and rehospitalization by people with sickle cell disease have had limited generalizability and are not population based.

Objective: To provide benchmark data for rates of acute care utilization and rehospitalizations for patients with sickle cell disease.

Design: Retrospective cohort of sickle cell disease–related emergency department (ED) visits and hospitalizations from select states in the 2005 and 2006 Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases and State Emergency Department Databases.

Setting: Eight geographically dispersed states (Arizona, California, Florida, Massachusetts, Missouri, New York, South Carolina, and Tennessee) that provide encrypted identifiers and have sufficient numbers of patients with sickle cell disease; together these states have 33% of the US population with sickle cell disease.

Patients: A total of 21,112 patients with sickle cell–related treat-and-release ED visits or inpatient hospitalizations.

Main Outcome Measures: Rates of acute care utilization and rehospitalizations. Population-based utilization rates were also calculated.

Results: The 21,112 people with sickle cell disease had 109,344 encounters, a mean of 2.59 (95% confidence interval [CI], 2.53-2.65) encounters per patient per year, 1.52 (95% CI, 1.48-1.55) encounters for hospitalizations and 1.08 (95% CI, 1.04-1.11) for treat-and-release ED visits. Utilization was highest for 18- to 30-year-olds, 3.61 (95% CI, 3.47-3.75) encounters per patient per year, and those with public insurance, 3.22 (95% CI, 3.13-3.31) encounters per patient per year. Publicly insured 18- to 30-year-olds had 4.80 (95% CI, 4.58-5.02) encounters per patient per year. Approximately 29% of the

population had no encounters while 16.9% had 3 or more encounters per year. The 30-day and 14-day rehospitalization rates were 33.4% (95% CI, 33.0%-33.8%) and 22.1% (95% CI, 21.8%-22.4%), respectively. The rehospitalization rate was highest for 18- to 30-year-olds, with 41.1% (95% CI, 40.5%-41.7%) rehospitalized within 30 days and 28.4% (95% CI, 27.8%-29.0%) within 14 days. Rehospitalizations were also highest for publicly insured patients.

Conclusion: Among patients with sickle cell disease, acute care encounters and rehospitalizations were frequent, particularly for 18- to 30-year-olds.

Friedman B, Basu J. The rate and cost of hospital readmissions for preventable conditions. *Medical care research and review : MCRR*, 2004 Jun;61(2):225-240

Objectives: The study estimates the rate and cost of preventable readmissions within 6 months after a first preventable admission, by age-group, and by payer and race within age-group.

Methods: The descriptive results are contrasted with several hypotheses. The hospital discharge data are for residents of New York, Pennsylvania, Tennessee, and Wisconsin in 1999, from files of the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality.

Results: About 19 percent of persons with an initial preventable admission had at least one preventable readmission rate within 6 months. Hospital cost for preventable readmissions during 6 months was about 730 million US dollars. There were substantial differences in readmission rates by payer group and by race. Some evidence suggests that preventable readmissions may partly reflect complexity of underlying problems. Interventions to reduce cost might focus on identifying high-risk patients before discharge and devising new approaches to follow-up.

Friedman B, Encinosa W, Jiang, JH, Mutter R. Do patient safety events increase readmissions? *Medical Care* 2009 May; 7(5): 583-590.

Objective: Adverse safety events in the hospital could impose extra costs not only due to longer stays and corrective treatments, but also due to deaths and readmissions. The effects of safety events on readmissions have rarely been analyzed. Large, all-payer and all-diagnosis databases permit new tests. This study simultaneously tests the effects of safety events on risks of deaths and readmission.

Study Design: The population is a selection of almost 1.5 million adult surgery patients initially treated in 1088 short stay hospitals. These are patients at risk for at least 1 of 9 types of patient safety events, as specified in software in the public domain from the Agency for Healthcare Research and Quality. The main data sources are 7 statewide databases of hospitalizations in 2004, maintained by the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project. We control for many factors affecting readmission or death, particularly the severity of illness, chronic comorbidities, age, and payer group. Separate models are used for each type of safety event and a composite model is used for any safety event.

