Factors influencing readmission risk: Implications for quality monitoring

by James J. Holloway and J. William Thomas

By applying multiple logistic regression to data from the 1980 National Medical Care Utilization and Expenditure Survey, independent risk factors for readmission to an acute care hospital within 31 days of the preceding discharge were identified. Subjects who were initially admitted for a high-risk condition, those with poor perceived health status, and those who had no surgical procedures performed were most likely to be readmitted. Sex, race, marital status, insurance coverage, and access to outpatient care did not independently influence readmission risk. Readmission risk models used to monitor quality of care need not adjust for these nonmedical factors.

Introduction

The release by the Health Care Financing Administration (1987, 1988a) of hospital-specific mortality data for Medicare beneficiaries has highlighted national concerns over both the quality of hospital care and the validity of interhospital comparisons of quality. Like mortality, readmission to a hospital shortly following discharge is an easily identifiable event with a potential, although as yet unproved, connection to quality of care. The Medicare prospective payment system, based on diagnosis-related groups, theoretically provides incentives for the early discharge of Medicare beneficiaries. Early discharges may increase the risk of subsequent readmission if all necessary medical care is not completed during a patient's first hospital stay. Therefore, the Health Care Financing Administration (1988b) requires that readmissions within 31 days of discharge be reviewed by peer review organizations to determine if the preceding discharge was premature or if other quality problems existed.

Although a clear linkage between readmission and poor quality of care during the preceding hospital stay has not yet been established, further research may demonstrate that properly risk-adjusted readmission rates are useful indicators of the quality of care provided during the preceding stay. As with mortality data, data used for interhospital comparisons of readmission rates should be risk adjusted for patient-specific factors that may influence readmission risk (Blumberg, 1986). However, the risk adjustments required to render readmission data suitable for quality of care comparisons may be more complex than similar adjustments to mortality data. By definition, readmission implies that the patient was not under the direct supervision of the hospital for a period of time following discharge. Therefore, before readmission rates adjusted only for age, sex, diagnosis, and clinical severity of illness are accepted as quality measures, other factors not under hospital control that influence readmission risk should be identified. Such factors may include social support systems, access to ambulatory care by private physicians, insurance coverage, and general health status. (Health status may be determined by factors other than the nature and severity of the illness responsible for a patient's most recent hospitalization).

Factors influencing readmission risk can be divided into three broad categories:

- Medical factors for which information is readily available from secondary data sources (e.g., discharge abstracts and claims forms), such as age, sex, diagnosis, and procedures performed.
- Other medical factors, such as self-reported global and functional health status.
- Nonmedical factors, such as marital status, living arrangements, access to care, and insurance coverage.

If nonmedical factors and health status are not important determinants of readmission risk, readmission rates adjusted only for the clinical characteristics of patients that are reported in secondary data sources may prove useful as quality indicators. However, if nonmedical factors and health status are important determinants of readmission risk, readmission rates adjusted only for items commonly found in claims data will probably be of limited value as quality indicators.

The purpose of the study discussed in this article was to explore the potential use of risk-adjusted readmission rates as indicators of the quality of inpatient care, with special attention to determining the predictive importance of health status and nonmedical risk factors. Associations between hypothesized demographic, medical, health status, and nonmedical risk factors and readmission to an acute care hospital within 31 days of a preceding discharge were examined. A 31-day period was chosen for the definition of readmission because it corresponds to the Health Care Financing Administration (1988b) review criterion for Medicare hospitalizations.

This research was supported by Grant No. 058-RDHCCC/86-01 from the Michigan Health Care Research and Education Foundation.

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Methods

Definitions of readmissions

All readmissions do not necessarily have equivalent quality implications. Therefore, the following categories of readmissions are defined:

Any readmission—Readmission for any condition or procedure, regardless of whether related to conditions treated during the preceding stay.

Same-condition readmission—Readmission for the condition that was responsible for the previous hospital stay.

Linked readmission—Readmission for performance of a diagnostic or therapeutic procedure that is medically related to a diagnosis treated during the preceding stay. For linkage to occur, a procedure related to a preceding diagnosis must have been performed during the readmission.

Unlinked readmission—Readmission for any reason other than the performance of a procedure that is related to a diagnosis treated during the previous stay (complement of linked readmission).

Discretionary readmission—Readmission for a condition that can sometimes be treated on an ambulatory basis, depending on the severity of illness and any associated comorbidities.

Nondiscretionary readmission—Readmission for a condition that virtually always requires inpatient management, or readmission during which major surgery is performed.

Our definition of linked readmission is consistent with previous work that identified some diagnosis-related groups for which paired admissions might be justifiable (Gertman and Lowenstein, 1984). Usually, a linked readmission is also a same-condition readmission. However, if a secondary diagnosis from the preceding stay is linked to a procedure performed during the readmission, the linked readmission is not necessarily classified as a same-condition readmission. A patient may require admission for one condition, only to have a second condition discovered that requires procedures legitimately performed during a subsequent stay. By definition, the second condition is not primarily responsible for the first stay, and it is listed as a secondary diagnosis. Such a readmission is linked by virtue of a procedure related to a preceding diagnosis. However, it is not a same-condition readmission, because the condition necessitating the readmission differs from the condition that was responsible for the first admission.

The purpose of defining linked readmissions was to approximate a definition of legitimately planned, or scheduled, readmission, using data similar to those found in discharge abstracts and insurance claims data bases. By restricting the definition of linked readmission to one during which diagnostic or therapeutic procedures that are medically related to a diagnosis listed during the previous stay are performed, we come as close to the concept of scheduled readmission as is possible using data from secondary data sources.

To examine discretionary readmissions, we first developed a list of nondiscretionary diagnoses. A nondiscretionary readmission was defined as one for which either the condition responsible for the hospital stay or a procedure performed during the stay virtually mandated hospitalization, according to commonly accepted standards of care in the United States. Examples of nondiscretionary hospitalizations include those for acute myocardial infarction, intracerebral hemorrhage, bleeding esophageal varices, and respiratory problems associated with premature birth, as well as hospitalizations during which major surgery was performed. In these cases, the need for hospitalization is established by the diagnosis or procedure alone. Other hospitalizations, such as those for congestive heart failure, chronic lung disease, asthma, and cystitis, were considered discretionary, because the need for hospitalization is not evident from the diagnosis or procedure alone. Instead, patients' severity of illness, comorbid conditions, overall functional capabilities, and home support systems may legitimately affect the decision between inpatient and outpatient treatment. The physician often has considerable latitude in deciding if a patient with a discretionary condition should be admitted or treated as an outpatient. Lists of diagnoses and procedures that prompted classification of the associated readmission as discretionary or nondiscretionary are provided in the "Technical note."

