Utilization of Short-Stay Hospitals By Persons With Heart Disease And Malignant Neoplasms:

National Hospital Discharge Survey

United States, 1977

Based on data obtained from a national sample of the hospital records of inpatients discharged from non-Federal short-stay hospitals, hospital utilization by heart disease and malignant neoplasm patients is examined. The measures of hospital utilization employed are frequencies, rates, percents, and average lengths of stay. Data are provided for these two specific diagnostic categories and for all other patients and are tabulated by patient age, sex, and surgical status.

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COOPERATION OF THE U.S. BUREAU OF THE CENSUS

Under the legislation establishing the National Health Survey, the Public Health Service is authorized to use, insofar as possible, the services or facilities of other Federal, State, or private agencies.

In accordance with specifications established by the National Center for Health Statistics, the Bureau of the Census, under a contractual arrangement, participated in planning the survey and collecting the data.

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Utilization of Short-Stay Hospitals by Persons With Heart Disease and Malignant Neoplasms: National Hospital Discharge Survey

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INTRODUCTION

This report presents 1977 national estimates of the utilization of non-Federal short-stay hospitals by patients with a first-listed diagnosis of heart disease or a malignant neoplasm. Statistics on these two types of discharge are selected for inspection and comparison with statistics on all other discharges because of the substantive importance of these conditions as the two leading causes of death in the United States.[1]

Estimates of the discharge frequency, rate per 1,000 noninstitutionalized population, and average length of stay per discharge are presented in tables 1-3 for the different diagnostic categories. These statistics are further categorized by the surgical status of the patient, controlling for age and sex. The main aspects of these tabulations are summarized in the discussion sections that follow. All statistical statements referring to age-related trends have been tested by using linear regression, that is, the weighted least squares method. All other statistical statements refer to differences between pairs of statistical estimates, such as rates or regression slopes, and were tested by using the Bonferroni method for multiple comparisons. Unless stated, the differences that are discussed are statistically significant at the $p < .05$ level. Similarly, any statement indicating no difference between estimates refers to the lack of a statistically significant difference (i.e., $p > .05$). Because only the main aspects of the data are investigated, not all significant differences between statistics are included in the discussion. A more detailed explication of the specific hypothesis-testing procedures used can be found in appendix I.

The estimates presented are based on data collected by means of the National Hospital Discharge Survey, which has been conducted annually by the National Center for Health Statistics since 1965. Data for the survey are abstracted from the face sheets of the medical records for patients sampled from among all patients discharged from specific hospitals. The set of hospitals selected for the survey constitutes a sample of the non-Federal general and specialty short-stay hospitals in the 50 States and the District of Columbia. Maxima of five diagnoses and three surgical procedures are recorded for each medical record in the patient sample.

The medical data for 1977 examined in this report are coded according to the *Eighth Revision International Classification of Diseases, Adapted for Use in the United States* (ICDA-8),[2] with modifications. For this report, all discharges with first-listed diagnoses of ICDA-8 codes 390-398, 400.1, 402, 404, 410-414, and 420-429 were selected to form the group of heart disease discharges. With the exception of the inclusion of code 400.1, these codes conform to those used by the Division of Vital Statistics of the National Center for Health Statistics for publishing data on deaths with an underlying cause of diseases of the heart. Code 400.1 specifies malignant hypertension with heart involvement classifiable to codes 427.1-429 (i.e., symptomatic heart disease excluding congestive heart failure, other myocardial insufficiency, or ill-defined heart disease). Because fewer than one thousand hospital discharges in 1977 are accounted for by this code, its inclusion here does not notably affect the results of the analysis. The group of heart disease patients, however, excludes all discharges with first-listed diagnoses of other circulatory diseases.

Similarly, the discharges with first-listed diagnoses of ICDA-8 codes 140-209, which include all diagnoses of neoplasms specifically identified as malignant, comprise the group of malignant neoplasm patients. This group excludes all discharges with first-listed diagnoses of benign neoplasms or neoplasms of an unspecified nature. These codes also were selected so that the information presented here would be compatible with the mortality statistics published by the National Center for Health Statistics (NCHS). A more detailed listing of the diagnoses included in each set of codes can be found in appendix II.

Familiarity with the technical aspects of the survey, including the precise definitions of terms, is essential for accurate interpretation of the data and for valid comparisons of the National Hospital Discharge Survey (NHDS) statistics to statistics from other data sources. Appendix I contains a facsimile of the abstract form used for data collection as well as summaries of the survey design, data collection procedures, estimation procedure, sampling error estimates, and hypothesis testing procedures. Definitions of the terms used in this report are presented in appendix II. More extensive coverage of these topics and a detailed presentation of the NHDS modifications of the ICDA-8 can be found in appendixes I and II of "Utilization of Short-Stay Hospitals: Annual Summary for the United States, 1977."[3] A separate report on the design of the NHDS also has been published.[4]

HIGHLIGHTS

Of 35.9 million discharges, approximately 2.8 million had a first-listed diagnosis of heart disease and approximately 1.7 million had a first-listed diagnosis of a malignant neoplasm; these figures represent 7.9 and 4.8 percent of all discharges, respectively. A total of 262.4 million days of care were used in 1977.[a] Of this total, discharges with a first-listed diagnosis of heart disease accounted for 28.3 million days, or 10.8 percent, and discharges with a first-listed diagnosis of a malignant neoplasm accounted for 21.0 million days, or 8.0 percent. The disproportionate share of hospital days used by these two types of discharge is readily apparent by comparing the differing average lengths of stay. The discharges with a first-listed diagnosis of heart disease had an average length of stay of 9.9 days, and those with a malignant neoplasm had an even longer average stay of 12.2 days. Both averages exceeded the average length of stay of 6.8 days for all other discharges.

CHARACTERISTICS OF DISCHARGES WITH HEART DISEASE OR A MALIGNANT NEOPLASM

Inspection of the frequency and rate statistics for all discharges, regardless of diagnosis, reveals a number of trends. Table 1 shows that, of the total of 35.9 million discharges, the majority (20.9 million) did not have surgery. Surgery was performed on 40.4 percent of all male discharges and 42.8 percent of all female discharges, proportions that are not significantly different. Moreover, the number of female discharges exceeded that of male discharges (21.5 million compared with 14.4 million). Omission of the 3.3 million female patients who gave birth during their hospitalizations reduces this difference, but it remains significant. The rates for all discharges, presented in table 2, demonstrate that females, for whom the rate was 196.0 per 1,000 civilian noninstitutionalized population, were hospitalized more than males were, for whom the rate was 140.5. Omission of the women who gave birth reduces the statistic for females again, to a rate of 165.7 per 1,000 population, but the sex difference in rates remains significant. Finally, discharges 15-44 years of age (15.2 million) outnumbered those

[a]Days of care are not tabulated.

in every other age category. This difference was partly due both to the inclusion of women who gave birth and to the large proportion of the population in that age range. As the rates for all discharges show, the trend was for the likelihood of hospitalization to increase with age, with the slope of the increase greater for females than for males. The rates increased from 81.4 per 1,000 population for males under 15 years of age to 396.9 for those 65 years and over; for females, the rates increased from 65.0 to 358.6. Although these summary statistics for all discharges demonstrate some significant trends in hospitalization, they also mask substantial differences among the heart disease, malignant neoplasm, and other diagnosis groups.

Age and Sex

As shown in table 1, the total number of heart disease discharges was significantly greater than the total number of malignant neoplasm discharges for each sex separately as well as for both sexes together. Moreover, the residual category of other discharges constituted the majority of cases for each sex. The frequencies for the diagnostic categories were influenced by age and sex. A majority of the heart disease discharges were male and a majority were 65 years of age and over. In contrast, for the malignant neoplasm discharges no difference was found between the male and female discharge frequencies or between the frequencies for ages 45-64 years and 65 years and over, although each of these latter two frequencies was significantly larger than each frequency for the younger age groups. Finally, a majority of the other discharges were female, with the largest number in the 15-44-year age group.

The combined effect of age and sex on the diagnostic distribution is shown in figure 1. For each sex, both the proportion of patients with a first-listed diagnosis of heart disease and with a first-listed diagnosis of a malignant neoplasm increased with age. Although the trends for these four sex by diagnosis groups were alike in direction, they differed in slope. The proportion of males with heart disease increased with age faster than the proportions for the other three groups did, and the proportion of female heart disease patients increased the most slowly. The slopes for the male and female malignant neoplasm patients were at an intermediate level and did not differ significantly from each other. Consequently, the proportion of patients with any other first-listed diagnosis decreased with age, and the rate of decrease was greater for males than for females. Together, these trends clearly reflect the dependence of the diagnostic case mix in non-Federal short-stay hospitals on the age and sex distributions of the patient load.

Patients with Surgery

Overall, the proportion of patients on whom surgery was performed was dependent on the first-listed diagnosis. This proportion was greatest for the malignant neoplasm discharges (54.4 percent) and least for the heart disease patients (16.9 percent), with the remaining discharges at an intermediate level (43.4 percent). As shown in figure 2, the combined influence of age and sex on the proportion of surgical patients also varied with the diagnostic category. No age-related trend in the proportion of malignant neoplasm patients with surgery was found for either sex. For males, no age change in this proportion was significant, although for the females the proportion for the 15-44-year age group (70.1 percent) was significantly larger than the proportions for the youngest and next oldest age groups. Furthermore, no sex difference in the proportions of patients with surgery was found for all malignant neoplasm patients nor for any age group except the group 15-44 years of age. For that group, the proportion for females (70.1 percent) was significantly greater than that for males (47.7 percent).

