**RESEARCH REPORT**

Use of acute hospital beds does not increase as the population ages: results from a seven year cohort study in Germany

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**Objectives:** (1) To compare the number of hospital days used by survivors with those by persons in their last, second last, and third last year of life in relation to age; (2) to analyse lifelong hospital utilisation in relation to life expectancy.

**Design:** Cohort study using a 10% sample (stratified by age and sex) of persons insured by one sickness fund.

**Setting:** Germany, 1989–1995.

**Subjects:** 69847 survivors (with a minimum of three more years to live), 1385 persons in last, 1368 in second last, and 1333 in third last year of life.

**Results:** The number of days spent in hospital in the last year of life was lowest for the young (24.2 days under age 25) and the old (23.2 days at age 85+) and was greatest at ages 55–64 (40.6 days). The ratio of days to survivors was highest at age 35–44 (31.0) and fell continuously thereafter to 4.3 at age 85+. Similar patterns were seen for hospital days in the second and third year before death, except that peaks were at 35–44 years (22.5 and 13.7 days respectively). Calculated lifelong number of hospital days increased with age from 54.8 (death at age 20) to 201.0 (age 90). Numbers of hospital days per year of life, averaged over the entire lifespan, were stable at 2.0–2.2 for deaths between age 50 and 90 (and up to 2.7 at age 20).

**Conclusions:** Lifelong hospital utilisation for persons who die at 50 or later is directly proportional to the number of years lived. These data contradict results from cross sectional studies that suggest an exponential rise in health care costs as longevity increases. They have important implications for projections of future health care expenditure.

The belief that health care costs rise steeply with age is considered “common knowledge” by most clinicians, politicians, health care researchers, and lay people alike. Demographic changes leading to an aging population, a consequent rise in chronic diseases, and technological advances are considered by many to form a triad that will make health care costs unbearable in the future. The belief persists despite a growing body of evidence in support of a more complicated picture. The belief is apparently supported by cross sectional data showing a relation between age and (rising) costs.

Fuchs was the first to point to the fact that the relation between age and health care utilisation or costs is biased by the fact that the percentage of people in their last year of life (which costs well above average) is increasing rapidly with age. He hypothesised that if mortality in all age groups above 65 would be assumed to be constant, health care costs with age would also be constant.

US Medicare data support this assumption. In addition, however, two further things complicate the picture: (1) health care costs for persons in their last year of life reach a maximum at about the age of 70 years and fall with higher age, and (2) health care costs for the group of survivors rise until the age of about 85, reach a maximum and fall with higher age. The marginal increase in lifetime costs associated with an additional year of life decreases as the age at death rises. However, Medicare data have several drawbacks. Firstly, they are limited to over 65 year olds, which has two important shortcomings: (1) “lifetime costs” are actually costs for the lifespan beyond that age only, and (2) the apparent expenditure peak at 70 years is very close to the lower end of the age spectrum, which makes it difficult to tell whether this is really the maximum (or whether younger deceased incur even higher costs). Secondly, the system of health care financing and provision in the USA has many characteristics, including a complex set of incentives, which limit its generalisability to Europe. Such studies are, however, only possible in certain settings, where linked data encompassing both mortality and hospitalisation are available.

Internationally, the authors are aware of only three longitudinal studies that include persons under the age of 65 years, two of them limited to persons above 45 years. One further study from Switzerland included a limited number of decedents below 65 years but did not specify their age.

Concentrating on acute (including psychiatric) hospital utilisation as the largest share of total health care costs, this study had therefore three main objectives

(1) to compare the number of days spent in hospital by survivors in all age groups with those for persons of the same age in their final, second and third last year of life in order to see whether the maximum number of hospital days for decedents in their last year of life is, as US data suggest, around 70 or in fact earlier,

(2) to analyse whether the data found in a health system that is very different from the US system are comparable to the US data for the over 65 year olds, and

(3) to calculate lifelong hospital utilisation in relation to age at death or life expectancy respectively.