The concepts underlying the various definitions of readmission are illustrated by the example of a patient whose first hospitalization was for angina pectoris. A subsequent admission for angina would be considered a same-condition readmission. A subsequent admission for congestive heart failure, without cardiac catheterization or coronary bypass surgery, would be classified as "any" readmission (because it is for a different condition), unlinked (because no diagnostic or therapeutic procedures were performed during the second stay), and discretionary (because mild exacerbations of congestive failure often respond to outpatient treatment). A subsequent readmission for coronary bypass surgery would be classified as linked (because surgery was performed to definitively treat the angina) and nondiscretionary (because bypass surgery must be performed in the hospital). A readmission for acute myocardial infarction would be classified as same condition (because it is unequivocally a manifestation of coronary artery disease) and nondiscretionary (because prevailing standards of care require inpatient management of acute myocardial infarction). A subsequent readmission for lung cancer surgery would be classified as nondiscretionary (because the surgery must be performed in the hospital) but unlinked (because surgical treatment is provided for a condition other than the one responsible for the preceding hospital stay). However, if lung cancer had been listed as a secondary diagnosis during the preceding stay, a subsequent readmission for lung cancer surgery would be considered linked, because the patient could legitimately be readmitted for cancer surgery following stabilization of the heart condition.

From a quality-monitoring perspective, same-condition and unlinked readmissions are of most interest. Same-condition readmissions may be associated with a higher-than-average rate of incomplete treatment for the patient's presenting condition. Unlinked readmissions, which are analogous to unscheduled readmissions, also seem to be more likely to reflect quality problems than would linked readmissions, which are more likely to be planned. From a utilization review perspective, discretionary readmissions are of more concern than are nondiscretionary readmissions, because the designation "discretionary" implies that at least some such readmissions may be unnecessary. For these reasons and because of limited sample size, we restricted our analyses to any, same-condition, unlinked, and discretionary readmissions.

Data and risk factors examined

Data for this analysis came from the person and hospital stay files of the 1980 National Medical Care Utilization and Expenditure Survey, or NMCUES (National Center for Health Statistics, 1983). To obtain these data, a statistically representative sample of the noninstitutionalized U.S. population was interviewed. The five rounds of data collection included two personal interviews, two telephone interviews, and a final personal interview for each subject. Prior to the second and subsequent interviews, computer-generated summaries of previously reported medical visits and expenditures were sent to each household and to interviewers. Subjects' recall of previous utilization was facilitated by a calendar and diary, which they were given at the conclusion of the first interview. Preliminary coding of respondents' replies was performed by the interviewer; final data entry was performed centrally, following data editing and quality control procedures. Each reported condition was coded by a coding expert using the Health Interview Survey Medical Coding Manual (National Center for Health Statistics, 1979) and the World Health Organization's *International Classification of Diseases*, 1975 Revision (World Health Organization, 1977). Each condition classified in NMCUES was assigned a specific condition number and up to three four-digit *International Classification of Diseases* (ICD) diagnosis and procedure codes, based on the details of participants' responses to survey questions.

The NMCUES hospital stay file (National Center for Health Statistics, 1983) was used to identify hospital stays and to obtain data pertaining to those hypothesized medical risk factors for readmission that are commonly included in secondary data sources. The hospital file contains admission and discharge dates for all reported hospitalizations, two-digit NMCUES condition codes for the principal and secondary diagnoses associated with each hospitalization, four-digit ICD diagnosis codes, and two-digit ICD procedure codes (World Health Organization, 1977). For each hospitalization, a maximum of three ICD diagnosis codes and three ICD procedure codes were used. Readmissions were classified as same condition based on the NMCUES condition codes for the initial stay and readmission. Readmissions were classified as discretionary or linked based on the ICD diagnosis and procedure codes assigned to each stay.

The 57 conditions reported in NMCUES were classified into four expected readmission risk categories: low, moderate, high, and very high. Findings from previous studies of readmissions (Anderson and Steinberg, 1985; Fethke, Smith, and Johnson, 1986; Gooding and Jette, 1985; Holloway, Thomas, and Shapiro, 1988; Holloway, Medenorp, and Bromberg, to be published; Phillips et al., 1987; Riley and Lubitz, 1986; Smith, Norton, and McDonald, 1985; Victor and Vetter, 1985; Zook, Savickis, and Moore, 1980) provided the principal basis for assigning conditions to risk groups. For conditions without previously identified readmission risk, clinical judgment was used to assign a risk category. The risk classification for NMCUES conditions is displayed in Table 1. Other hypothesized risk factors identified through the hospital file included the performance of surgery or diagnostic procedures during the index stay.

Data pertaining to hypothesized health status and nonmedical risk factors were obtained from the NMCUES person file (National Center for Health Statistics, 1983). Such factors included social and demographic characteristics, access to ambulatory care, type of insurance coverage, self-reported health status, and self-reported functional limitations. Details of these variables, including their respective frequency distributions and univariate association with readmission, are displayed in Table 2. Except for the item pertaining to health-related activity limitations, Table 2 is self-explanatory. The 1980 NMCUES data include an aggregate score defining activity limitations, which was constructed as a Guttman scale (National Center for Health Statistics, 1983). The components of the item on activity limitations consisted of the responses to several questions pertaining to health-related limitations of activity, which ranged from the general (e.g., whether any limitations were present) to the highly specific (e.g., whether a person had trouble walking one block or climbing one flight of stairs because of health problems). For the purpose of this analysis, limitations of activity were stratified into three categories: no limitations of usual activity, some limitations, and inability to perform usual activity.