The patterns among the heart disease and other diagnosis categories were similar, but differed from the pattern for the malignant neoplasm discharges. For each sex, the trend for the proportion of surgical patients was to decrease with age for both the heart disease and other discharges. Moreover, for each of these diagnostic categories, significant sex differences were found in these proportions for only the 45-64-year age group: among the heart disease discharges, the proportion of male surgical discharges exceeded the female proportion for that age group, and among the other discharges, the female proportion exceeded that of males.

Together these findings indicate that substantial differences exist among the diagnostic

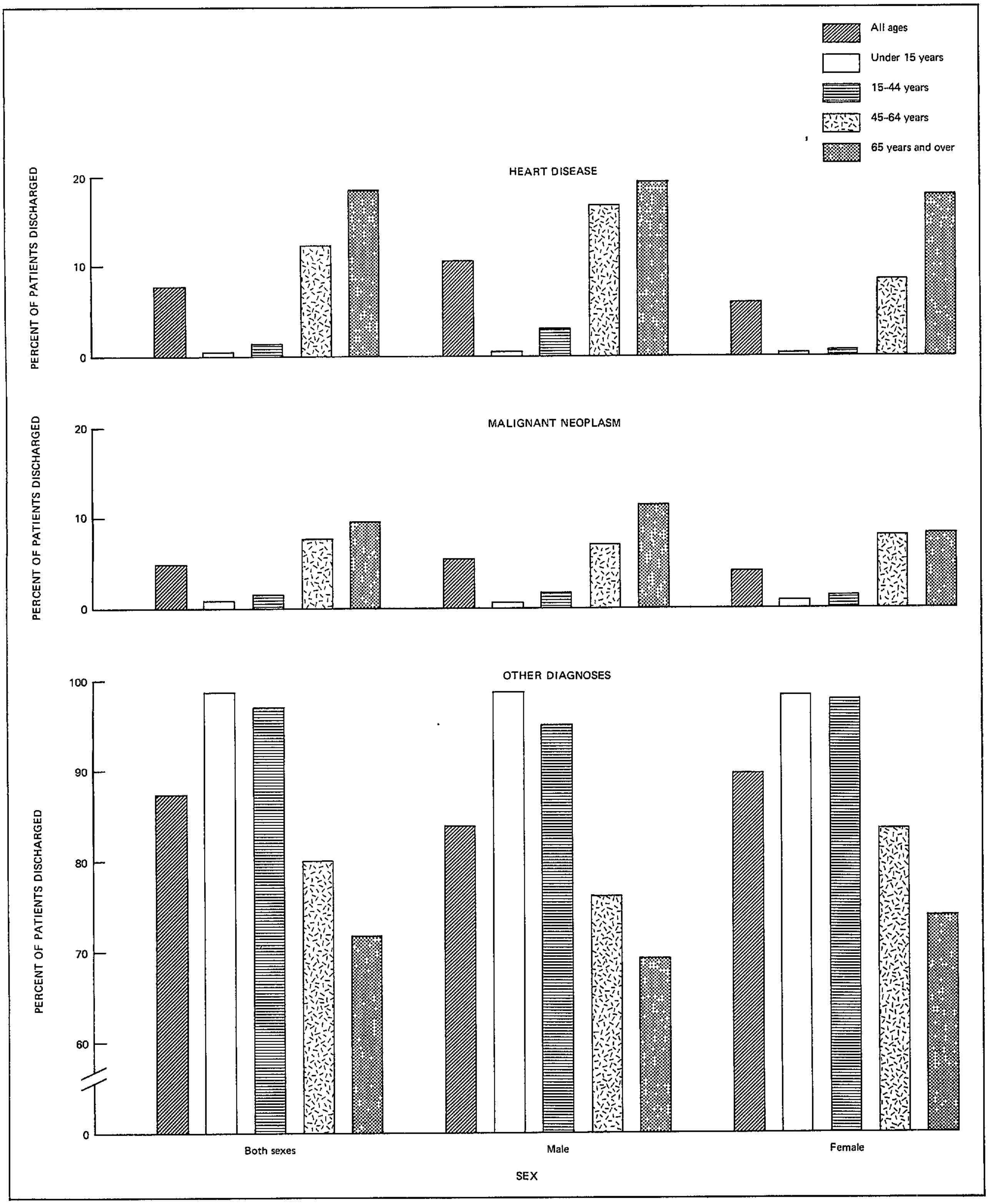

Figure 1. Percent of patients discharged from short-stay hospitals with first-listed diagnoses of heart disease, malignant neoplasm, or other diagnoses, by sex and age: United States, 1977

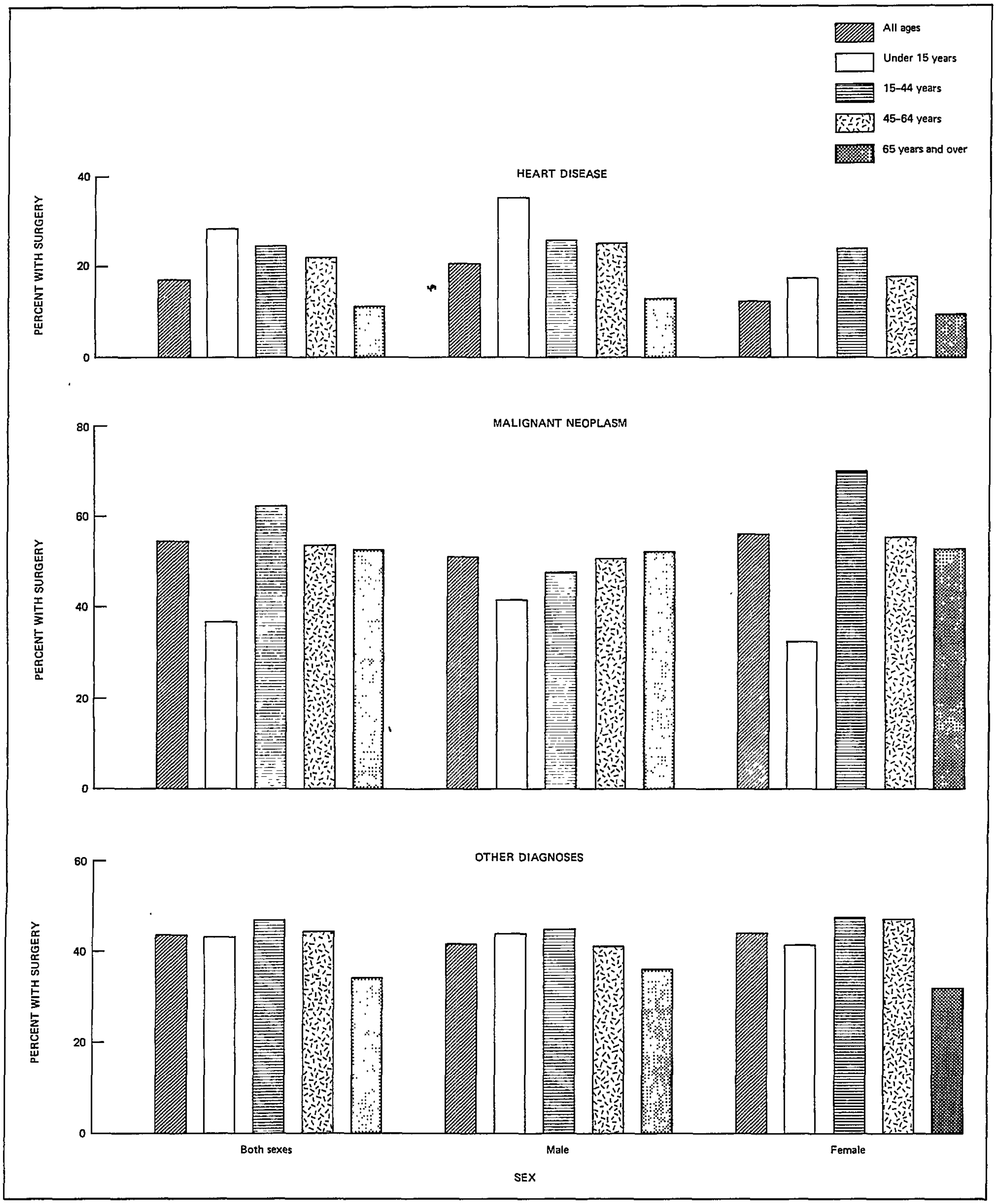

Figure 2. Percent of patients discharged from short-stay hospitals with surgery, by first-listed diagnostic category, sex, and age: United States, 1977

groups in the performance of surgical procedures. A major difference by sex was found among the patients with a first-listed diagnosis of a malignant neoplasm; whether or not surgery was performed was related to the age of the females but not of the males. Furthermore, only one female age group (15-44 years) differed from the other female age groups and it also differed from the corresponding male age group. One possible explanation for these variations is that malignancies are more likely to be detected, or are more likely to be detected at an early (i.e., operable) stage, in these females than in others because they obtain medical examinations that focus on, but are not limited to, fertility control and pregnancy. For the heart disease patients, the observed age and sex differences in the proportion of patients with surgery can be partly due to an age-related decline in the proportion of patients being treated for congenital heart defects and an associated increase in the proportion being treated for degenerative heart disease. For both the heart disease and other discharges, the underlying causes of the effects of age and sex can also include either an age-related increase in the severity or reparability of the disease being treated or an increase in the rejection of surgery as a mode of treatment because of patients' multiple medical problems or general physical condition. The relative explanatory power of these reasons for the variations in the proportions of patients with surgery, or of other reasons that were not suggested here, unfortunately cannot be assessed by using these data.