**METHODS**

The study is based on a 10% cohort of all insured persons of one German sickness fund which was drawn on 4 November
The total cohort included 87,109 persons. The dataset includes sociodemographic data (date of birth, sex, date of death), work related data (such as profession, type of employer, sick days, (early) retirement), administrative data (beginning of membership in sickness fund, membership status—that is, member, spouse, child, date and reason for end of membership), and data concerning certain health care utilizations (except for ambulatory services and pharmaceuticals) and diagnoses.

Table 1: Number of persons included in study

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>Survivors (male/ female)</th>
<th>Persons in their 3rd last year of life (male/ female)</th>
<th>Persons in their 2nd last year of life (male/ female)</th>
<th>Persons in their last year of life (male/ female)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-24</td>
<td>22272 (12776/ 9495)</td>
<td>28 (23/ 5)</td>
<td>25 (20/ 5)</td>
<td></td>
</tr>
<tr>
<td>25-34</td>
<td>15919 (11619/ 4300)</td>
<td>40 (30/ 10)</td>
<td>52 (42/ 10)</td>
<td></td>
</tr>
<tr>
<td>35-44</td>
<td>11927 (8599/ 3328)</td>
<td>88 (75/ 13)</td>
<td>89 (78/ 11)</td>
<td></td>
</tr>
<tr>
<td>45-54</td>
<td>9685 (6872/ 2813)</td>
<td>147 (118/ 29)</td>
<td>138 (109/ 29)</td>
<td></td>
</tr>
<tr>
<td>55-64</td>
<td>6149 (4205/ 1944)</td>
<td>269 (229/ 40)</td>
<td>257 (216/ 41)</td>
<td></td>
</tr>
<tr>
<td>65-74</td>
<td>2956 (1657/ 1299)</td>
<td>333 (238/ 95)</td>
<td>330 (244/ 86)</td>
<td></td>
</tr>
<tr>
<td>75-84</td>
<td>838 (372/ 466)</td>
<td>326 (171/ 155)</td>
<td>323 (169/ 154)</td>
<td></td>
</tr>
<tr>
<td>85+</td>
<td>102 (41/ 61)</td>
<td>102 (46/ 56)</td>
<td>171 (91/ 80)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>69847 (4414/ 23706)</td>
<td>1333 (930/ 403)</td>
<td>1385 (969/ 416)</td>
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</tr>
</tbody>
</table>

In every age group, at least 50% of persons in their last year of life were admitted to hospital at least once. Young decedents had generally the lowest rates. At around 80%, the rate was highest between 55 and 84 years of age while it dropped to 70% above that age. Percentages in the second and third last year of life were about one half and one third as high in all age groups. Admission rates for survivors increased continuously with age, however. Again, ratios of deceased to survivors were highest for young decedents (table 2).

Length of stay

Persons with any hospital stays in their last year of life spent between 30 and 60 days there with the shortest total stays in the oldest age groups. Similarly, younger decedents were treated longer than older decedents in their second and third last year of life. Like admission rates, treatment duration for survivors increased continuously with age. Ratios of deceased to survivors were again higher for younger deceased and approached 1 with increasing age (table 4). Of the two factors influencing the average number of hospital days, the admission rate to hospital had a larger impact than length of stay in the last two years of life. In the third last year, total length of stay was, however, the main determinant of hospital utilisation of younger decedents (tables 3 and 4).
Lifelong hospital utilisation

Table 5 shows that the lifelong number of hospital days increased steadily from 54.8 for those dying at age 20 to 201.0 for those dying at age 90. The number of hospital days before the last years of life increased by about 10 days for every 10 years lived for persons dying at or before 50 while the increase was more than 30 days for every additional 10 years of life for decedents after age 70. This increase was, however, to a large extent compensated as persons dying at 40 used twice as many hospital resources in their last three years of life as those dying at 90 (70.9 and 34.6 days, respectively).

The average numbers of hospital days per year of life were therefore stable at 2.0 to 2.2 for persons dying between ages 50 and 90 while they were higher for persons dying at younger ages: up to 2.7 at age 20 (table 5).

DISCUSSION

We conclude that the relation between health care costs and age is not as simple as “common knowledge” suggests. The most costly patients are those who die young: If only the last year of life is counted, the 45–64 year-olds have the highest number of hospital days; if the last three years are taken into account, the 35–44 year-olds accumulate the highest hospital utilisation. If the ratio of hospital days for deceased persons versus survivors of the same age is used as a criterion, persons up to 44 years of age are most expensive.