Principal Findings: Among the patients at risk for any of the patient safety events, 2.6% had at least one safety event. The 3-month readmission rate was about 17% for those with no safety event, but about 25% when a safety event was recorded. The corresponding rates for readmission within 1 month were 11% and 16%. The in-hospital death rate was 1.3% with no safety event, but 9.2% with a safety event. After risk adjustment, the relative risk of readmission within 3 months was about 1.20 ($P < 0.01$), ranging from 1.14 to 1.56 for specific types of events. The risk-adjusted result for readmission within 1 month associated with at least one safety event was 1.17 ($P < 0.01$). However, the models for specific safety events gave a significantly high risk of readmission within 1 month for only 2 of the more common types of safety events.

Conclusions: Hospital readmissions are one way that safety events can have costly consequences. More attention is warranted to assess the full extra cost of safety events, the factors influencing the rate of safety events, and strategies for health plans to improve incentives for safety.

Friedman B, Jiang HJ, Elixhauser A. Costly hospital readmissions and complex chronic illness. *Inquiry.* 2008-2009 Winter;45(4):408-21.

Abstract: People with multiple chronic conditions account for a large and disproportionate share of total health care costs. One aspect of the high cost for such patients is a relatively high number of hospital admissions per year. This study aims to clarify how the rate of hospital readmissions and hospital cost per person in a year depend on a patient's number of different chronic conditions ("complexity"), severity of illness, principal diagnosis at discharge, payer group, and other variables. We use a database of all hospital discharges for adults in six states. The number of different chronic conditions has a smoothly increasing effect on readmissions and cost per year, and there are notable differences by payer group. We offer illustrations of the potential savings from reducing total inpatient cost and readmissions in narrowly targeted populations with the most complex problems. The study's methods and descriptive data potentially could be useful for health plans and their sponsors (employers, government) when they design strategies to address the high cost of complex chronic illness.

Jiang HJ, Andrews R, Stryer D, Friedman B. Racial/Ethnic disparities in potentially preventable readmissions: the case of diabetes. *American Journal of Public Health*, 2005 Sep; 95(9):1561-1567.

Objectives: Considerable differences in prevalence of diabetes and management of the disease exist among racial/ethnic groups. We examined the relationship between race/ethnicity and hospital readmissions for diabetes-related conditions.

Methods: Nonmaternal adult patients with Medicare, Medicaid, or private insurance coverage hospitalized for diabetes-related conditions in 5 states were identified from the 1999 State Inpatient Databases of the Healthcare Cost and Utilization Project. Racial/ethnic differences in the likelihood of readmission were estimated by logistic regression with adjustment for patient demographic, clinical, and socioeconomic characteristics and hospital attributes.

Results: The risk-adjusted likelihood of 180-day readmission was significantly lower for non-Hispanic Whites than for Hispanics across all 3 payers or for non-Hispanic Blacks

among Medicare enrollees. Within each payer, Hispanics from low-income communities had the highest risk of readmission. Among Medicare beneficiaries, Blacks and Hispanics had higher percentages of readmission for acute complications and microvascular disease, while Whites had higher percentages of readmission for macrovascular conditions.

Conclusions: Racial/ethnic disparities are more evident in 180-day than in 30-day readmission rates, and greatest among the Medicare population. Readmission diagnoses vary by race/ethnicity, with Blacks and Hispanics at higher risk for those complications more likely preventable with effective postdischarge care.

Jiang HJ, Friedman B, Andrews R. Changes in hospital readmissions for diabetes-related conditions. Differences by payer. *Managed Care Interface* 2008 Jul;21(1):24-30.