Trends in Rates

The rates for the discharge statistics demonstrate a number of differences among the diagnostic groups due to the influence of age and sex. Table 2 shows that the overall rate per 1,000 civilian noninstitutionalized population for the residual category of other diagnoses (147.6) was much greater than the rate for heart disease (13.4), which was significantly greater than the rate for malignant neoplasms (8.1). Although this order of diagnostic rates appeared separately for each sex, the absolute magnitudes of the diagnostic rates varied by sex for two of the groups. The male heart disease rate (15.0) was significantly greater than the female rate (11.9), and the female rate of other discharges (175.6) was significantly greater than the male rate (117.7). Only for the malignant neoplasm discharges were the rates for males and females not significantly different (7.8 and 8.5, respectively).

Figure 3 displays the age trends in rates for each group formed by cross-classifying sex and diagnosis. For each sex within each diagnostic group, the trend was for the rates to increase significantly with age. The steepest slope of increase was that for females with other diagnoses, followed by that for males with other diagnoses. The slopes of increase for female malignant neoplasm patients and male heart

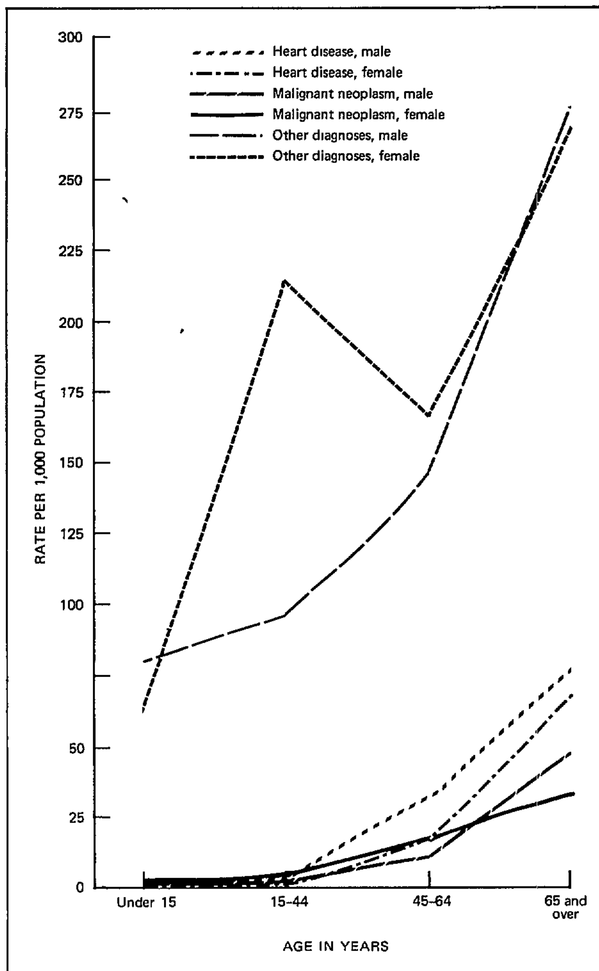

Figure 3. Rate per 1,000 civilian noninstitutionalized population of patients discharged from short-stay hospitals, by first-listed diagnostic category, sex, and age: United States, 1977

disease patients did not differ from each other, but were smaller than those for the residual category of other diagnoses. The smallest slopes were those for female heart disease and male malignant neoplasm patients (which also did not significantly differ from each other). Thus as age increased, the rate of hospitalization increased most for patients other than heart disease and malignant neoplasm patients and least for female heart disease and male malignant neoplasm patients.

In addition to this comparison of age trends in sex-specific diagnostic rates, the diagnostic rates for specific age by sex categories also were investigated. For each age by sex category, the rate of discharges in the residual group of other diagnoses was greater than both the heart disease and the malignant neoplasm discharge rates. Moreover, among males, the rate of heart disease discharges was significantly greater than the rate of malignant neoplasm discharges for each age group except the youngest, for which no difference was found. In contrast, among females, the heart disease discharge rate exceeded the malignant neoplasm rate only for the age group 65 years and over. For the two youngest age groups the reverse was true and for the age group 45-64 years no difference was found between the malignant neoplasm and heart disease discharge rates. This uniform predominance of heart disease over malignant neoplasm diagnoses for all males except the youngest, with the females experiencing a reversal in predominance from malignant neoplasm to heart disease diagnoses as a function of age, constitutes an important sex difference.

Average Length of Stay

As noted in the introduction, patients in the two diagnostic categories selected for inspection differed from all other patients in their average lengths of stay: the average length of stay for the malignant neoplasm discharges was significantly greater than the average length of stay for the heart disease patients (12.2 days compared with 9.9 days), and both stays were significantly greater than the average length of stay for all other patients (6.8 days).

Table 3 shows, however, that the diagnostic groups also differed in the effects of age, sex, and surgical status on the average length of stay. Among the heart disease patients and the residual category of other patients, the average lengths of stay were highest for the groups 65 years of age and over (10.9 days for the heart disease discharges and 10.8 days for other discharges). In contrast, among the malignant neoplasm discharges, the average lengths of stay for the two oldest groups (12.0 days for patients 45-64 years of age and 13.6 days for patients 65 years of age and over) did not differ from each other but were the highest of the age-specific average lengths of stay.

On the surface, the gross sex differences in the average lengths of stay for the diagnostic categories are equally striking. For the heart disease patients, the average length of stay for females was significantly greater than that for males (10.5 days compared with 9.5 days), but for the patients in the residual category of other diagnoses, the reverse was true; the average length of stay for males (7.3 days) was significantly greater than that for females (6.5 days). Only for the malignant neoplasm diagnostic groups were the average lengths of stay equal for males (12.3 days) and females (12.1 days). Closer inspection reveals, however, that these differences are explained by the differing age distributions of the males and females in each diagnostic category. With only one exception, no sex difference was found in the average length of stay for any age group within any diagnostic category. The sole exception was patients 15-44 years of age in the category of other diagnoses. For that group, the average length of stay of females (4.8 days) was significantly lower than that of males (6.2 days). Although exclusion of the 3.3 million women in this age group who gave birth and generally required relatively short hospitalizations increased the average length of stay for the remaining females to 5.3 days, the difference remained significant.

The combined effects of sex and age on the average length of stay of each diagnostic group are displayed in figure 4. For each sex by diagnosis group, the trend was that the average length of stay significantly increased with age. However, few significant differences were found among the slopes of these trends, indicating that this effect of age varied little among the groups.

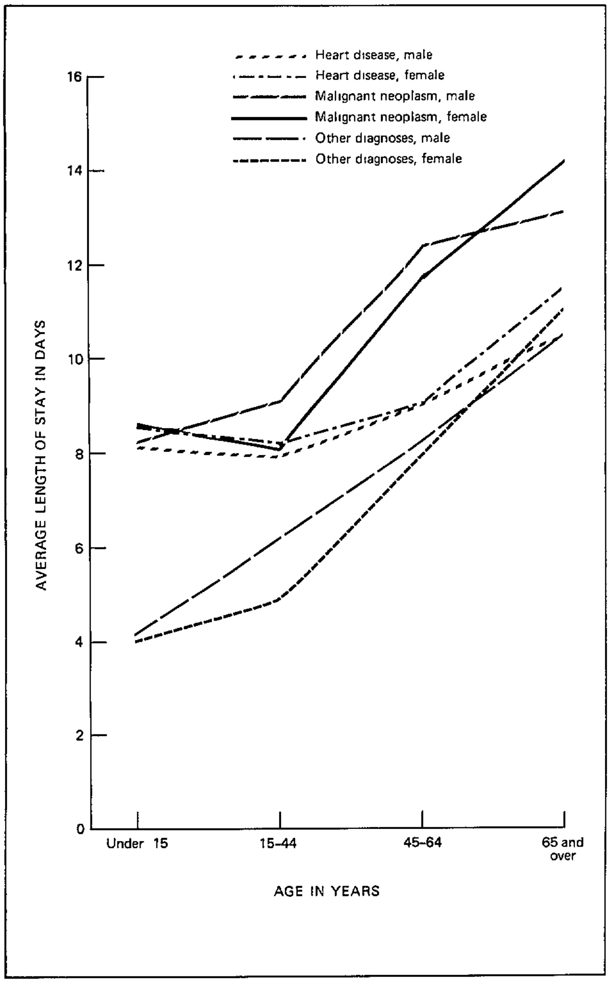

Figure 4. Average length of stay for patients discharged from short-stay hospitals, by first-listed diagnostic category, sex, and age: United States, 1977

The rate of increase with age of the average length of stay was greater for females with other diagnoses than for males and females with heart disease; the rate of increase also was smaller for males with heart disease than for females with malignant neoplasms and males with other diagnoses. For each diagnosis, no sex difference was found in the effect of age on the average length of stay. For these diagnostic groups, age clearly had a stronger and more consistent effect on the average length of stay than sex had.

In addition, table 3 shows that the average length of stay was greater for those with surgery than for those without surgery for both the heart disease patients (11.6 days compared with 9.6 days) and the malignant neoplasm patients (13.6 days compared with 10.4 days). Surprisingly, the average stays of the surgical and nonsurgical patients with other diagnoses (7.0 days and 6.7 days, respectively) did not differ significantly.