These results are generally in line with previous studies done in the USA, Canada, and the Netherlands: regarding hospital utilisation in the last year(s) of life in relation to age at death, these studies show maximums in age groups below 65, 65–74, 70–74, and 75–84. As far the ratio of hospital days of deceased to survivors is concerned, maximums are always in the youngest age groups included in the studies. Only data from one study from the UK provide a very different picture with hospital days in the last year of life increasing progressively with age or at least to age 85–89. The median of hospital days in this study is comparatively low for age groups up to about 75 years in international comparison but the rate of hospital admissions is not particularly low. Therefore, the shorter length of stay in the UK has apparently affected the younger age groups more than the older ones. The age span covered by our study is, however, considerably wider than all these previous studies, which, except for the Dutch one, excluded persons below age 45 or—mostly—65. Other problems complicating direct comparisons result from the fact that partly the units of measurement are different.
The study), our data are most likely to extend beyond the three years documented in hospital days per year of life. In addition, given the high number of age below 50 are “consuming” above average numbers of hospital days for persons who die at an age number per year of life in these age groups.

According to our calculations, the number of annual hospital days for persons who die at 50 or later is directly proportional to the number of years lived. An aging population might therefore have less impact on health care costs than generally expected. While this study expands our knowledge based on previous studies, further confirmation is needed from other countries and health care systems.

### Table 5

<table>
<thead>
<tr>
<th>Person dying at the age of...</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital days before last three years of life</td>
<td>10.1 (18)</td>
<td>20.2 (27)</td>
<td>30.0 (30)</td>
<td>42.4 (39)</td>
<td>62.2 (51)</td>
<td>86.2 (60)</td>
<td>120.9 (70)</td>
<td>166.4 (83)</td>
</tr>
<tr>
<td>Days in 3rd last year</td>
<td>9.3 (17)</td>
<td>13.4 (18)</td>
<td>13.7 (14)</td>
<td>11.0 (10)</td>
<td>6.9 (6)</td>
<td>9.0 (6)</td>
<td>8.5 (5)</td>
<td>5.1 (3)</td>
</tr>
<tr>
<td>Days in 2nd last year</td>
<td>11.2 (20)</td>
<td>12.0 (16)</td>
<td>22.5 (22)</td>
<td>15.5 (14)</td>
<td>12.4 (10)</td>
<td>12.9 (19)</td>
<td>11.4 (7)</td>
<td>6.3 (5)</td>
</tr>
<tr>
<td>Days in last year</td>
<td>24.2 (44)</td>
<td>28.6 (39)</td>
<td>34.7 (34)</td>
<td>39.2 (36)</td>
<td>40.6 (33)</td>
<td>36.4 (25)</td>
<td>31.8 (18)</td>
<td>23.2 (12)</td>
</tr>
<tr>
<td>Total</td>
<td>54.8 (100)</td>
<td>74.2 (100)</td>
<td>100.9 (100)</td>
<td>108.1 (100)</td>
<td>122.1 (100)</td>
<td>144.0 (100)</td>
<td>172.6 (100)</td>
<td>201.0 (100)</td>
</tr>
<tr>
<td>Average number of days per year of life</td>
<td>2.7</td>
<td>2.5</td>
<td>2.5</td>
<td>2.2</td>
<td>2.0</td>
<td>2.1</td>
<td>2.2</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Percentages shown in parentheses.

### Key points

- The correlation between age and hospital utilisation is complex as the percentage of dying persons with high numbers of hospital days increases with age.
- However, persons who die young “consume” more hospital days in their last years of life than those who die older.
- According to these German data, lifelong hospital utilisation is directly proportional to the number of years lived.
- An aging population might therefore have less impact on health care costs than generally expected.
- While this study expands our knowledge based on previous studies, further confirmation is needed from other countries and health care systems.

### REFERENCES

6. van Vliet RCJA, Lamers LM. The high costs of death: should health plans get higher payments when members die? Med Care 1998;36:1451–60.