This study examines changes in hospital readmissions for diabetes-related conditions in light of evidence showing improvements in the quality of diabetes care in the U.S. All adult nonmaternal patients covered by private, Medicare, or Medicaid insurance who were hospitalized for diabetes-related conditions in six states (Arizona, California, Missouri, New York, Tennessee, and Virginia) were identified from State Inpatient Databases of the Healthcare Cost and Utilization Project. Observed 180-day readmission rates for diabetes-related conditions ranged from 1 in 5 among privately insured patients to about 3 in 10 among Medicare or Medicaid patients. Small improvements in reducing hospital readmissions for diabetes-related conditions were observed in a four-year period among the privately insured and Medicare HMO enrollees. The risk-adjusted odds of readmission was 6% lower ($p<0.05$) in 2003 than in 1999 for privately insured patients or Medicare HMO enrollees. Among Medicaid patients, the odds of being readmitted for acute diabetes complications more than doubled in 2003 compared to 1999. The odds of being readmitted for lower extremity complications and renal complications also significantly increased over the years. Among Medicare patients, the odds of being readmitted for renal complications, congestive heart failure, and stroke were significantly higher in 2003 than in 1999. For patients covered by Medicaid or fee-for-service Medicare, interventions should be designed to more effectively prevent particular complications and hospital readmissions.

Jiang HJ, Stryer D, Friedman B, Andrews R. Multiple hospitalizations for patients with diabetes. *Diabetes Care*. 2003 May;26(5):1421-6.

Objective: To describe the extent to which hospitalizations for patients with diabetes reflect multiple stays by the same individuals and to examine how multiple hospitalizations vary by patient demographic and socioeconomic characteristics.

Research Design And Methods: Using the Healthcare Cost and Utilization Project complete discharge data for five states (California, Missouri, New York, Tennessee, and Virginia) in 1999, we identified 648,748 nonneonatal, nonmaternal patients who had one or more hospitalizations listing diabetes. Multiple hospitalizations were measured as percent of patients with multiple stays, percent of total stays represented by multiple stays, and average number of stays per patient. Total hospital costs were also examined. Stratified analysis and regression were performed to assess differences by age, sex, race/ethnicity, payer, location, and income.

Results: Among patients with diabetes who had been hospitalized, 30% had two or more stays accounting for >50% of total hospitalizations and hospital costs. Controlled for patient age, sex, and clinical characteristics, the likelihood of having multiple hospitalizations was higher for Hispanics and non-Hispanic blacks compared with non-Hispanic whites, as well as for patients covered by Medicare or Medicaid and those living in low-income areas. The prevalence of diabetes complications and multiple conditions differed by age, race/ethnicity, and payer among patients with multiple stays.

Conclusions: Multiple hospitalizations are common among patients with diabetes but vary by age, race/ethnicity, payer, and income, with those populations traditionally considered to be more vulnerable experiencing higher likelihoods of multiple stays. Significant opportunities exist to reduce the proportion of multiple hospitalizations for patients with diabetes. Clinical and policy interventions to improve the quality of care and outcomes for these patients should be designed accordingly and have the potential to pay major dividends.

SooHoo NF, Krenek L, Eagan MJ, Gurbani B, Ko CY, Zingmond DS. Complication rates following open reduction and internal fixation of ankle fractures. *J Bone Joint Surg Am*. 2009 May;91(5):1042-9.

Background: Ankle fractures are among the most common injuries treated by orthopaedic surgeons. The purpose of the present investigation was to examine the risks of complications after open reduction and internal fixation of ankle fractures in a large population-based study.

Methods: With use of California's discharge database, we identified 57,183 patients who had undergone open reduction and internal fixation of a lateral malleolar, bimalleolar, or trimalleolar ankle fracture as inpatients in the years 1995 through 2005. Short-term complications were examined on the basis of the rates of readmission within ninety days after discharge. The intermediate-term rate of reoperation for ankle fusion or arthroplasty was also analyzed. Logistic regression and proportional hazard regression models were used to determine the strength of the relationships between the rates of complications and fracture type, patient demographics and comorbidities, and hospital characteristics.