The age trends in the average length of stay for the diagnostic groups according to surgical status are displayed in figures 5 and 6; figure 5 shows these trends only for males and figure 6 shows them only for females. With one exception, the trend for the average length of stay to increase with age for each sex by diagnosis group remained significant when those groups were

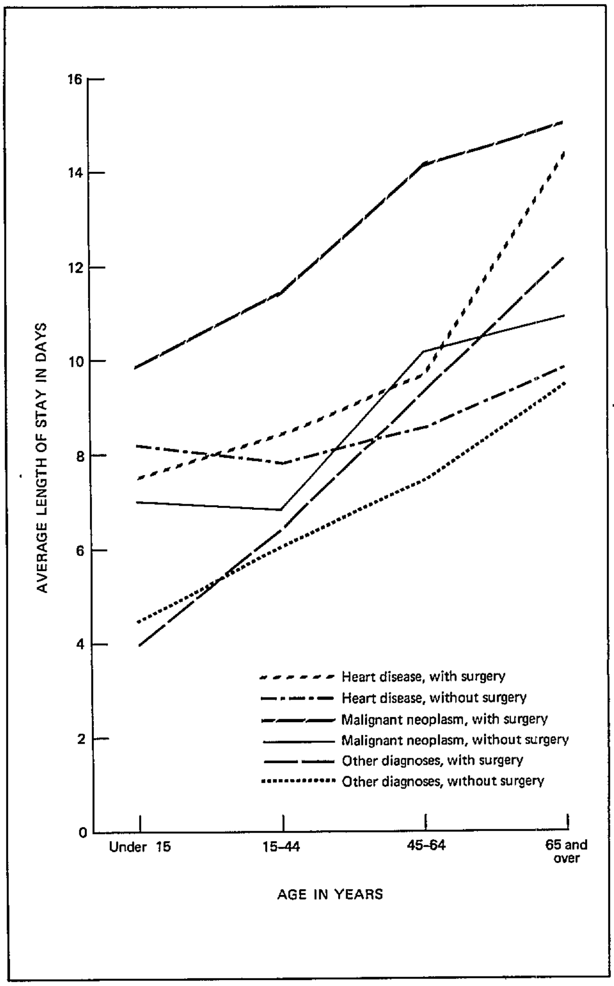

Figure 5. Average length of stay for male patients discharged from short-stay hospitals, by first-listed diagnostic category, surgical status, and age: United States, 1977

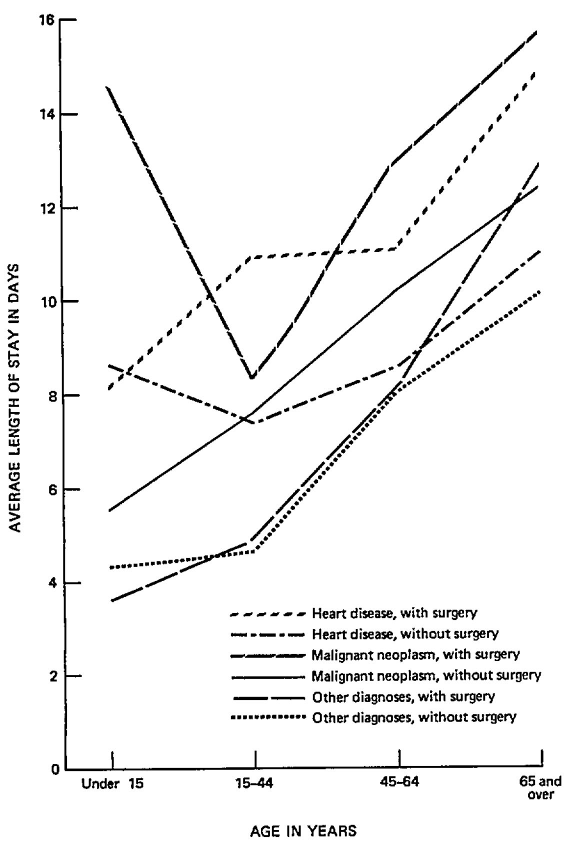

Figure 6. Average length of stay for female patients discharged from short-stay hospitals, by first-listed diagnostic category, surgical status, and age: United States, 1977

further divided according to surgical status. The sole exception is the group of male heart disease discharges without surgery, for whom the age trend was not significant. Comparisons among the slopes of these trends for each sex reveal a pattern, but it is not a clear and consistent one. For the males, all of the significant differences among the increase slopes revolved around the surgical patients in the residual category of other diagnoses. The slope of the age-related increase in the average length of stay of this group of patients was significantly greater than the corresponding slopes for all three diagnostic groups of males without surgery. For the females a similar, although not identical, view emerges. For them also, the slope of the age-related increase in the average length of stay was greater for the surgical patients with other diagnoses than for the nonsurgical patients with heart disease or other diagnoses, but it did not differ from the slope for the malignant neoplasm patients without surgery. In addition, the increase slope for the malignant neoplasm patients with surgery was significantly greater than that for the heart disease patients without surgery. Despite these variations, the statistical significance of all but one of the age trends in the average length of stay displayed in figures 4-6 clearly indicates that the influence of age on the average length of stay was consistent, pervasive, and remained stable when simultaneously controlling for diagnosis (as categorized in this analysis), sex, and surgical status.

SUMMARY

This summary of 1977 NHDS data on hospital discharges has concentrated on describing and comparing three diagnostic groups of patients: those with a first-listed diagnosis of heart disease, those with a first-listed diagnosis of a malignant neoplasm, and all other patients. A number of similarities and differences among these groups appeared. The most notable are

- Of a total of 35.9 million discharges, those with a first-listed diagnosis of heart disease (approximately 2.8 million) exceeded those with a first-listed malignant neoplasm diagnosis (approximately 1.7 million), but patients with all other diagnoses constituted the majority.
- The proportions of male and female patients with a first-listed diagnosis of heart disease and male and female patients with a first-listed diagnosis of malignant neoplasm increased significantly with age. The rate of increase with age was greatest for the male heart disease patients and least for the female heart disease patients. As a result of these increases, the proportion of all patients who had any other first-listed diagnosis decreased with age,

and that decrease was greater for males than for females.

- The performance of surgery was related to the first-listed diagnosis. Surgery was performed most frequently on malignant neoplasm patients (54.4 percent) and more frequently on patients in the residual category of other diagnoses (43.4 percent) than on heart disease patients (16.9 percent).
- For each sex of both heart disease patients and patients in the residual category of other diagnoses, the trend was for the proportion of patients with surgery to decrease with age. No trend was found for the proportion of patients with surgery to change with age for either male or female malignant neoplasm discharges.
- The rate per 1,000 civilian noninstitutionalized population of male heart disease patients exceeded that of female heart disease patients and the rate of female patients in the residual category of other diagnoses exceeded that of males. For malignant neoplasm discharges, no difference was found between the male and female rates.
- For each sex in each diagnostic category, the trend was for the discharge rate to increase with age. The age-related increases in slope from largest to smallest were: (1) females in the residual category of other diagnoses, (2) males with other diagnoses, (3) female malignant neoplasm patients and male heart disease patients, and (4) female heart disease patients and male malignant neoplasm patients.
- The heart disease and malignant neoplasm patients used disproportionate shares of all hospital care days, leading to average lengths of stay (9.9 and 12.2 days, respectively) that were significantly greater than the average length of stay of all other patients (6.8 days).
- The trend was for the average length of stay to increase with age. This trend remained statistically significant for all but one of the groups formed by cross-tabulating diagnostic category, sex, and surgical status. The sole exception was for the group of male patients who had a first-listed diagnosis of heart disease and who did not have surgery performed.

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LIST OF DETAILED TABLES

Table 1. Number of patients discharged from short-stay hospitals, by age, sex, first-listed diagnostic category, and surgical status: United States, 1977

[Excludes newborn infants and discharges from Federal and long-term hospitals]

Sex, first-listed diagnostic category, surgical status, and ICDA code	All ages	Under 15 years	15-44 years	45-64 years	65 years and over
	Number in thousands				
Both sexes					
All diagnoses	35,902	3,775	15,180	8,604	8,344
Without surgery	20,888	2,150	8,110	4,933	5,696
With surgery	15,014	1,626	7,070	3,671	2,647
Heart disease 390-398, 400.1, 402, 404, 410-414, 420-429	2,847	22	216	1,063	1,546
Without surgery	2,366	16	162	819	1,370
With surgery	481	6	55	244	177
Malignant neoplasm 140-209	1,728	33	235	658	803
Without surgery	788	20	88	302	377
With surgery	940	12	147	355	426
Other diagnoses Residual	31,327	3,721	14,728	6,884	5,995
Without surgery	17,735	2,113	7,860	3,812	3,950
With surgery	13,593	1,607	6,868	3,072	2,045
Male					
All diagnoses	14,385	2,137	4,553	4,042	3,653
Without surgery	8,576	1,194	2,530	2,443	2,408
With surgery	5,809	943	2,023	1,598	1,245
Heart disease 390-398, 400.1, 402, 404, 410-414, 420-429	1,540	13	141	681	705
Without surgery	1,226	8	104	505	609
With surgery	313	5	37	176	96
Malignant neoplasm 140-209	794	16	80	285	413
Without surgery	385	9	42	139	195
With surgery	409	7	38	147	217
Other diagnoses Residual	12,051	2,108	4,333	3,075	2,535
Without surgery	6,964	1,177	2,385	1,800	1,603
With surgery	5,087	931	1,948	1,276	932
Female					
All diagnoses	21,518	1,638	10,627	4,562	4,690
Without surgery	12,313	955	5,579	2,490	3,289
With surgery	9,205	683	5,047	2,072	1,402
Heart disease 390-398, 400.1, 402, 404, 410-414, 420-429	1,307	9	76	381	841
Without surgery	1,140	7	58	314	761
With surgery	168	2	18	68	81
Malignant neoplasm 140-209	934	17	156	372	390
Without surgery	403	11	47	164	181
With surgery	532	6	109	209	208
Other diagnoses Residual	19,276	1,613	10,395	3,808	3,459
Without surgery	10,770	937	5,475	2,012	2,347
With surgery	8,506	676	4,921	1,796	1,113

