Trends in Infectious Disease Hospitalizations in the United States, 1980-1994

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Background: A recent study concluded that between 1980 and 1992, deaths from infectious diseases increased 58%. This article explores trends in infectious diseases as a cause of hospitalization.

Methods: We analyzed data from the National Hospitalization Discharge Survey for 1980 through 1994 using a previously developed approach to evaluate infectious diseases in data coded according to the International Classification of Diseases, Ninth Revision.

Results: Between 1980 and 1994, the rate of hospitalizations in the United States declined approximately 33%; hospitalizations occurred at a rate of 133 ± 5 per 1000 US population (35 million ± 1 million discharges) in 1994. The rate of hospitalization for infectious diseases declined less steeply—12% during this interval—resulting in an increased proportion of hospitalizations because of infectious diseases. In 1994, the rate of hospitalizations for infectious diseases was 15.4 ± 0.7 per 1000 US population (4.0 million ± 0.2 million discharges). The fatality rate associated with hospitalizations for infectious diseases increased from 1.9% ± 0.1% to 4.0% ± 0.3%, attributable to increased hospitalizations of elderly persons and an increased fatality rate among those younger than 65 years. Among selected categories, hospitalizations for human immunodeficiency virus infections and acquired immunodeficiency syndrome, prosthetic device infections, sepsis, and mycosis increased substantially, and hospitalizations for upper respiratory tract infections, pelvic inflammatory disease, and oral infections declined sharply. Hospitalizations for lower respiratory tract infections declined sharply. Hospitalizations for infectious diseases constituted 37% of all infectious disease hospitalizations in 1994.

Conclusions: Considering hospitalizations as a dimension of the burden of infectious diseases involves an array of factors: secular trends in hospitalization, changing case management practices, demographic changes, and trends in the variety of infectious diseases themselves. Increases in the proportions of hospitalizations because of infectious diseases during years when hospitalizations for all causes were decreasing reflect an increasing burden of infectious diseases in the United States between 1989 and the mid-1990s.

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MATERIALS AND METHODS

DATA SOURCE

We analyzed public-use tapes of data for 1980 through 1994 from the NHDS, which is maintained by the Centers for Disease Control and Prevention’s National Center for Health Statistics, Hyattsville, Md.\(^\text{10-1}\text{2}\) These tapes contain approximately 200,000 discharge records per year from a survey sample of short-stay, nonfederal hospitals located in the United States. The survey is based on a stratified, multistage probability design; the sampled hospital discharge records are weighted to produce national estimates. The database includes demographic information, up to 7 discharge diagnoses per hospitalization, number of days of care, and vital status at discharge. With a few exceptions, NHDS tapes tabulate discharge diagnoses in the order they are listed on the abstract form.\(^\text{10-1}\text{2}\)

First-Listed Diagnosis

When not otherwise specified, a hospitalization for infectious disease was defined as a discharge record with an infectious disease ICD-9 code as the first-listed diagnosis. The first-listed diagnosis is the one specified as the principal diagnosis on the face sheet or discharge summary of the medical record or the diagnosis listed first if the principal diagnosis is not specified.\(^\text{10-1}\text{2}\)

Multiple-Cause Diagnoses

In addition to the first-listed diagnosis, we also used as a definition of hospitalization for infectious disease a discharge record with any mention of an infectious disease ICD-9 code among the up to 7 listed discharge diagnoses (multiple cause).

We included all discharges in the database, including routine hospital stays for newborns.

PROTOCOL FOR CLASSIFYING ICD-9 CODES

We used a protocol previously developed for infectious disease mortality to classify ICD-9-coded diagnoses according to whether they are infectious diseases, and we restricted this analysis to those ICD-9 codes that indicated an infectious disease in almost all cases.\(^9\)

DATA ANALYSIS

First-Listed Diagnosis vs Any Mention (Multiple Cause)

Using statistical analysis software (SAS, SAS Institute, Cary, NC), we computed the estimated number of hospitalization discharges (1) assigned to an infectious disease ICD-9 code as the first-listed diagnosis or (2) with any mention of an infectious disease among the up to 7 discharge diagnoses (ie, multiple cause). Unless specifically described as multiple-cause rates, the reported numbers and rates are based on the first-listed diagnosis.