Derivation of sample

Using the 2,946 unique records in the 1980 NMCUES hospital stay file (National Center for

Table 1
Number of hospitalizations, by risk category and condition: United States, 1980

Risk category and condition[1]	Number of hospitalizations[2]
Total	2,173
Low risk	1,080
Intestinal infectious diseases (1)	17
Other bacterial diseases (3)	2
Viral diseases (4)	16
Rickettsiosis, arthropod-borne diseases (5)	0
Venereal diseases (6)	0
Other infectious and parasitic diseases (7)	2
Malignant neoplasm of oropharynx (8)	2
Benign neoplasm (15)	30
Carcinoma in situ (16)	0
Other and unspecified neoplasms (17)	25
Diseases of ear and mastoid process (24)	20
Hypertensive disease (26)	24
Diseases of upper respiratory tract (31)	62
Diseases of mouth, salivary glands, and jaws (33)	16
Other and unspecified digestive diseases (34)	196
Diseases of male genital organs (36)	13
Diseases of female genital organs (37)	104
Diseases of skin and subcutaneous tissue (42)	30
Congenital anomalies (44)	16
Signs and symptoms (46)	113
Dislocations, sprains, and strains (48)	23
Foreign body entering through orifice (51)	1
Complications of medical and surgical care (54)	14
Partial impairment sensation (57)	1
Unknown and missing conditions	353
Moderate risk	829
Tuberculosis (2)	3
Malignancy of bone, skin, and breast (11)	10
Endocrine and immune disorders (18)	56
Nutritional deficiencies (19)	1
Mental disorders (21)	39
Neurologic diseases (not cerebrovascular) (22)	37
Moderate risk—Con't.	
Diseases of eye and adnexa (23)	46
Other diseases of circulatory system (30)	51
Other diseases of respiratory system (32)	125
Diseases of urinary system (35)	84
Abortion (38)	22
Normal pregnancy and delivery (41)	76
Musculoskeletal and connective tissue diseases (43)	124
Fractures (47)	66
Intracranial and internal injuries (49)	15
Open wounds and injury to blood vessels (50)	19
Burns (52)	6
Injuries, complications of trauma (55)	33
Late effects of injury, poisoning, and drugs (56)	16
High risk	
Ischemic heart disease (27)	57
Cerebrovascular disease (29)	26
Direct obstetric causes (39)	46
Indirect obstetric causes (40)	0
Poisonings and toxic effects (53)	10
Very high risk	
Malignancy of digestive organs and peritoneum (9)	9
Malignancy of respiratory and thoracic organs (10)	8
Malignancy of genitourinary organs (12)	8
Malignancy of other and unspecified sites (13)	17
Lymphoma, hematopoietic tissue malignancy (14)	4
Diseases of blood and blood-forming organs (20)	17
Rheumatic fever and rheumatic heart disease (25)	4
Other heart disease, congestive failure (28)	47
Conditions arising during perinatal period (45)	11

[1]Each hospitalization was attributed to 1 of 57 medical conditions coded in the National Medical Care Utilization and Expenditure Survey (NMCUES) based on the 4-digit *International Classification of Diseases, 9th Revision, Clinical Modification* code assigned to the diagnosis reported by the respondent as the first condition responsible for the stay. The official NMCUES condition number appears in parentheses following the condition description.
[2]The figures shown are numbers of hospital stays for which respondents described the associated condition as the first condition responsible for the hospitalization.

SOURCE: (National Center for Health Statistics, 1983); data development by the University of Michigan School of Public Health Department of Health Services Management and Policy and Department of Biostatistics.

Health Statistics, 1983), a person-based analysis set was created by sorting all hospital stay records by the NMCUES identification number for the subject. For each subject, a single hospital stay was selected to serve as the data source for medical risk factors. This stay was designated the subject's index hospitalization; a subsequent readmission within 31 days of discharge from this stay established the subject as readmitted for the purpose of this study. Hospital stay records with imputed admission or discharge dates were excluded from the analysis. Hospitalizations during which the subject died were excluded from consideration as index stays but were included if they represented readmissions.

Subjects with a single hospital stay in 1980 were classified as not readmitted, and their sole hospital stay was designated as their index hospitalization. For subjects with two stays or more, index hospitalizations were selected by a sequential process. Hospitalizations were first sorted by NMCUES person identification number, and the differences between all discharge dates and subsequent readmission dates were computed. Using these discharge-readmission intervals, subjects with two hospital stays or more were stratified into three groups: those with multiple hospitalizations, none of which satisfied the 31-day readmission criterion; those with a single hospitalization-readmission pair that satisified this definition; and those with two or more hospitalization-readmission pairs that met the criterion.

Subjects with multiple stays but with no discharge-readmission intervals of 31 days or fewer were classified as not readmitted for analytic purposes; one of their hospital stays was randomly selected as the index hospitalization. Subjects with one or more discharge-readmission intervals of 31 days or fewer were classified as readmitted for analytic purposes.

Table 2

Percent of hospital discharges readmitted within 31 days of discharge, by selected variables, and *p*-value and explanatory power of variables: United States, 1980

Variable	Number of subjects[1]	Percent of subjects readmitted	*p*-value	Explanatory power[2]
Race				
White	1,877	10	.20	.95
All other	296	7		
Sex				
Male	900	11	.009	.95
Female	1,273	8		
Marital status				
Under 17 years of age	505	5	.0002	.90
Married	1,073	11		
Widowed	211	13		
Separated	50	20		
Divorced	98	8		
Never married	232	9		
Education of household head				
None or elementary school	432	13	.009	.80
Some high school or high school graduate	1,124	9		
Some college	302	11		
College graduate or more	315	6		
Armed Forces veteran				
Yes	267	15	.0001	.95
No	1,357	10		
Not applicable	549	5		
Employment				
Under 17 years of age	505	5	.0001	.80
Employed at least part time	916	8		
Unemployed	62	10		
Retired because of poor health	120	18		
Retired for other reasons	307	18		
Student or other	263	10		
Usual source of care				
Has any usual source of care:				
Yes	1,834	9	.14	.95
No or unknown	339	12		
Site:				
Physician's office	1,442	9	.04	.95
Hospital outpatient department or emergency room	193	14		
Other	90	4		
Unknown	448	11		
Night hours:				
Yes	363	8	.41	.65
No or unknown	1,810	10		
Saturday hours:				
Yes	63	9	.32	.95
No or unknown	1,410	10		
Other weekend hours:				
Yes	133	10	.88	.45
No or unknown	2,040	9		
Makes house calls:				
Yes	217	12	.25	.55
No or unknown	1,956	9		
Available after hours:				
Yes	1,139	10	.92	.95
No or unknown	1,034	9		

See footnotes at end of table.