Table 2. Rate per 1,000 civilian noninstitutionalized population of patients discharged from short-stay hospitals, by age, sex, first-listed diagnostic category, and surgical status: United States, 1977

[Excludes newborn infants and discharges from Federal and long-term hospitals]

Sex, first-listed diagnostic category, surgical status, and ICDA code	All ages	Under 15 years	15-44 years	45-64 years	65 years and over
	Rate per 1,000 population				
Both sexes					
All diagnoses	169.2	73.3	159.7	198.4	374.4
Without surgery	98.4	41.8	85.3	113.8	255.6
With surgery	70.8	31.6	74.4	84.7	118.8
Heart disease ... 390-398, 400.1, 402, 404, 410-414, 420-429	13.4	0.4	2.3	24.5	69.4
Without surgery	11.2	0.3	1.7	18.9	61.5
With surgery	2.3	0.1	0.6	5.6	7.9
Malignant neoplasm ... 140-209	8.1	0.6	2.5	15.2	36.0
Without surgery	3.7	0.4	0.9	7.0	16.9
With surgery	4.4	0.2	1.5	8.2	19.1
Other diagnoses ... Residual	147.6	72.3	154.9	158.8	269.0
Without surgery	83.6	41.1	82.7	87.9	177.2
With surgery	64.1	31.2	72.3	70.9	91.8
Male					
All diagnoses	140.5	81.4	98.5	195.2	396.9
Without surgery	83.7	45.5	54.7	118.0	261.6
With surgery	56.7	35.9	43.8	77.2	135.3
Heart disease ... 390-398, 400.1, 402, 404, 410-414, 420-429	15.0	0.5	3.0	32.9	76.6
Without surgery	12.0	0.3	2.2	24.4	66.2
With surgery	3.1	0.2	0.8	8.5	10.4
Malignant neoplasm ... 140-209	7.8	0.6	1.7	13.8	44.8
Without surgery	3.8	0.4	0.9	6.7	21.2
With surgery	4.0	0.3	0.8	7.1	23.6
Other diagnoses ... Residual	117.7	80.3	93.7	148.5	275.5
Without surgery	68.0	44.8	51.6	86.9	174.2
With surgery	49.7	35.5	42.1	61.6	101.3
Female					
All diagnoses	196.0	65.0	217.6	201.4	358.6
Without surgery	112.2	37.9	114.3	109.9	251.4
With surgery	83.8	27.1	103.4	91.5	107.2
Heart disease ... 390-398, 400.1, 402, 404, 410-414, 420-429	11.9	0.3	1.6	16.8	64.3
Without surgery	10.4	0.3	1.2	13.9	58.1
With surgery	1.5	0.1	0.4	3.0	6.2
Malignant neoplasm ... 140-209	8.5	0.7	3.2	16.4	29.8
Without surgery	3.7	0.4	1.0	7.2	13.9
With surgery	4.8	0.2	2.2	9.2	15.9
Other diagnoses ... Residual	175.6	64.0	212.9	168.1	264.5
Without surgery	98.1	37.1	112.1	88.8	179.4
With surgery	77.5	26.8	100.8	79.3	85.1

Table 3. Average length of stay for patients discharged from short-stay hospitals, by age, sex, first-listed diagnostic category, and surgical status: United States, 1977

[Excludes newborn infants and discharges from Federal and long-term hospitals]

Sex, first-listed diagnostic category, surgical status, and ICDA code	All ages	Under 15 years	15-44 years	45-64 years	65 years and over
	Average length of stay in days				
Both sexes					
All diagnoses	7.3	4.2	5.3	8.5	11.1
Without surgery	7.1	4.4	5.2	8.0	10.2
With surgery	7.5	3.9	5.5	9.2	13.1
Heart disease 390-398, 400.1, 402, 404, 410-414, 420-429	9.9	8.2	8.0	8.9	10.9
Without surgery	9.6	8.5	7.6	8.6	10.5
With surgery	11.6	7.7	9.2	10.1	14.5
Malignant neoplasm 140-209	12.2	8.4	8.4	12.0	13.6
Without surgery	10.4	6.2	7.2	10.2	11.6
With surgery	13.6	12.1	9.1	13.4	15.3
Other diagnoses Residual	6.8	4.1	5.2	8.1	10.8
Without surgery	6.7	4.4	5.1	7.7	9.9
With surgery	7.0	3.8	5.3	8.6	12.5
Male					
All diagnoses	7.8	4.3	6.3	8.6	10.8
Without surgery	7.4	4.5	6.1	7.8	9.7
With surgery	8.4	4.0	6.5	9.8	12.8
Heart disease 390-398, 400.1, 402, 404, 410-414, 420-429	9.5	8.0	7.9	8.9	10.4
Without surgery	9.1	8.2	7.8	8.6	9.8
With surgery	10.9	7.5	8.4	9.7	14.3
Malignant neoplasm 140-209	12.3	8.2	9.1	12.3	13.1
Without surgery	10.1	7.0	6.8	10.2	10.9
With surgery	14.3	9.8	11.5	14.2	15.0
Other diagnoses Residual	7.3	4.2	6.2	8.2	10.5
Without surgery	6.9	4.5	6.1	7.4	9.5
With surgery	7.7	4.0	6.4	9.3	12.2
Female					
All diagnoses	7.0	4.1	4.9	8.4	11.3
Without surgery	7.0	4.3	4.8	8.2	10.5
With surgery	7.0	3.8	5.0	8.7	13.3
Heart disease 390-398, 400.1, 402, 404, 410-414, 420-429	10.5	8.6	8.2	9.0	11.4
Without surgery	10.1	8.7	7.4	8.6	11.0
With surgery	12.8	8.2	10.9	11.1	14.8
Malignant neoplasm 140-209	12.1	8.6	8.1	11.7	14.1
Without surgery	10.7	5.6	7.6	10.2	12.3
With surgery	13.1	14.7	8.3	12.9	15.7
Other diagnoses Residual	6.5	4.0	4.8	8.0	11.0
Without surgery	6.5	4.3	4.7	8.0	10.2
With surgery	6.5	3.7	4.9	8.1	12.8

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APPENDIX I

TECHNICAL NOTES ON METHODS

Statistical Design of the National Hospital Discharge Survey

Scope of the survey.—The National Hospital Discharge Survey (NHDS) encompasses patients discharged from hospitals located in the 50 States and the District of Columbia. Only hospitals having six beds or more for patient use and an average length of stay for all patients of less than 30 days are included in the survey. Although all discharges of patients from these hospitals are within the scope of the survey, discharges of newborn infants are excluded from this report.

Sampling frame and size of sample.—The sampling frame (universe) for hospitals in the NHDS is the National Master Facility Inventory of Hospitals and Institutions (NMFI). A detailed description of how the NMFI was developed, its contents, plans for maintaining it, and procedures for assessing the completeness of its coverage has been published.[5]

The universe for the survey consisted of 6,965 short-stay hospitals contained in the NMFI in 1963, 442 hospitals that were added to the NMFI in 1969, 223 hospitals that were added in 1972, and 273 hospitals that were added in 1976. The distributions of the hospitals in the NMFI and in the NHDS sample are shown by bed size and geographic region in table I.

The sample of hospitals for 1977 consisted of 535 hospitals. Of these hospitals, 68 refused to participate and 44 were out-of-scope either because they had gone out of business or because they failed to meet the definition of a short-stay hospital. Thus 423 hospitals participated in the survey during 1977 and provided approximately 224,000 abstracts of medical records.

Sample design.—All hospitals with 1,000 beds or more in the universe of short-stay hospitals were selected with certainty in the sample. All hospitals with fewer than 1,000 beds were stratified; the primary strata were the 24 size-by-region classes shown in table I. Within each of these 24 primary strata, allocation of the sample hospitals was made through a controlled selection technique so that hospitals in the sample would be representatively distributed regarding type of ownership and geographic division. Sample hospitals were drawn with probabilities ranging from certainty for the largest hospitals to 1 in 40 for the smallest hospitals.

The within-hospital sampling ratio for selecting sample discharges varied inversely with the probability of selection of the hospital. The smallest sampling fraction of discharged patients was taken in the largest hospitals, and the largest fraction was taken in the smallest hospitals. This compensation for the probability of hospital selection ensured that the overall probability of selecting a discharge would be approximately the same for each hospital size class.

In nearly all sample hospitals, the daily listing sheet of discharges was the frame from which the subsamples of discharges were selected. The sample discharges were selected by a random technique, usually on the basis of the terminal digit(s) of the patient's medical record number—a number assigned when the patient was admitted to the hospital. If the hospital's daily discharge listing did not show the medical record numbers, the sample was selected by

NOTE: A list of references follows the text.