Results: The overall rate of short-term complications was low, including the rates of pulmonary embolism (0.34%), mortality (1.07%), wound infection (1.44%), amputation (0.16%), and revision open reduction and internal fixation (0.82%). The intermediate-term rates of reoperation were also low, with ankle fusion or ankle replacement being performed in 0.96% of the patients who were observed for five years. Open fractures, age, and medical comorbidities were significant predictors of short-term complications. The presence of complicated diabetes was a particularly strong predictor (odds ratio, 2.30; $p < 0.001$), as was peripheral vascular disease (odds ratio, 1.65; $p < 0.001$). The intermediate-term rate of reoperation for ankle fusion or replacement was higher in patients with trimalleolar fractures (hazard ratio, 2.07; $p < 0.001$) and open fractures (hazard ratio, 5.29; $p < 0.001$). Treatment at a low-volume hospital was not significantly associated with either the aggregate risk of short-term complications or the risk of intermediate-term reoperation.

Conclusions: By analyzing a large, diverse patient population, the present study clarifies the risks associated with open reduction and internal fixation of ankle fractures. Open injury, diabetes, and peripheral vascular disease were strong risk factors predicting a

complicated short-term postoperative course. Fracture type was a strong predictor of reoperation for ankle fusion or replacement. Hospital volume did not play a significant role in the rates of short-term or intermediate-term complications.

Zhan C, Kaczmarek R, Loyo-Berrios N, et al. Incidence and short-term outcomes of primary and revision hip replacement in the United States *The Journal of Bone and Joint Surgery (American)* 2007;89:526-533.

Background: The purpose of this study was to use 2003 nationwide United States data to determine the incidences of primary total hip replacement, partial hip replacement, and revision hip replacement and to assess the short-term patient outcomes and factors associated with the outcomes.

Methods: We screened more than eight million hospital discharge abstracts from the 2003 Healthcare Cost and Utilization Project Nationwide Inpatient Sample and approximately nine million discharge abstracts from five State Inpatient Databases. Patients who had undergone total, partial, or revision hip replacement were identified with use of International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes. In-hospital mortality, perioperative complications, readmissions, and the association between these outcomes and certain patient and hospital variables were analyzed.

Results: Approximately 200,000 total hip replacements, 100,000 partial hip replacements, and 36,000 revision hip replacements were performed in the United States in 2003. Approximately 60% of the patients were sixty-five years of age or older and at least 75% had one or more comorbid diseases. The in-hospital mortality rates associated with these three procedures were 0.33%, 3.04%, and 0.84%, respectively. The perioperative complication rates associated with the three procedures were 0.68%, 1.36%, and 1.08%, respectively, for deep vein thrombosis or pulmonary embolism; 0.28%, 1.88%, and 1.27% for decubitus ulcer; and 0.05%, 0.06%, and 0.25% for postoperative infection. The rates of readmission, for any cause, within thirty days were 4.91%, 12.15%, and 8.48%, respectively, and the rates of readmissions, within thirty days, that resulted in a surgical procedure on the affected hip were 0.79%, 0.91%, and 1.53%. The rates of readmission, for any cause, within ninety days were 8.94%, 21.14%, and 15.72%, and the rates of readmissions, within ninety days, that resulted in a surgical procedure on the affected hip were 2.15%, 1.61%, and 3.99%. Advanced age and comorbid diseases were associated with worse outcomes, while private insurance coverage and planned admissions were associated with better outcomes. No consistent association between outcomes and hospital characteristics, such as hip procedure volume, was identified.

Conclusions: Total hip replacement, partial hip replacement, and revision hip replacement are associated with different rates of postoperative complications and readmissions. Advanced age, comorbidities, and non-elective admissions are associated with inferior outcomes.