Table 2—Continued

Percent of hospital discharges readmitted within 31 days of discharge, by selected variables, and *p*-value and explanatory power of variables: United States, 1980

Variable	Number of subjects[1]	Percent of subjects readmitted	*p*-value	Explanatory power[2]
Insurance				
Private	1,259	7	.0001	.85
Medicaid	126	8		
Medicare	337	15		
Medicare and other public	66	27		
Part year	167	10		
None or other	218	10		
Self-reported health status				
Excellent	823	5	.0001	.95
Good	767	9		
Fair	355	13		
Poor	228	23		
Self-reported health-related limitations of usual activity				
Not limited	1,686	7	.0001	.95
Some limits	79	9		
Cannot perform	408	19		
Index stay				
Condition risk group:				
Low[3]	1,079	5	.0001	.95
Moderate	830	11		
High	139	16		
Very high	125	35		
Surgery performed:				
Yes	885	6	.0001	.95
No	1,265	12		
Diagnostic procedure performed:				
Yes	1,019	13	.0001	.95
No	1,029	7		

[1]Includes 206 readmitted subjects and 1,967 non-readmitted subjects. The number of respondents for a given question may deviate from 2,173 because some subjects did not respond to all questions.
[2]Reported power to detect a risk ratio of 2.0 for each level of the variable for the outcome of readmission for any reason is given. A Type I error rate of .1 is assumed, because it represents the value required for entry into the stepwise logistic regression.
[3]For analytic purposes, includes 353 subjects with missing data for condition causing index hospital stay. The readmission rate for those with missing condition data was 3 percent; that for the remainder of the low-risk group was 5 percent.

SOURCE: (National Center for Health Statistics, 1983); data development by the University of Michigan School of Public Health Department of Health Services Management and Policy and Department of Biostatistics.

For individuals with a single discharge-readmission interval of 31 days or fewer, the first hospital stay of the sequence was designated the index admission and the second the readmission. For individuals with multiple readmissions within 31 days of discharge, priority for selection of an index-stay-readmission pair was given to pairs for which the same condition was responsible for both stays. Within this subset of pairs, the pair with the shortest discharge-readmission interval was selected. If two pairs of admissions for the same condition had equal discharge-readmission intervals or if no pair of hospitalizations contained two hospital stays for the same condition, a pair was randomly selected from all pairs meeting the 31-day time criterion.

This selection process assured that each subject was represented only once in the analysis data set, regardless of the number of hospital stays he or she experienced. Therefore, all observations were statistically independent. For subjects with multiple hospital stays followed by readmission within 31 days, the selection process also assured that index stays associated with same-condition readmissions or with readmissions that occurred in closest proximity to the index discharge were preferentially selected. Such readmissions were of most interest, because they appeared most likely to be related both to quality defects and to the health status and nonmedical risk factors that were the principal focus of this study.

Analysis

After all variables were categorized into a manageable number of levels, chi-square tests were applied to the relationship between each variable and readmission status at 31 days. The post-analysis power for the detection of a univariate relative risk of 2.0 or more with a Type I error of .1 was also estimated for each hypothesized risk factor, using standard tables (Cohen, 1977). Those variables whose univariate association with readmission was significant at the $p < .20$ level of significance were considered for entry into four multiple logistic regression models that related each type of readmission studied to potential explanatory variables.

For respondents hospitalized one time or more in 1980, logistic regression was used to relate readmission within 31 days of discharge to hypothesized medical, general health status, and nonmedical risk factors. The stepwise logistic regression program from BMDP Statistical Software, Inc. (1987), was used to build the models for readmission. A significance level of $p < .1$ was required for variables to enter the models, with a level of $p > .15$ required to remove previously entered variables. The final sample size of 2,173 index hospital stays, only 206 of which were followed by readmission, required an analysis strategy focused on the identification of readmission risk factors rather than on formal split-sample validation of detailed models. Although split-sample validation was not performed, the goodness of fit of all logistic models was assessed.

To enable the development of national estimates using the NMCUES sample of respondents, the National Center for Health Statistics assigned a weight to each person in the data base. The NMCUES person weights were not used in the primary regression analysis. However, they were incorporated into a subsidiary analysis, which was performed to determine if exclusion of person weights could have biased the estimated regression coefficients.

Examination for classification bias

Two potential sources of classification bias were recognized in the NMCUES data. First, because hospitalization data were available only for the 12 months covered by the 1980 NMCUES, subjects whose only reported hospitalization occurred during the first or last 31 days of the year may have been classified incorrectly as not readmitted. A subject whose sole reported hospital stay occurred during the first 31 days of the year would ordinarily be classified as not readmitted; however, this hospital stay could have represented a readmission within 31 days of a discharge that occurred before the year began. Similarly, a subject whose sole reported hospital discharge was during the final 31 days of 1980 might have sustained an unreported readmission within 31 days of this discharge, beyond the termination of the survey period. A decision to simply exclude all subjects with admission or discharge dates in the first or last 31 days of the study period would have eliminated misclassification bias. However, the resulting sample might itself be biased if subjects with the particular characteristics under study were more likely to be hospitalized at particular times of the year. The inadvertent introduction of any such biases would have vitiated a principal strength of the study, which was the use of a sample representative of the U.S. population. Therefore, two analyses were performed: the primary analysis, which included all 2,173 subjects who were discharged alive at least once during 1980, and a secondary analysis, which excluded the 364 subjects whose only hospital stay occurred during the first or last 31 days of the survey period. Coefficients of the models generated by these two approaches were compared to determine if the uncertain readmission status of these 364 subjects could have biased the models generated by the primary analysis.

The inability to unequivocally identify interhospital transfers of patients represented a second source of potential classification errors in the NMCUES data. Some readmissions within 1 day of discharge probably represented interhospital transfers rather than true readmissions; unfortunately, transfers were not identified as such in NMCUES. Therefore, we included readmissions within 1 day of discharge in the primary analyses but excluded them in subsidiary analyses. These two sets of models were then compared to determine if unavoidable uncertainty surrounding the identification of interhospital transfers could have biased the results of the primary analysis.

Results

The NMCUES data tapes contain information on 17,123 persons, representing a random sample of the 1980 U.S. population. Respondents reported a total of 2,946 hospitalizations. Admission or discharge dates were imputed for only 3.2 percent of hospital stays. Data pertaining to the remaining 2,834 hospitalizations, for which actual admission and discharge dates were reported, were used in this analysis. These 2,834 hospitalizations were experienced by 2,206 persons, for each of whom a person-based data base was constructed, as described in the section on methods. Of these persons, 2,000 did not experience a readmission; after excluding the 33 persons who died during their only hospital stay, 1,967 non-readmitted persons remained to serve as controls. Persons readmitted within 31 days of discharge constituted 9.5 percent of the sample (206 persons); 68 persons (3.1 percent of the sample) had linked readmissions, 138 persons (6.4 percent) had unlinked readmissions, 132 persons (6.1 percent) had same-condition readmissions, and 112 persons (5.1 percent) had discretionary readmissions.