Table I. Distribution of short-stay hospitals in the universe (National Master Facility Inventory) and in the National Hospital Discharge Survey sample and number of hospitals that participated in the survey, by geographic region and bed size of hospital: United States, 1977

Bed size of hospital	All regions	North-east	North Central	South	West
	Number of hospitals				
All sizes					
Universe	7,903	1,177	2,214	3,130	1,472
Total sample	535	132	152	170	81
Number participating	423	113	120	125	65
6-49 beds					
Universe	3,486	221	889	1,658	718
Total sample	69	8	18	30	13
Number participating	44	6	15	16	7
50-99 beds					
Universe	1,871	299	482	721	369
Total sample	79	14	20	31	14
Number participating	58	10	14	23	11
100-199 beds					
Universe	1,371	298	404	448	221
Total sample	117	26	33	39	19
Number participating	98	25	28	27	18
200-299 beds					
Universe	614	193	164	160	97
Total sample	97	31	27	24	15
Number participating	76	26	21	17	12
300-499 beds					
Universe	408	112	134	109	53
Total sample	97	25	32	28	12
Number participating	81	21	26	25	9
500-999 beds					
Universe	135	45	48	29	13
Total sample	58	19	19	13	7
Number participating	49	17	13	12	7
1,000 beds or more					
Universe	18	9	3	5	1
Total sample	18	9	3	5	1
Number participating	17	8	3	5	1

starting with a randomly selected discharge and taking every *k*th discharge thereafter.

Data Collection and Processing

Data collection.—Depending on the study procedure negotiated with each hospital's administrator, the sample selection and the transcription of information from the hospital records to abstract forms were performed by the hospital staff, representatives of the National Center for Health Statistics (NCHS), or both. This task was performed by the medical records department in about two-thirds of the hospitals that participated in the NHDS during the year. In the remaining hospitals, this task was performed by personnel of the U.S. Bureau of the Census acting for NCHS.

An abstract form was used to transcribe data from hospital records. The abstract form provided space for recording demographic data, admission and discharge dates, zip code of the patient's residence, expected sources of payment, disposition of patient at discharge, and information on discharge diagnoses and surgical operations or procedures (figure I). With one exception, all discharge diagnoses and operations for each sample discharge were listed on the abstract form in the order in which they appeared on the face sheet of the medical record. The exception was that any diagnosis identified on the face sheet as the principal diagnosis was always recorded as the first-listed diagnosis.

Shipments of completed abstract forms for each sample hospital were transmitted, along with sample selection control sheets, to a Census Regional Office. Every shipment of abstracts was reviewed and each abstract form was checked for completeness. Abstracts were then sent to NCHS for processing.

Medical coding and edit.—The medical information recorded on the sample patient abstracts was coded centrally by the staff of NCHS. A maximum of five diagnostic codes was assigned for each sample abstract; in addition, if the medical information included surgery, a maximum of three codes for surgical operations and procedures was assigned. Following the conversion of the data on the Medical Abstract form to computer tape, a final medical edit was accomplished by computer inspection runs and a review of rejected abstracts. If the sex or age of the patient was incompatible with the recorded medical information, priority was given to the medical information in editing.

The basic system used for coding the diagnoses on the NHDS sample patient abstracts was the *Eighth Revision International Classification of Diseases, Adapted for Use in the United States*[2] (ICDA-8). Modifications of the ICDA-8 have been made for NHDS because of incomplete or ill-defined terminology on the abstracts. Only one such modification affects the data presented in this report: code 400.1, malignant hypertension with heart involvement classifiable to codes 427-429, was modified to include only malignant hypertension with heart involvement classifiable to codes 427.1-429.

The basic system for coding surgical operations and procedures was the ICDA-8 section on "Surgical Operations, Diagnostic and Other Therapeutic Procedures," which was modified in certain areas to accommodate incomplete terminology on the source documents, that is, lack of specificity of the body site involved, of surgical method or approach, or of other details prescribed by the ICDA-8. The following operations or procedures were not coded: some operations inducing or assisting delivery (75.0-75.6, 75.9), Diagnostic Endoscopy (A4-A5), Diagnostic Radiography (A8-A9), Radiotherapy and Related Therapies (R1), Physical Medicine and Rehabilitation (R4), and Other Nonsurgical Procedures (R9). Except for these omissions, the surgical modifications employed in coding NHDS medical data do not apply to the classifications used in this report.

Presentation of Estimates

Patient characteristics not stated.—If the age or sex of the patient was not stated on the face sheet of a sample discharge's medical record, it was imputed by assigning the patient an age or sex consistent with the age or sex of other patients with the same diagnostic code. Age and sex were not stated for less than one-fourth of 1 percent of the discharges. If the dates of admission or discharge were not given and if they could not be obtained from the monthly sample listing sheet transmitted by the sample hospital, a length of stay was imputed by assigning the patient a stay characteristic of the stays of other patients of the same age.

Rounded numbers.—Estimates of the numbers of inpatient discharges have been rounded to the nearest thousand for tabular presentation. Therefore, detailed figures within the tables do not always add to totals. Rates, percents, and average lengths of stay were calculated on the basis of unrounded figures and will not necessarily agree with computations made from the rounded data.

Population estimates.—The population estimates used in computing rates are unpublished

Form Approved: O.M.B. No. 68-R0620

CONFIDENTIAL – All information which would permit identification of an individual or of an establishment will be held confidential, will be used only by persons engaged in and for the purposes of the survey, and will not be disclosed or released to other persons or used for any other purpose.

FORM HDS-1
(12-13-76)

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
HEALTH RESOURCES ADMINISTRATION
NATIONAL CENTER FOR HEALTH STATISTICS

MEDICAL ABSTRACT – HOSPITAL DISCHARGE SURVEY

A. PATIENT IDENTIFICATION

1. Hospital number . . . . . ☐☐☐☐
2. HDS number . . . . ☐☐☐☐
3. Medical Record number ________

4. Date of admission . . . Month ☐☐ - Day ☐☐ - Year ☐☐
5. Date of discharge . . . ☐☐ - ☐☐ - ☐☐
6. Residence ZIP Code ☐☐☐☐☐

B. PATIENT CHARACTERISTICS

7. Date of birth . . . Month ☐☐ - Day ☐☐ - Year ☐☐
8. Age *(Complete only if Date of Birth not given)* . . . . Units ☐☐ { 1 ☐ Years, 2 ☐ Months, 3 ☐ Days }

9. Sex *(Mark one)*: 1 ☐ Male 2 ☐ Female 3 ☐ Not stated

10. Race or Color *(Mark one)*: 1 ☐ White 2 ☐ Black 3 ☐ Other 4 ☐ Not stated

11. Marital Status *(Mark one)*: 1 ☐ Married 2 ☐ Single 3 ☐ Widowed 4 ☐ Divorced 5 ☐ Separated 6 ☐ Not stated

12. Expected Source(s) of payment

Principal *(Mark one)*	Other *(Mark all that apply)*
1 ☐	☐ Self-pay
2 ☐	☐ Workmen's Compensation
3 ☐	☐ Medicare
4 ☐	☐ Medicaid
5 ☐	☐ Other government payments
6 ☐	☐ Blue Cross
7 ☐	☐ Other private or commercial insurance
8 ☐	☐ No charge
9 ☐	☐ Other *(Specify)* ________
10 ☐	☐ Not stated

13. Disposition of Patient *(Mark one)*

1 ☐ Routine discharge/discharged home
2 ☐ Left against medical advice
3 ☐ Discharged/transferred to another facility or organization
4 ☐ Discharged/referred to organized home care service
5 ☐ Died
6 ☐ Not stated

C. DIAGNOSES

Principal: ________

Other/additional: ________

____

____

☐ See reverse side

D. SURGICAL AND DIAGNOSTIC PROCEDURES

Date: Month Day Year

Principal: ________ ☐☐-☐☐-☐☐

Other/additional: ________ ☐☐-☐☐-☐☐

________ ☐☐-☐☐-☐☐

________ ☐☐-☐☐-☐☐

________ ☐☐-☐☐-☐☐

☐ NONE ☐ See reverse side

Completed by | Date

☆U.S. GOVERNMENT PRINTING OFFICE. 1976-758-250

Figure 1. Medical Abstract for the 1977 National Hospital Discharge Survey

Table II. Civilian noninstitutionalized population by sex and age: United States, July 1, 1977

[Population estimates consistent with Series P-25, *Current Population Reports,* U.S. Bureau of the Census]

Age	Both sexes	Male	Female
	Population in thousands		
All ages	212,182	102,399	109,782
Under 15 years	51,481	26,260	25,220
15-44 years	95,060	46,231	48,828
45-64 years	43,357	20,704	22,653
65 years and over	22,284	9,204	13,080

U.S. Bureau of the Census estimates for the U.S. civilian noninstitutionalized population on July 1, 1977. The estimates by age and sex are presented in table II and are consistent with the population estimates published in *Current Population Reports,* Series P-25. However, they are not official population estimates of the Bureau of the Census.

Reliability of Estimates

Estimation.—Statistics produced by NHDS are derived through a procedure in which the basic unit of estimation is the sample inpatient discharge abstract. The estimating procedure produces essentially unbiased national estimates and has three principal components: inflation by reciprocals of the probabilities of sample selection, adjustment for nonresponse, and ratio adjustment to fixed totals. These components of estimation are described in appendix I of two earlier publications.[6,7]

Measurement errors.—As in any survey, results are subject to nonsampling or measurement errors, which include errors due to hospital nonresponse, missing abstracts, information incompletely or inaccurately recorded on abstract forms, and processing errors. Some of these errors were discussed under a previous section entitled "Patient characteristics not stated."