Age, Sex, Race, and Fatality Rate

We examined hospitalizations for 6 age groups (0-4, 5-24, 25-44, 45-64, 65-84, and 85 years and older) and for males vs females. Data on race were dichotomized (whites vs blacks and all other races). We used the variable of vital status at discharge to compute the fatality rate associated with hospitalizations.

Disease Groups

We arranged the infectious disease ICD-9 codes into 21 groups of related conditions, which accounted for about 93% of discharges associated with infectious disease in 1980 and 1994 (the remaining 7% of discharges associated with infectious disease diagnoses were not specific enough to be included in one of these disease groups) (Table 1). Each disease group was evaluated for trends in hospitalizations.

Point Estimates and SEs

For each year, we estimated the number of hospital discharges for infectious disease, the number of days of care, and the fatality rate. We present SEs that were estimated using variables and equations for the relative SE produced by the National Center for Health Statistics for use with the NHDS, which used a computerized routine based on a rigorous, unbiased algebraic estimator of the variance for 1980 to 1987 data and statistical analysis software (SESUDAAN, Research Triangle Institute, Research Triangle Park, NC) for 1988 through 1994 data.\(^\text{10-1}\text{2}\) The approximate SEs in percentage estimates, in which the numerator either was or was not a subclass of the denominator, were computed with appropriate formulas derived by the National Center for Health Statistics for this purpose.\(^3\)

Analysis of Trends

We used weighted linear regression to assess trends for each of 15 point estimates (1980-1994) in the number and rate of hospitalizations and hospitalizations for infectious diseases and in the number of hospitalizations for each of the selected infectious disease groups. Weighting was done by the inverses of the variances of the point estimates. Estimates of the average annual change in the number of hospitalizations were based on the slope of the regression line; relative changes among the various infectious disease groups were characterized by the average annual change in number of hospitalizations divided by the number of 1987 hospitalizations (the midpoint year for the period studied). The determination of statistical inference is based on \(t_{13} = 2.16\) \((P = .05)\).\(^3\)

per 1000 US population (35 million ± 1 million discharges). The rate of hospitalization for infectious diseases declined less steeply: 12% during this interval (Figure 1). In 1994, the rate of infectious disease hospitalizations was 15.4 ± 0.7 per 1000 US population (+0.0 million ± 0.2 million discharges). As a consequence of these differing rates of change, the proportion of hospitalizations because of infectious diseases increased approximately 27%; in 1994, infectious diseases accounted for 12% ± 0.2% of hospitalizations.
Between 1980 and 1994, the number of hospital days of care for all causes declined significantly; in contrast, the number of days of hospitalization for infectious diseases increased significantly. Thus, the proportion of hospitalization days attributable to infectious disease as the first-listed cause was 8.8% ± 0.3% in 1980 and 13.9% ± 0.1% in 1994. The rate of hospitalization days for all causes declined during the study interval (1275 ± 45 days per 1000 US population in 1980 and 717 ± 30 days per 1000 population in 1994). However, the rate of hospitalization days for infectious diseases did not change significantly (113 ± 6 days per 1000 US population in 1980 and 104 ± 4 days per 1000 population in 1994).

Rates of hospitalization in 65- to 84-year-olds and those 85 years and older increased significantly, whereas rates in persons aged 25 to 64 years and those younger than 25 years decreased significantly.