The mean age of the study sample was 36.6 years, with the mean age for non-readmitted subjects being 35.5 years and that for readmitted subjects 47.5 years ($p < .0001$). The mean age of the study sample was lowered by the 505 subjects who were under 17 years of age at the time of the survey, who represented 23 percent of the total sample. Approximately 19 percent of the sample, 403 subjects, were covered by Medicare.

Other variables considered in the analysis, their frequency distributions, the p-values for their univariate associations with readmission, and the estimated power to detect such associations are displayed in Table 2. The most striking fact about these results is the relative weakness of the association between readmission and variables describing access to outpatient care. Only one such variable, the site persons perceived as their usual source of care, was significantly related to readmission. The readmission rate for those using a hospital outpatient department or emergency room as their usual source of care was 14 percent, as compared with 11 percent for those who did not know their usual source of care; 9 percent for those using a physician's office; and 4 percent for those describing their home, a company clinic, or "other" as their usual source of care. The following variables were considered for entry into the logistic regression models: age, sex, marital status, educational attainment of household head, Armed Forces veteran status, usual source of care, insurance coverage, self-reported health status, self-reported health-related activity limitations, activity limitations score, condition group responsible for index stay, surgery during index stay, and diagnostic procedure performed during index stay. Although employment status was significantly related to readmission, inspection of these data revealed that the reason for this association was the low readmission rate of those under 17 years of age, coupled with the high rates observed for those who were retired because of poor health or for other reasons. Because of its obvious confounding with age and health status, the independent effect of employment on readmission could not be evaluated using these data, so it was not included as a candidate variable.

Logistic regression coefficients for variables that entered the stepwise models with a p-value of .1 or less are displayed in Table 3, along with the ratios between their coefficients and standard errors. For the sake of clarity, only results from the primary regression analyses are reported. The results of the analyses in which NMCUES person weights were used did not differ from those reported in Table 3. For all types of readmission studied, the best predictors of increased readmission risk were very-high-risk or high-risk condition group for the index stay, poor or fair health status, and surgery during the index stay on a subject with health-related activity limitations (Table 3). In the absence of health-related activity limitations, surgery during the index stay lowered readmission risk for all varieties of early readmission. In contrast to the univariate results reported in Table 2, neither access to care nor insurance coverage was significantly related to readmission risk, after adjustment for variables that entered the models.

Similarities among the any, unlinked, discretionary, and same-condition readmission models can be better appreciated by viewing a table of adjusted odds ratios for variables that entered these models (Table 4). With the exceptions of diagnostic procedures (which entered only the unlinked model) and activity limitation (which failed to enter the same-condition model), the same variables entered all models. Furthermore, odds ratios for the any, unlinked, and discretionary readmission models were similar. Although the same-condition readmission model has the same relative ranking of odds ratios as the other models have, the striking findings for this model are the markedly higher odds ratios for the very-high-risk condition group (odds ratio = 10.6) and for poor health status (odds ratio = 4.7) relative to the other models. Diagnosis and health status are therefore the predominant factors influencing same-condition readmission risk. The relatively large odds ratios for fair or poor health status in all four models confirm that health status is strongly associated with readmission risk, even after adjustment for condition responsible for the stay and performance of surgery during the stay.

The results of our examination for possible classification bias are displayed in Table 5. Exclusion of the 364 subjects whose only admission or discharge occurred during the first or last 31 days of the study period and whose readmission status was therefore unknown does not appreciably change the results of the analysis. The same variables enter each model in the same order as they did in the primary analysis. The mean discrepancies observed between the values of the odds ratios for a given variable in models including and excluding these subjects ranged from 2.8 percent (any readmission model) to 4.8 percent (discretionary readmission model). The greatest observed discrepancies between odds ratios for models including and excluding these subjects ranged from 5.8 percent (any readmission model) to 8.1 percent (same-condition readmission model). Such small discrepancies are of no practical importance. Excluding the seven subjects whose readmissions might have been transfers (i.e., those whose readmission occurred within 1 day of discharge) exerted an even smaller effect on observed odds ratios than did exclusion of the subjects with uncertain readmission status. Therefore, the reported results are robust to variations in the analytic treatment of subjects who may have been misclassified as not readmitted and to differences in the treatment of possible interhospital transfers.

Several considerations enhance the confidence that can be placed in the reported models. First, the goodness-of-fit statistics shown in Table 3 are associated with insignificant p-values, implying that the models fit the data reasonably well. Second, because of the size of the reported p-values, it is unlikely that any of the entered variables represent false positive results, which could occur as a consequence of multiple comparisons when several models are built from the same data. Virtually all variables that entered at the $p < .1$ level of significance have a ratio between the value of their coefficient and standard error of 2.58 or more for at least one level of the variable or one of its interactions. Therefore, using a Student's t-test with infinite degrees of freedom, these variables are significant at the $p = .01$ level, and correcting for multiple comparisons by applying a more stringent Type I error rate does not alter the results.

Finally, the findings that marital status, insurance coverage, and access to care do not independently influence readmission risk are unlikely to represent

Table 3

Regression coefficients for hospital readmission within 31 days of discharge and ratio of coefficient to standard error, by type of readmission and selected variables: United States, 1980

	Type of readmission							
	Any		Unlinked		Same condition		Discretionary	
Variable	Coefficient	Ratio of coefficient to standard error	Coefficient	Ratio of coefficient to standard error	Coefficient	Ratio of coefficient to standard error	Coefficient	Ratio of coefficient to standard error
Index stay:								
Condition risk group								
Low[1]	—	—	—	—	—	—	—	—
Moderate	.635	3.35	.607	2.58	.874	3.42	.768	2.86
High	1.024	3.61	.809	2.27	1.461	4.26	.958	2.44
Very high	11.941	7.69	1.885	6.44	2.356	7.55	1.959	5.93
Surgery performed	−1.155	−4.95	−.996	−3.29	−1.197	−4.04	−1.433	−3.66
Diagnostic procedure performed	—	—	−.599	−2.83	—	—	—	—
Self-reported health status:								
Excellent[1]	—	—	—	—	—	—	—	—
Good	.385	1.81	.402	1.40	.448	1.57	.273	.84
Fair	.549	2.20	.723	2.30	.945	3.04	.770	2.22
Poor	.959	3.51	1.036	3.10	1.552	4.65	1.031	2.81
Self-reported limitation of usual activity	[2]−.007	[2]−.030	.430	1.65	—	—	.527	1.90
Interaction: Activity limitation and surgery	1.312	3.59	1.257	3.00	—	—	1.437	2.85
Constant	−2.829	−12.26	−3.382	−11.25	−3.684	−11.79	−3.702	−10.99
Goodness of fit:								
Chi-square[3]	p = .19		p = .45		p = .19		p = .88	
Hosmer[4]	p = .26		p = .49		p = .25		p = .32	

[1]Reference level for variable.