Sampling errors.—The standard error (SE) is primarily a measure of the variability that is attributed to using a value obtained from a sample as an estimate of a population value. In this report it also reflects part of the measurement error. The value that would have been obtained if a complete enumeration of the population had been made will be contained in an interval represented by the sample estimate plus or minus 1 standard error about 68 out of 100 times and plus or minus 2 standard errors about 95 out of 100 times.

The standard error of one statistic generally differs from that of another of equal size, even when the two come from the same survey. To derive standard errors that would be applicable to a wide variety of statistics and that could be prepared at a moderate cost, a number of approximations are required. As a result, the figures shown in table III provide general standard errors for a wide variety of discharge and average length-of-stay estimates rather than the specific errors for particular statistics. Standard errors for those values omitted from the table can be approximated through interpolation.

The relative standard error (RSE) of a statistic is obtained by dividing the standard error by the estimate and multiplying the resulting value by 100. This calculation expresses the standard error as a percentage of the estimate. The RSE's of the rates presented in this report are assumed to be equivalent to those of the corresponding discharge estimates. Consequently, the SE for a rate can be approximated by using the information provided in table I to compute the RSE for the corresponding discharge estimate and then applying that RSE to the rate.

The RSE's of the percentages used in this report can be approximated by using the formula

$$RSE_P = \sqrt{RSE_N^{\,2} - RSE_D^{\,2}}$$

where

RSE_P = the approximate relative standard error of a percentage;

RSE_N = the approximate relative standard error of the numerator used in computing the percentage; and

RSE_D = the approximate relative standard error of the denominator used in computing the percentage.

The SE of the percentage then can be approximated by applying the RSE to the percentage.

NOTE: A list of references follows the text.

Table III. Approximate standard errors of estimated numbers of discharges and of associated average lengths of stay: United States, 1977

Number of discharges in thousands (base of average length of stay)	Approximate standard error of discharge estimate, in thousands	Average length of stay in days							
		2	4	6	8	10	12	14	16
		Standard error in days							
2	0.5	0.4	0.7	1.0	1.3	1.6	1.9	2.2	2.5
5	1.0	0.3	0.5	0.8	1.0	1.3	1.5	1.7	2.0
10	1.7	0.3	0.5	0.7	0.9	1.1	1.3	1.5	1.7
20	2.9	0.2	0.4	0.6	0.7	0.9	1.1	1.2	1.4
40	4.8	0.2	0.3	0.5	0.6	0.8	0.9	1.0	1.2
60	6.6	0.2	0.3	0.5	0.6	0.7	0.8	1.0	1.1
80	8.2	0.2	0.3	0.4	0.5	0.7	0.8	0.9	1.0
100	9.7	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0
300	22.4	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
500	33.3	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7
1,000	57.1	0.1	0.2	0.3	0.3	0.4	0.4	0.5	0.6
5,000	204.6	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4
10,000	357.9	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4
20,000	629.8	0.1	0.1	0.1	0.2	0.2	0.2	0.3	-
30,000	878.7	0.1	0.1	0.1	0.2	0.2	-	-	-

Illustration of use of table III: As shown in tables 1-3, an estimated 803,000 patients 65 years of age and over with a first-listed diagnosis of a malignant neoplasm were discharged in 1977 from non-Federal short-stay hospitals. This rate is equal to a rate of 36.0 discharges per 1,000 civilian noninstitutionalized population 65 years of age and over. This group constitutes 9.6 percent of all discharges 65 years of age and over. The average length of stay for these discharges was 13.6 days.

By interpolation, the standard error of the discharge estimate is approximately 47.7 thousand discharges

$$SE_{803{,}000 \text{ discharges}} = 33{,}300 + \left(\frac{803{,}000 - 500{,}000}{1{,}000{,}000 - 500{,}000}\right) \times (57{,}100 - 33{,}300) = 47{,}722.8$$

Also by interpolation, the standard error of the associated length of stay of 13.6 days is approximately 0.5 days

$$SE_{13.6 \text{ days}, 500{,}000 \text{ discharges}} = 0.5 + \left(\frac{13.6 - 12}{14 - 12}\right) \times (0.6 - 0.5) = 0.58$$

$$SE_{13.6 \text{ days}, 1{,}000{,}000 \text{ discharges}} = 0.4 + \left(\frac{13.6 - 12}{14 - 12}\right) \times (0.5 - 0.4) = 0.48$$

$$SE_{13.6 \text{ days}, 803{,}000 \text{ discharges}} = 0.58 + \left(\frac{803{,}000 - 500{,}000}{1{,}000{,}000 - 500{,}000}\right) \times (0.48 - 0.58) = 0.52$$

The standard error of the associated rate of 36.0 discharges per 1,000 civilian noninstitutionalized population is approximately 2.1 discharges

$$RSE_{803{,}000 \text{ discharges}} = \left(\frac{47{,}700}{803{,}000}\right) \times 100 = 5.9 \text{ percent}$$

$$SE_{36.0 \text{ per thousand}, 803{,}000 \text{ discharges}} = 0.059 \times 36.0 = 2.12$$

Finally, the standard error of the 9.6 percent is approximately 0.4 percentage points

$$SE_{8{,}344{,}000 \text{ discharges}} = 204{,}600 + \left(\frac{8{,}344{,}000 - 5{,}000{,}000}{10{,}000{,}000 - 5{,}000{,}000}\right) \times (357{,}900 - 204{,}600) = 307{,}127.0$$

$$RSE_{8{,}344{,}000 \text{ discharges}} = \left(\frac{307{,}100}{8{,}344{,}000}\right) \times 100 = 3.7 \text{ percent}$$

$$RSE_{9.6 \text{ percent}} = \sqrt{5.9^2 - 3.7^2} = 4.6 \text{ percent}$$

$$SE_{9.6 \text{ percent}} = 9.6 \times 0.046 = 0.4 \text{ percent}$$

Hypothesis Testing

Two methods of hypothesis testing were used in this report.

Bonferroni test.—For testing the difference between two estimates (e.g., frequencies, percentages, regression slopes), the two-tailed Bonferroni test for multiple comparisons was performed. The size of the test statistic computed determines whether or not the null hypothesis that the two parameters being estimated do not differ is rejected in favor of the alternate hypothesis that they do differ. For the estimates X_1 and X_2, the null hypothesis is $H_0 : P_1 = P_2$, and the alternate hypothesis is $H_A : P_1 \neq P_2$, where P_1 and P_2 are the population parameters of which X_1 and X_2 are estimates.

The test statistic is equal to the difference between the two estimates divided by the standard error of that difference. The standard error of the difference between two estimates is approximated by the square root of the sum of the squares of the standard errors of each of the estimates. (This calculation represents the actual standard error for the difference between separate and uncorrelated statistics, although it is only a rough approximation in most other cases.)

Thus the null hypothesis that two parameters P_1 and P_2 do not differ is rejected if the probability of a type I error (i.e., the probability of rejecting a true null hypothesis) is less than 5 percent, that is, if:

$$Z = \left/ \frac{X_1 - X_2}{\sqrt{SE_{X_i}^2 + SE_{X_2}^2}} \right/ \geqslant \text{critical value}$$

The critical value increases from 1.96 to 3.291 as the total number of possible comparisons among estimates for subdomains of a domain increases from 1 to 50. (A domain can consist of the entire underlying population or a subset of the underlying population that contains all elementary units belonging to a particular category of at least one health or demographic variable. A subdomain is a subset of a domain consisting of all elementary units that belong to a particular category of at least one health or demographic variable other than the variables that define the domain.)

For example, in detailed table 2, the rate per 1,000 civilian noninstitutionalized population of male heart disease discharges was 15.0 (X_1), the rate of male malignant neoplasm discharges was 7.8 (X_2), and the rate of all other male discharges was 117.7 (X_3). The difference between the male heart disease and malignant neoplasm discharge rates (i.e., $H_0 : P_1 = P_2$, and $H_A : P_1 \neq P_2$) is tested. For this example, later comparisons among these rates and the corresponding rates for females (X_4, X_5, and X_6) are planned. Thus the domain consists of all discharges and the subdomains are the six sex by diagnosis categories. Fifteen possible comparisons among the estimates for the subdomains exist (i.e., X_1 and X_2, X_1 and X_3, X_1 and X_4, etc.), and the critical value for the test statistic for each possible comparison is 2.935. By using the method presented in the preceding section of this appendix: $RSE_{X_1} = 5.000$ percent; $SE_{X_1} = 0.750$; $RSE_{X_2} = 5.597$ percent; and $SE_{X_2} = 0.465$. Because

$$Z = \left/ \frac{15.0 - 7.8}{\sqrt{.750^2 + .465^2}} \right/ = 8.159 > 2.935$$

the male heart disease discharge rate is significantly greater than the male malignant neoplasm rate.

Weighted least squares as a test for trend.—If it is hypothesized that a linear relationship exists between an independent variable and a dependent variable (e.g., age and average length of stay), then a useful test for this relationship is to fit a regression line to the data, determine the slope of the line, and then determine whether or not this slope is significantly different from zero. That is, a regression line of the form

$$\overline{Y}_i = a + bX_i$$

is fitted to the data, where, for this example, $\overline{Y}_i$ = predicted average length of stay, X_i = age, a = the estimated $\overline{Y}$-intercept, that is, the estimated average length of stay if age equals zero, and b = the estimated slope of $\overline{Y}$ on $\overline{X}$, that is, the estimated rate of change in average length of stay per unit change in age.