Overall, hospitalization rates for infectious disease did not differ by sex in 1994 (14.9 ± 1.0 per 1000 males and 15.8 ± 0.6 per 1000 females). However, between 1980 and 1994, trends in infectious disease hospitalizations differed between males and females by age group. Rates declined in those younger than 25 years in both sexes (39% in males and 53% in females) and increased among those older than 65 years in both sexes (44% in males and 50% in females). However, in 25- to 64-year-olds, infectious disease hospitalization rates declined significantly in females (31%) but did not change in males.

The proportion of all hospitalizations that were for infectious diseases was 11% for whites and 12% for blacks and all other races in 1994. Approximately 20% of all hospitalization records in the 1994 NHDS data set did not include information about race, and no further analysis of race-specific data was done.

**DAYS OF CARE**

**AGE, SEX, AND RACE**

Trends in hospitalizations for infectious disease from 1980 through 1994 differed among age groups (Figure 2).

**FATALITY RATE**

The fatality rate for patients hospitalized for infectious disease as the first-listed discharge diagnosis increased
from 1.9% ± 0.1% in 1980 to 4.0% ± 0.3% in 1994 (Figure 3). In contrast, the fatality rate for other (non-infectious) hospitalizations remained unchanged at approximately 2.4% ± 0.2%. For persons 65 years and older, the fatality rate among those hospitalized for an infectious disease was 7.2% ± 0.5% in 1980 and 7.4% ± 0.3% in 1994; for persons younger than 65 years, the rate was 0.5% ± 0.1% in 1980 and 1.9% ± 0.2% in 1994. Among persons younger than 65 years, human immunodeficiency virus infection and acquired immunodeficiency syndrome (AIDS) accounted for approximately 2% of infectious disease hospitalizations (although it appeared as one of the diagnoses 5 times as often as it was listed as the first diagnosis); in this age group, human immunodeficiency virus infection and AIDS had a 10% fatality rate. For hospital discharges related to non-infectious disease, the fatality rate was significantly lower in 1994 than in 1980 among persons 65 years and older (6.9% ± 0.3% in 1980 and 5.1% ± 0.1% in 1994) and was comparable for persons younger than 65 years (1.0% ± 0.1% in 1980 and 0.8% ± 0.2% in 1994).

MULTIPLE CAUSES FOR HOSPITALIZATION

In contrast to decreases in the number of hospitalizations, the total number of discharge diagnoses listed for all hospitalizations was an estimated 28% higher in 1994 (125 million total diagnoses) than in 1980 (98 million total diagnoses). Consequently, the average number of listed discharge diagnoses per hospitalization was also higher: 3.6 in 1994 vs 2.3 in 1980. For hospitalizations that included an infectious disease diagnosis, an average of 4.7 diagnoses were listed in 1994 compared with 3.0 in 1980. The proportion of hospitalizations in which an infectious disease appeared among the diagnoses was 16% (6.5 million of 42 million) in 1980 and 22% (7.6 million of 35 million) in 1994.

GROUPS OF INFECTIOUS DISEASES

Trends in hospitalizations varied substantially by infectious disease group (Table 2). For example, hospitalizations for septicemia, infections caused by prosthetic devices, and infections in pregnancy were among the diseases for which the number of hospitalizations increased most, whereas hospitalizations for meningitis, hepatobiliary disease, and oral infections were among the diseases for which the number of hospitalizations decreased most. The proportion of hospitalizations in which an infectious disease appeared among the diagnoses was 16% in 1980 and 22% in 1994.