[2]Despite its statistically insignificant coefficient, limitation of activity entered this model because of the significance of its interaction with surgery.

[3]Computed as follows: ((2 x observed) x ln (observed/expected)) for each cell in the model.

[4]Comparison of observed and expected frequencies of 10 cells, each of which is defined by its expected values based on the model.

NOTE: This ratio is the regression coefficient divided by its standard error. This value can be referred to a Student's t-distribution to estimate the statistical significance of the coefficient. For the sample size of this study, values of this statistic in excess of 2.58 are associated with a 2-tailed p-value of $<.01$; values in excess of 1.96, with $p < .05$; and values in excess of 1.65, with $p < .1$.

SOURCE: (National Center for Health Statistics, 1983); data development by the University of Michigan School of Public Health Department of Health Services Management and Policy and Department of Biostatistics.

Table 4

Adjusted odds ratios for hospital readmission within 31 days of discharge, by type of readmission and selected variables: United States, 1980

Variable	Type of readmission			
	Any	Unlinked	Same condition	Discretionary
	Odds ratio			
Index stay:				
Condition group				
Low	[1]1.0	[1]1.0	[1]1.0	[1]1.0
Moderate	1.9	1.8	2.4	2.1
High	2.8	2.2	4.3	2.6
Very high	7.0	6.6	10.6	7.0
Surgery performed	.3	.4	.3	.2
Diagnostic procedure performed	—	.5	—	—
Self-reported health status:				
Excellent	[1]1.0	[1]1.0	[1]1.0	[1]1.0
Good	1.5	1.5	1.6	1.3
Fair	1.7	2.1	2.6	2.1
Poor	2.6	2.8	4.7	2.8
Self-reported limitation of usual activity	[2]1.0	1.5	—	1.7
Interaction: Activity limitation and surgery	3.7	3.5	—	4.6

[1]Reference level for variable.

[2]Despite its statistically insignificant coefficient, limitation of activity entered this model because of the significance of its interaction with surgery.

SOURCE: (National Center for Health Statistics, 1983); data development by the University of Michigan School of Public Health Department of Health Services Management and Policy and Department of Biostatistics.

false negative results. The study possessed reasonable power (> .9) to detect odds ratios of 2.0 or more (Table 2), making false negative results unlikely. Adequate statistical power is of major importance when negative results are presented (Freiman et al., 1978). Although collinearity among candidate predictors could theoretically have resulted in the exclusion of some variables from the model, our examination for collinearity suggests that this is unlikely. As would be expected, increased age was moderately correlated with unmarried status, limitations of activity, and poorer self-reported health status (R^2 = .41-.48). Likewise, activity limitations and poorer self-reported health status were moderately correlated, with an R^2 of .49. However, the correlation coefficients between other candidate variables were consistently less than .3, implying that the failure of nonmedical factors to enter the models is not attributable to collinearity with other variables.

Table 5

Discrepancies between odds ratios for 2 models of hospital readmission within 31 days of discharge, by type of readmission: United States, 1980

Type of readmission	Mean odds ratio discrepancy[1]	Maximum odds ratio discrepancy[2]
	Percent	
Any	2.8	5.8
Unlinked	4.7	6.9
Same condition	4.0	8.1
Discretionary	4.8	7.5

[1]Absolute value in percentage terms of the mean differences between the coefficients of the 2 models.

[2]Maximum observed difference between the coefficients of the 2 models.

NOTE: Odds ratios are compared for 2 models: that including all 2,173 subjects with at least 1 reported hospital stay in 1980 and that excluding the 364 subjects whose only admission or discharge occurred during the first or last 31 days of 1980.

SOURCE: (National Center for Health Statistics, 1983); data development by the University of Michigan School of Public Health Department of Health Services Management and Policy and Department of Biostatistics.

Discussion

Consistent with prior research (Anderson and Steinberg, 1985; Fethke, Smith, and Johnson, 1986; Gooding and Jette, 1985; Holloway, Thomas, and Shapiro, 1988; Holloway, Medenorp, and Bromberg, to be published; Phillips et al., 1987; Riley and Lubitz, 1986; Smith, Norton, and McDonald, 1985; Victor and Vetter, 1985; Zook, Savickis, and Moore, 1980), our results affirm the dominant importance of medical factors (condition causing the index stay, surgery) and health status for predicting readmission risk. More importantly from the perspective of using risk-adjusted readmission rates as a measure of one dimension of quality, these results affirm the relative unimportance of nonmedical factors (marital status, access to care, and insurance coverage). The inability to predict readmission risk through nonmedical factors had previously been reported for the Medicare population (Holloway, Thomas, and Shapiro, 1988) and for Armed Forces veterans (Holloway, Medenorp, and Bromberg, to be published); our findings suggest that the earlier results are generalizable to the national population. Therefore, hospitals that serve socially disadvantaged populations will not be unfairly treated by a quality measure based on readmission rates if accurate adjustments are made for medical risk factors, activity limitations, and health status.

Our finding that readmission risk is unrelated to access to or type of ambulatory care customarily used should not be overinterpreted. Specifically, it would be inappropriate to conclude from these data that usual source of care exerts no influence on use of hospital-based care. In fact, our findings may simply reflect the fact that all subjects who were hospitalized at least once possessed some minimum level of access to medical care. Given this minimum level of access, access to and type of outpatient care used, as measured in NMCUES, do not independently influence readmission risk.

The results of this study may prove useful to physicians and hospitals attempting to reduce readmission rates. As with a previous study of Medicare beneficiaries (Holloway, Thomas, and Shapiro, 1988), the results reported here suggest that the relationship between surgery and readmission risk is not straightforward. When performed for nonchronic conditions, surgery during the index stay diminishes readmission risk; when performed on those with chronic diseases (Holloway, Thomas, and Shapiro, 1988) or those whose activities are limited by poor health (as confirmed by this study), surgery is associated with a higher readmission risk. Hospitals may wish to focus preventive efforts on patients with chronic diseases or health-related activity limitations who undergo surgery.