The data available from the National Hospital Discharge Survey present certain basic problems that discourage the use of classical regression procedures. Among these problems are violation of the assumptions of independence of the original observations, violation of homoscedasticity, that is, equal variances of the dependent variable within each category of the independent variable, perhaps violation of the normality assumption, and so forth. Dr. Paul Levy, formerly of NCHS, has devised a "modified regression model which makes no assumptions about the original observations and which makes no stronger assumptions about the sample estimates than are made in testing whether two means are equal when the estimated means and their standard errors are obtained from complex surveys."[b]

The proposed model is as follows:

1. Let $\overline{Y}_i$ be the estimated mean and $S_{\bar{y}_i}$ be the estimated standard error for the ith group.
2. Let X_i be the midpoint of the independent variable for the group.
3. Assume $S_{\bar{y}_i}$ is based on a large enough number of observations that it can be assumed to be equal to $\sigma_{\bar{y}_i}$ and thus without sampling error.
4. Further assume that

   $E(\overline{Y}_i) = \alpha + \beta X_i$

   $V(\overline{Y}_i) = S^2_{\bar{y}_i}$ for $i = 1, 2, \ldots, K$,

   where α is the true $\overline{Y}$-intercept, β is the true slope, and K is the number of groups.
5. Finally, assume that the $\overline{Y}_i$'s are normally distributed and are statistically independent of each other.

The weighting procedure proposed weights all observations by the reciprocal of the variance. That is, $w_i = 1/S^2_{\bar{y}_i}$ and the mean $X = \Sigma w_i \overline{X}_i / \Sigma w_i$ and the mean $\overline{Y} = \Sigma w_i \overline{Y}_i / \Sigma w_i$.

[b] From an unpublished memorandum by Dr. Levy.

The slope is computed in a manner similar to the classical least squares regression, by using the following formula

$$b = \frac{\Sigma w_i (X_i - \overline{X})\, \overline{Y}_i}{\Sigma w_i (X_i - \overline{X})^2}$$

This is easily computed by using

$$b = \frac{\Sigma w_i X_i \overline{Y}_i - (\Sigma w_i)(\overline{X})(\overline{\overline{Y}})}{\Sigma w_i X_i^2 - (\Sigma w_i)\overline{X}^2}$$

The variance of the slope is

$$\sigma_b^2 = \frac{\Sigma w_i (X_i - \overline{X})^2\, \sigma^2_{\bar{y}}}{[\Sigma w_i (X_i - \overline{X}^2)]^2}$$

Because $w_i = 1/\sigma^2_{\bar{y}_i}$, this formula can be simplified to

$$\sigma_b^2 = \frac{\Sigma w_i (X_i - \overline{X})^2}{[\Sigma w_i (X_i - \overline{X})^2]^2} = \frac{1}{\Sigma w_i (X_i - \overline{X})^2}$$

and computationally

$$S_b = \sqrt{\frac{1}{\Sigma w_i X_i^2 - (\Sigma w_i)\overline{X}^2}}$$

For the weighted least squares test, the null hypothesis is that the slope of the regression line does not significantly differ from zero, and the alternate hypothesis is that it does differ from zero (i.e., $H_0 : \beta = 0$, and $H_A : \beta \neq 0$). An approximate normal deviate test of the null hypothesis can be performed by computing $z = b/S_b$ and comparing the absolute value of the result to the appropriate critical value. The critical value for this test also varies from 1.96 to 3.291 as the number of simultaneous trends being tested varies from 1 to 50.

As an example, the average length of stay ($\overline{Y}$) for male heart disease discharges by age (X) is recorded as shown in table IV. Because a test of the relationship between age and average length of stay is planned for each of the six sex by diagnosis categories, the appropriate critical

Table IV. Worksheet for weighted least squares regression of average length of stay on age for male patients discharged from short-stay hospitals with a first-listed diagnosis of heart disease: United States, 1977

Age	Midpoint of age group in years	Average length of stay in days ($\overline{Y}$)	Standard error of average length of stay ($S_{\overline{Y}}$)	$w_i = 1/S^2_{\overline{Y}_i}$
Under 15 years	7.0	8.0	0.805	1.543
15-44 years	29.5	7.9	0.472	4.489
45-64 years	54.5	8.9	0.379	6.962
65 years and over	75.0	10.4	0.429	5.434

value for a weighted least squares test here is 2.638. By applying the method described to the data shown, we have:

$\Sigma w_i X_i \overline{Y}_i = 8{,}748.008$ $\qquad \overline{X} = 50.478$

$\Sigma w_i = 18.428$ $\qquad \overline{\overline{Y}} = 9.023$

$\Sigma w_i X_i = 930.206$ $\qquad b = 0.043$

$\Sigma w_i \overline{Y}_i = 166.282$ $\qquad S_b = 0.011$

$\Sigma w_i X_i^2 = 55{,}227.290$ $\qquad z = 3.909$

Because the z value is greater than the critical value, a positive association between the average length of stay and age is demonstrated for the male heart disease discharges.

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APPENDIX II

DEFINITIONS OF CERTAIN TERMS USED IN THIS REPORT

Hospitals and Hospital Characteristics

Hospitals.—Short-stay special and general hospitals having six beds or more for inpatient use and an average length of stay of less than 30 days. Federal hospitals and hospital units of institutions are not included.

Bed size of hospital.—Measured by the number of beds, cribs, and pediatric bassinets regularly maintained (set up and staffed for use) for patients; bassinets for newborn infants are not included. In this report the classification of hospitals by bed size is based on the number of beds at or near midyear reported by the hospitals.

Terms Relating to Hospitalization

Patient.—A person who is formally admitted to the inpatient service of a short-stay hospital for observation, care, diagnosis, or treatment. In this report the number of patients refers to the number of discharges during the year, including any multiple discharges of the same individual from one short-stay hospital or more. Infants admitted on the day of birth, directly or by transfer from another medical facility, with or without mention of a disease, disorder, or immaturity are included. All newborn infants, defined as those admitted by birth to the hospital, are excluded. The terms "patient" and "inpatient" are used synonymously.

Discharge.—The formal release of a patient by a hospital; that is, the termination of a period of hospitalization by death or by disposition to the place of residence, a nursing home, or another facility. The terms "discharges" and "patients discharged" are used synonymously.

Discharge rate.—The ratio of the number of hospital discharges during a year to the number of persons in the civilian noninstitutionalized population July 1 of that year.

Days of care.—The total number of patient days accumulated at time of discharge by patients discharged from short-stay hospitals during a year. A stay of less than 1 day (patient admission and discharge on the same day) is counted as 1 day in the summation of total days of care. For patients admitted and discharged on different days, the number of days of care is computed by counting all days from (and including) the date of admission to (but not including) the date of discharge.

Average length of stay.—The total number of patient days accumulated at the time of discharge by patients discharged during the year, divided by the number of patients discharged.

Terms Relating to Diagnoses

Discharge diagnosis.—One or more diseases or injuries (or special conditions and examinations without sickness or tests with negative findings) that the attending physician assigned in the medical record of a patient. The number of principal or first-listed diagnoses is equivalent to the number of discharges.

Principal diagnosis.—The condition established after study to be chiefly responsible for occasioning the admission of the patient to the hospital for care.

First-listed diagnosis.—The coded diagnosis either identified as the principal diagnosis or listed first on the face sheet of the medical record. The number of first-listed diagnoses is equivalent to the number of discharges.

Heart diseases.—ICDA-8 codes 390-398, 400.1, 402, 404, 410-414, and 420-429. The diagnoses included in these codes are: active rheumatic fever; chronic rheumatic heart disease; malignant hypertension with heart involvement classifiable to ICDA-8 codes 427.1-429; hypertensive heart disease; hypertensive heart and renal disease; acute myocardial infarction; chronic and acute ischemic heart disease; angina pectoris; asymptomatic ischemic heart disease; acute pericarditis, nonrheumatic; acute and subacute endocarditis; acute myocarditis; chronic disease of pericardium, nonrheumatic; chronic disease of endocardium; cardiomyopathy; pulmonary heart disease; symptomatic heart disease; other myocardial insufficiency; and ill-defined heart disease. Other diseases of the circulatory system that are excluded by these codes are: malignant hypertension except with heart involvement classifiable to ICDA-8 codes 427.1-429; essential benign hypertension; hypertensive renal disease; cerebrovascular disease; diseases of arteries, arterioles, and capillaries; diseases of veins and lymphatics; and other diseases of the circulatory system.

Malignant neoplasms.—ICDA-8 codes 140-209. These codes include all diagnoses of a neoplasm specified as malignant. Excluded are all diagnoses of a benign neoplasm or a neoplasm of an unspecified nature.

Terms Relating to Surgery

Discharges with surgery.—The estimated number of surgically treated patients discharged from non-Federal short-stay hospitals during the year.

Operation.—One or more surgical operations, procedures, or special treatments that are assigned by the physician to the medical record of a patient discharged from the inpatient service of a sample hospital. For NHDS, all terms listed on the face sheet (summary sheet) of the medical record under the captions "operation," "operative procedures," "operations and/or special treatments," and the like are transcribed in the order listed.

Demographic Terms

Age.—Patient's age refers to age at birthday prior to admission to the hospital inpatient service.

Geographic region.—Hospitals are classified by location in one of the four geographic regions of the United States delineated by the U.S. Bureau of the Census.

Region	*States included*
Northeast	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Pennsylvania
North Central	Michigan, Ohio, Illinois, Indiana, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas
South	Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, and Texas
West	Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Oregon. California, Hawaii, and Alaska

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