**Table 2. Hospitalizations for Groups of Infectious Diseases by First-Listed Diagnosis, United States, 1994**

<table>
<thead>
<tr>
<th>Infectious Disease Group</th>
<th>Estimated No. of Hospitalizations With This Disease Group as the First-Listed Diagnosis (No./100 000 Population)</th>
<th>Estimated Annual Increase or Decrease (95% Confidence Interval) in No. of Hospitalizations per Year From 1980 to 1994</th>
<th>Annual % Change in the No. of Hospitalizations†</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV and AIDS</td>
<td>41 700 (16)</td>
<td>2300 (1600 to 3000)</td>
<td>16.5</td>
</tr>
<tr>
<td>Septicemia</td>
<td>301 800 (116)</td>
<td>18 300 (16 200 to 20 400)</td>
<td>10.5</td>
</tr>
<tr>
<td>Infectious and inflammatory reaction to prosthetic devices</td>
<td>73 500 (28)</td>
<td>4000 (3500 to 4500)</td>
<td>9.8</td>
</tr>
<tr>
<td>Mycosis</td>
<td>29 500 (11)</td>
<td>900 (400 to 1400)</td>
<td>5.7</td>
</tr>
<tr>
<td>Postoperative infection</td>
<td>72 800 (28)</td>
<td>2300 (1600 to 3000)</td>
<td>4.9</td>
</tr>
<tr>
<td>Osteomyelitis</td>
<td>48 100 (18)</td>
<td>1800 (900 to 2700)</td>
<td>4.2</td>
</tr>
<tr>
<td>Infections of the heart</td>
<td>16 300 (6)</td>
<td>400 (100 to 700)</td>
<td>2.3</td>
</tr>
<tr>
<td>Lower respiratory tract infections</td>
<td>1 480 600 (568)</td>
<td>28 700 (21 000 to 36 400)</td>
<td>2.2</td>
</tr>
<tr>
<td>Kidney, urinary tract, and bladder infections</td>
<td>470 200 (180)</td>
<td>6600 (5000 to 8200)</td>
<td>1.6</td>
</tr>
<tr>
<td>Cellulitis</td>
<td>335 300 (129)</td>
<td>2200 (500 to 3900)</td>
<td>0.7</td>
</tr>
<tr>
<td>Selected perinatal infections</td>
<td>14 200 (5)</td>
<td>400 (-50 to 900)</td>
<td>. . .</td>
</tr>
<tr>
<td>Viral CNS infection</td>
<td>28 100 (11)</td>
<td>400 (-400 to 1200)</td>
<td>. . .</td>
</tr>
<tr>
<td>Infections in pregnancy</td>
<td>56 000 (22)</td>
<td>100 (-800 to 1000)</td>
<td>. . .</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>16 600 (6)</td>
<td>-500 (-1000 to 70)</td>
<td>. . .</td>
</tr>
<tr>
<td>Enteric infections</td>
<td>154 200 (59)</td>
<td>-900 (-2600 to 800)</td>
<td>. . .</td>
</tr>
<tr>
<td>Abdominal and rectal infections</td>
<td>282 600 (108)</td>
<td>-3900 (-6000 to -1800)</td>
<td>-1.3</td>
</tr>
<tr>
<td>Meningitis</td>
<td>8000 (3)</td>
<td>-600 (-1000 to -200)</td>
<td>-3.9</td>
</tr>
<tr>
<td>Hepatobiliary disease</td>
<td>22 700 (9)</td>
<td>-1200 (-1500 to -900)</td>
<td>-4.6</td>
</tr>
<tr>
<td>Pelvic inflammatory disease</td>
<td>48 000 (16)</td>
<td>-7800 (-9600 to -6600)</td>
<td>-8.6</td>
</tr>
<tr>
<td>Oral infections</td>
<td>12 600 (5)</td>
<td>-1700 (-2200 to -1200)</td>
<td>-8.9</td>
</tr>
<tr>
<td>Upper respiratory tract infections</td>
<td>191 400 (73)</td>
<td>-38 700 (-44 500 to -32 900)</td>
<td>-9.2</td>
</tr>
<tr>
<td>Total infectious disease</td>
<td>4 003 900 (1536)</td>
<td>400 (-9900 to 10 700)</td>
<td>. . .</td>
</tr>
<tr>
<td>All hospitalizations</td>
<td>34 592 400 (13 268)</td>
<td>-724 000 (-873 600 to -574 400)</td>
<td>-1.9</td>
</tr>
</tbody>
</table>

* HIV indicates human immunodeficiency virus; AIDS, acquired immunodeficiency syndrome; CNS, central nervous system; and ellipses, the regression line was not statistically significant at the .05 level.
† Based on the 1987 (the midpoint year) hospitalizations. See the “Materials and Methods” section.
devices, AIDS, and postoperative infections increased more than 9%. In contrast, hospitalizations for upper respiratory tract infections, pelvic inflammatory disease, and oral cavity infections decreased more than 8%. Hospitalizations for lower respiratory tract infections constituted 37% of all hospitalizations for infectious disease in 1994.