The potential limitations of this study should be considered. First, the data are based on interviews with subjects, some of whom may have been interviewed in close proximity to a recent hospitalization and all of whom were required to recall at least some data. Although this may have produced inaccuracies in some responses, one would not expect such inaccuracies to be distributed in a biased fashion between readmitted and non-readmitted subjects for most of the variables considered. The primary exceptions are health status and limitations of activity, self-reports of which might have been influenced by recent hospitalizations. However, in a previous study, it was documented that health status for most subjects with readmissions is relatively stable over time (Lichtenstein and Thomas, 1987). In addition, the results reported here are similar to those of a previous study (Holloway, Thomas, and Shapiro, 1988).

Second, although we used the most recent NMCUES data available at the time of the study, these data are approximately 8 years old. During the intervening period, changes in payment systems have been introduced, especially for Medicare beneficiaries. However, the dominant first sources of payment for hospital stays reported in NMCUES were self or family, followed by Blue Cross-Blue Shield or commercial insurance; Medicare was the first source of payment for only 12 percent of reported hospital stays, with Medicaid covering an additional 3 percent (National Center for Health Statistics, 1983). Additionally, we did not find insurance coverage to be related to readmission risk in this study or in previous work (Holloway, Thomas, and Shapiro, 1988). For these reasons, it is unlikely that the age of the data appreciably influenced the results obtained.

The definition of nondiscretionary readmissions was complicated by two unavoidable factors. One problem is that the NMCUES data contained only two-digit procedure codes, making it difficult to ascertain whether some coded procedures were truly surgical operations or merely represented diagnostic procedures. When in doubt, we assumed that a two-digit procedure code referred to a surgical operation, making the readmission nondiscretionary.

Another problem is that we defined nondiscretionary readmissions in 1988, but the medical decisions that led to these admissions occurred in 1980, well before the recent shift toward outpatient surgery for low-risk operations. We attempted to define nondiscretionary readmissions in the context of medical practice in 1980 in order to assure congruence between our definitions and the medical opinions and practices of the period during which the study data were generated. Consequently, admissions for certain operations that are now commonly performed on an outpatient basis, such as hernia repair and cataract extraction, were classified as nondiscretionary.

For these reasons, our list of nondiscretionary readmissions probably includes more cases than it would have included if more detailed procedure codes had been available or if we had decided to define nondiscretionary readmissions in the context of medical practice in 1988. However, no more than six readmissions were for operations now commonly performed in outpatient surgical suites, and only six readmissions were classified as nondiscretionary on the basis of procedures that could have been diagnostic in nature. Therefore, altering the definition of nondiscretionary readmission to make it conform more closely to modern practice could not appreciably alter the results of this study.

Another concern is that the strategy for selecting index admissions may have been biased. As previously noted, for subjects with multiple index admissions that were followed by readmission, index hospitalizations followed by same-condition readmissions were preferentially selected. We employed this strategy because previous work suggested that nonmedical factors were unimportant predictors of readmission risk (Holloway, Thomas, and Shapiro, 1988), and we wanted to maximize our ability to disprove a null hypothesis based on this previous finding. We reasoned that a readmission that is for the same condition as was treated during the index stay or that occurs in closer proximity to it is more likely than other types of readmission to be related to quality defects or nonmedical risk factors. When evaluating this strategy for possible bias, one must recall that the analysis was person based and that we attempted to identify nonmedical characteristics that predisposed subjects to readmission. The process of selecting an index admission for subjects with multiple hospital stays did not bias the analysis sample toward persons with particular health status levels or hypothesized nonmedical risk factors, because these data came from the NMCUES person file and were identical for all admissions of a particular person. Nonetheless, for subjects with multiple pairs of index admissions and readmissions, our strategy could have resulted in the selection of a different set of medical conditions treated during the index stay than would have been selected had index admissions been selected randomly for such subjects. The coefficients of the any, unlinked, and discretionary readmission models could therefore have been biased by the preferential inclusion of same-condition readmissions in the analysis. However, review of these cases revealed that less than 7 percent of readmitted subjects had more than one index admission followed by a readmission. Most subjects' hospitalizations were for the same condition. Thus, in practice, a random selection process for index admissions of subjects with multiple possible index admissions could have altered the index admission condition for less than 6 percent of readmitted subjects. For these reasons, the person-based analysis for any, unlinked, and discretionary readmissions could not have been seriously biased by the preferential selection of same-condition readmissions.

Conclusion

Empirical research must ultimately be used to answer the question of which types of readmission, if any, are useful quality monitors. Quality defects must be defined carefully to provide a plausible causal link to readmission. The dimension of quality most closely related to readmission is probably premature discharge, although other quality defects can also conceivably cause readmissions. Future research is necessary to define the sensitivity, specificity, and predictive value of various readmission-based measures of quality of care. Physician review of index admission medical records for evidence of premature discharge or other quality defects could be employed as the gold standard for ascertaining the sensitivity and predictive value of readmission rates as a quality monitor. Data from State peer review organizations may be useful in this regard.

As in a previous study of the Medicare population (Holloway, Thomas, and Shapiro, 1988), in this analysis, health status was proven to be independently related to readmission risk, even after adjustment for diagnosis and surgery. In addition, health-related limitations of activity were also predictive of any, unlinked, and discretionary readmissions. Failure to explicitly include information on health status and activity limitations in readmission risk models or failure to identify appropriate proxies for them may result in the incomplete specification of such models. Obviously, incomplete specification could result in inequities if risk-adjusted readmission rates were used to compare the quality of care provided by different hospitals. Perceived health status and activity limitations are not included in secondary data sources, such as insurance claims data bases. Although modifications of claims data to incorporate adjustments for severity of illness are potentially attractive substitutes, there are no assurances that such severity measures will be sufficient. Further research is needed to clarify the extent to which modifications of information contained in claims data, including severity-of-illness measures, can adequately substitute for perceived health status and activity limitations in readmission risk models.

Acknowledgment

The authors are grateful to Kenneth Guire, of the University of Michigan School of Public Health Department of Biostatistics, for performing the data management and statistical analyses for this project.

Technical note

We attempted to define discretionary and nondiscretionary readmissions in the context of medical practice in 1980 to assure congruence between our definitions and the medical opinions and practices of the period during which these data were generated. Consequently, admissions for certain operations that are now commonly performed on an outpatient basis, such as hernia repair and cataract extraction, were classified as nondiscretionary. The conditions comprising the discretionary and nondiscretionary groups are as follows:

Discretionary readmissions

Congestive heart failure
Chronic obstructive pulmonary disease
Cerebrovascular disease, unspecified
Cardiomegaly
Bladder cancer without surgery
Rheumatic heart disease without surgery
Hyperthyroidism
Urinary tract infection
Contusion of lower limb
Gastric ulcer without perforation, bleeding, or surgery
Essential hypertension
Lower limb ulcer without surgery
Alcohol dependence
Vertebral fracture or injury, unspecified
Ischemic heart disease, unspecified
Heart disease, unspecified
Pseudocyst of pancreas without surgery
Noninfectious gastroenteritis
Unspecified neurotic disorder
Intra-abdominal malignancy without surgery
Malignancy of skin with operation on nose
Disseminated malignancy, site unspecified, without surgery
Angina pectoris
Second admission for fracture of pelvis, no surgery (surgery for same fracture performed during previous stay)
Drug withdrawal syndrome
Blood disorder without surgery
Stomach or intestinal disorder, unspecified
Unspecified effect of high altitude

Brain malignancy, unspecified, without surgery
Pernicious anemia
Cancer of pancreas without surgery
Muscle or ligament disorder, unspecified
Second admission for concussion, no surgery (also treated during previous stay)
Ankle sprain
Diverticulosis of colon without surgery
Emphysema
Second admission for fracture of facial bones, no surgery (surgery for same fracture performed during previous stay)
Adverse drug reaction
Cataract without surgery
Lung cancer without surgery
Prostate cancer without surgery
Menometrorrhagia without surgery
Unspecified arthropod-borne disease
Aortic aneurysm without rupture or surgery
Ill-defined condition causing morbidity or mortality
Asthma
Kidney stone without surgery
Malignancy of larynx and neck lymph nodes without surgery
Fracture of ribs or sternum without surgery
Cancer of stomach without surgery
Neurotic depression and anorexia nervosa
Unspecified neoplasm of digestive system, no surgery (cancer not specified)
Allergic urticaria, rhinitis, or dysphagia
Staphylococcal infection, without bacteremia
Chronic cystitis
Open wound, unspecified
Endometriosis
Benign neoplasm of skin without surgery
Unspecified disorder of vulva and perineum without surgery
Malignancy of vertebral column without surgery
Anemia, unspecified
Degenerated cervical disc, no surgery
Acute gastritis without bleeding or surgery
Poisoning by unspecified drug or medicine
Skin symptoms
Esophagitis with unspecified hemorrhage of gastrointestinal tract without surgery or blood transfusion
Leukemia
Second admission for abortion (initial abortion performed during previous stay); no procedure coded for second admission
Migraine headaches
Multiple sclerosis
Displacement of lumbar intervertebral disc without spinal cord injury or surgery
Neonatal jaundice
Influenza without pneumonia
Malignancy of rectum without hemorrhage or surgery
Gastrointestinal complications of previous stomach surgery without additional surgery
Dizziness
Pulmonary congestion (not acute pulmonary edema)
Cystic kidney disease without surgery
Hypoglycemia
Viral hepatitis
Volume depletion
Chronic bronchitis
Late effect of contusion
Cancer of kidney without surgery
Secondary malignancy of brain or spinal cord without surgery
Unspecified viral meningitis
Depression

Nondiscretionary

Sciatic nerve problem with surgery
Pulmonary embolism
Cancer of rectum with surgery
Hemorrhage following joint repair
Complications of internal device with prostate surgery
Ectopic pregnancy with surgery
Open head or facial wound with surgery
Urinary tract infection with surgery
Thyroid cancer with surgery
Pleural effusion with surgery
Hemorrhage from placenta previa (delivery during previous stay)
Bladder cancer with surgery
Contusion of face with operation on cornea
Lung cancer with surgery
Acute pancreatitis
Diverticulosis of colon with surgery
Open hand wound with surgery
Intestinal obstruction and urinary complication with surgery for both
Pregnancy with disorder of perineum, with operation on uterus and fallopian tube
Open angle glaucoma with surgery
Fracture of vertebral column with spinal cord injury
Hemorrhoids with surgery on anus and vagina
Benign neoplasm of colon with surgery
Hernia and hemorrhoids with surgery for both
Rupture of blood vessel with hemorrhage
Hernia with surgery
Conduction disorder of heart with surgery
Malignancy of uterus with surgery on uterus
Genital tract infection with surgery
Asphyxia, newborn infant
Kidney infection with surgery
Thrombophlebitis with surgery
Intracerebral hemorrhage
Cardiac arrhythmia
Aortic aneurysm with surgery
Hip fracture with surgery
Respiratory distress after birth
Disorder of lacrimal system with surgery
Cerebrovascular disease with surgery on vessels
Influenza with pneumonia, newborn
Undiagnosed morbidity in preterm infant
Atresia of small intestine with surgery
Asthma with operation on stomach
Fracture of bone with surgical repair of joint
Pelvic inflammatory disease with surgery on uterus
Pregnancy with surgery on fallopian tubes and procedure assisting delivery

Pregnancy with delivery, with or without cesarean section
Prostatic hypertrophy with surgery
Arterial embolism or thrombosis
Disorder of genitals with surgery on uterus
Cataract removal
Bleeding esophageal varices
Ovarian cyst with surgery
Unspecified neoplasm with surgery on intestine
Thrombophlebitis of lower extremity, postoperative
Chronic renal failure with surgery on urinary tract
Unspecified skin infection with surgery on blood vessels
Syncope and collapse
Complication of pregnancy and delivery with surgery on urinary bladder
Malignant neoplasm of ill-defined site with surgery
Postoperative infection following joint surgery with additional surgery
Surgery on fallopian tubes following pregnancy and delivery during previous stay
Disorder of stomach or duodenum with surgery
Rheumatoid arthritis with joint surgery
Sprain of knee with surgery on joint
Pain in limb with limb surgery
Postoperative infection with surgery on penis
Spontaneous abortion complicated by hemorrhage
Late effect of fracture of skull or facial bones with surgery on face and bone marrow or spleen
Inflammatory disease of uterus with surgery
Proctocolitis with rectal or intestinal surgery
Carpal tunnel syndrome with surgery

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