COMMENT

From 1980 through 1994, the rate of hospitalizations declined by approximately one third in the United States, and the rate of hospitalizations for infectious diseases declined only 12%. Consequently, the proportion of all hospitalizations that were because of infectious diseases increased approximately 27%, reaching 12% of all hospitalizations in 1994. If there were less discretion in decisions about hospitalizing persons with infectious diseases than with other conditions, this increasing proportion of infectious disease hospitalizations could be solely a consequence of general trends toward fewer hospitalizations. Another possible explanation is that the burden of infectious diseases has been increasing in recent years in a climate favoring fewer hospitalizations.

Changes in practices of discharge diagnosis coding might have affected the patterns observed. Diagnosis-related groups, introduced in 1983, and the associated changes in reimbursement policies created an incentive for choosing discharge diagnoses with higher reimbursement rates, which could have had an impact; we did not evaluate this possibility directly.

Analysis of the data on multiple causes of hospitalization shows an increasing number of diagnoses between 1980 and 1994, even as the number of hospitalizations was decreasing. This trend could reflect hospitalization of sicker persons or simply a tendency toward listing more diagnoses. Hospitalizations with an infectious disease as one of the diagnoses have a higher number of diagnoses than other hospitalizations; in addition, the average number of diagnoses for these hospitalizations was 57% higher in 1994 than in 1980 (4.7 vs 3.0). Infectious disease is often a complication of other conditions (ie, an additional diagnosis), a factor that may explain this observation. Because of these complications in evaluating the data on multiple causes of hospitalization, and to provide a conservative estimate of the impact of infectious diseases on hospitalizations, we focused on the first-listed diagnosis. In addition, this analysis focused only on those diagnosis codes that represent an infectious disease in almost all cases.

Trends in hospitalization for specific infectious disease diagnoses varied considerably, reflecting an assortment of developments. Increasing hospitalizations for AIDS reflects the increasing incidence of that disease, and the increases for prosthetic device infections may reflect the increasing use of these devices (not necessarily an increased per device infection rate). In contrast, hospitalizations decreased substantially for upper respiratory tract infections, pelvic inflammatory disease, and oral infections, perhaps reflecting a tendency toward outpatient management of these conditions.

For certain diagnoses, estimates of the burden of disease differed depending on whether only the first-listed or all diagnoses were counted. For example, the diagnoses of AIDS and mycoses were listed among all diagnoses more frequently than they were the first-listed diagnosis (5 and 10 times, respectively); using the first-listed diagnosis alone underestimates the burden of these infections.

Considering hospitalizations as a dimension of the burden of infectious diseases involves a complicated array of factors in addition to trends in infectious diseases themselves. A general move toward fewer hospitalizations has had an impact on infectious disease hospitalizations, although the proportion of hospitalizations because of infectious diseases has increased. Demographic changes, including an aging population and longer survival of persons with a variety of medical conditions who are more susceptible to infectious diseases, have affected trends in infectious disease hospitalizations. Current medical technologies, which have contributed to improved survival, may also have increased the opportunity for infections through increased use of indwelling intravascular and other invasive devices. This analysis of trends in hospitalizations for infectious diseases extends a previous analysis of infectious disease deaths. The picture emerges from both studies of an increasing burden of infectious diseases in the United States between 1980 and the mid-1990s.

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REFERENCES