Record Linkage in Studies of Cerebrovascular Disease in Oxford, England

BY ROY M. ACHESON, M.D., SC.D.,* AND ANTHONY S. FAIRBAIRN, M.B.†

Abstract:

Data collected by record linkage are used as a basis for an analysis of the burden of cerebrovascular diseases in a population of 340,000 in central England. Comparison with studies which use other methods in the United States and England indicate that for all cerebrovascular diseases together, and for subarachnoid hemorrhage, the assumptions underlying the analysis may have reflected the overall incidence of and survival from serious disease in Oxford reasonably accurately, but this may not be true for two individual rubrics, cerebral hemorrhage and infarction. Criticisms made of this conclusion in the recent literature are discussed. The system in its present state does not permit the study of transient ischemic attacks. Data shown here and elsewhere indicate that subarachnoid hemorrhage is the most reliable of the stroke diagnoses, and the Oxford data show reasonable consistency with others gathered elsewhere using other methods. It would appear that there are considerable age-specific and sex-specific differences for subarachnoid hemorrhage in terms of incidence and survival. Attention is drawn to the extent to which cerebrovascular disease occurs in people under age 65 years.

Additional Key Words: epidemiology, subarachnoid hemorrhage, incidence rates, medical services, survival rates

Introduction

Record linkage has received a good deal of publicity in recent years. This is not because it is new (indeed it is nearly half a century since the concept was first developed by Greenwood) but because modern electronic data-processing techniques have made it feasible on a large scale. The concept is that each person, as he goes through his life, leaves behind him a series of separate pieces of information which, were they pieced together, would paint a complete history of his health and that of his immediate family. These pieces of information come from two different sources: his birth, marriage and death certificates, which are collected by the local government, and his more detailed health records, which are put together by a variety of individuals and agencies, including hospitals, industry, his private physician and insurance companies. More can be achieved from the linking together of these records than compiling the health history of individuals. If a population is defined and information of this kind is obtained for all the people in that population, then it becomes possible to examine the epidemiology of the diseases to which that population is prone as well as to study the use of medical services made by people with those diseases. In this paper we attempt to draw conclusions about the epidemiology of debilitating cerebrovascular dis-

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48
RECORD LINKAGE IN CEREBROVASCULAR DISEASE

TABLE 1
Oxford Record Linkage Area, Estimated Population, 1963

<table>
<thead>
<tr>
<th>Age, years</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;34</td>
<td>94,981</td>
<td>84,045</td>
<td>179,026</td>
</tr>
<tr>
<td>35-44</td>
<td>21,902</td>
<td>22,042</td>
<td>43,944</td>
</tr>
<tr>
<td>45-54</td>
<td>22,293</td>
<td>22,488</td>
<td>44,781</td>
</tr>
<tr>
<td>55-64</td>
<td>16,992</td>
<td>18,221</td>
<td>35,213</td>
</tr>
<tr>
<td>65-74</td>
<td>9,177</td>
<td>13,679</td>
<td>22,856</td>
</tr>
<tr>
<td>75 &amp; over</td>
<td>4,902</td>
<td>8,788</td>
<td>13,690</td>
</tr>
<tr>
<td>Total</td>
<td>170,247</td>
<td>169,263</td>
<td>339,510</td>
</tr>
</tbody>
</table>

ease, and the demands it makes on medical services.

In 1962, Donald Acheson undertook a pioneer study of the feasibility of this system in Oxford, England.1 For the first three years of his investigation he confined his attention to the city of Oxford and to the surrounding countryside, almost all of it in Oxfordshire. The population with which he was concerned at that time was a little less than 340,000; details of this by age and sex are shown in table 1. For the purposes of the present report, we are concerned first with hospital records which bore the discharge diagnosis of cerebrovascular disease and which were obtained from the 29 hospitals in the area, and second with death certificates bearing the diagnosis cerebrovascular disease. The latter were collected by the local governments of Oxford City, Oxfordshire and Berkshire.

As table 2 shows, during the year 1963, 391 people were discharged from the hospital with the diagnosis of cerebrovascular disease. In addition, however, there were 239 people whose deaths were attributed to this cause, but who were not admitted to a hospital for any reason during that year. The distribution of these two groups is shown by the four pertinent rubrics of the seventh revision of the International Classification of Disease in table 2.

Of the 391 people discharged from the hospital during 1963, 214 died within 12 months of admission. In many instances, however, the certified cause of their death was not cerebrovascular disease. On the other hand, there was another group who had been in a hospital during the same year for a disease other than cerebrovascular accident, yet were considered by the certifier to have died of this cause. Further details of such changes in diagnosis are given in tables 3 and 4, each of which contain information for the two years 1963 and 1964.

Table 3 is concerned with the former group, namely people whose last hospital diagnosis was cerebrovascular disease. It can be seen that over the two years there were 341 such people and that in 31.4% of instances the death certificate bore a completely different diagnosis. This compares closely with a figure of 29.1% found when the same comparison was made in Rochester, Minnesota.2 Further examination of table 3 indicates that of the four ICD categories, 330 (subarachnoid hemorrhage) were least likely to change and that

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**Table 2**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

<table>
<thead>
<tr>
<th>ICD code</th>
<th>Hospital discharge (alive or dead)</th>
<th>Males &quot;Home death&quot;</th>
<th>Both</th>
<th>Hospital discharge (alive or dead)</th>
<th>Females &quot;Home death&quot;</th>
<th>Both</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>330</td>
<td>14</td>
<td>3</td>
<td>17</td>
<td>31</td>
<td>6</td>
<td>37</td>
<td>54</td>
</tr>
<tr>
<td>331</td>
<td>54</td>
<td>24</td>
<td>78</td>
<td>76</td>
<td>64</td>
<td>140</td>
<td>218</td>
</tr>
<tr>
<td>332</td>
<td>58</td>
<td>55</td>
<td>113</td>
<td>66</td>
<td>72</td>
<td>138</td>
<td>251</td>
</tr>
<tr>
<td>334</td>
<td>44</td>
<td>8</td>
<td>52</td>
<td>48</td>
<td>7</td>
<td>55</td>
<td>107</td>
</tr>
<tr>
<td>Total</td>
<td>170</td>
<td>90</td>
<td>260</td>
<td>221</td>
<td>149</td>
<td>370</td>
<td>630</td>
</tr>
</tbody>
</table>

*Hospital discharge includes all cases in which cerebrovascular disease was a diagnosis on the hospital discharge sheet whether or not, in those who died, this diagnosis was considered to be the underlying cause of death.

**Table 3**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 4**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 5**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 6**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 7**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 8**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 9**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 10**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 11**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 12**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 13**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 14**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 15**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 31**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 32**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 33**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 34**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 35**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 38**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 39**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification

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**Table 40**

Cases of Cerebrovascular Disease in the Oxford Linkage Study Area in 1963 by Sex, Source of Information, and ICD Classification
ICD 334 (other and ill-defined forms of stroke) was the most likely to change. Table 4 considers the people who were in the hospital during the two years for a reason other than a stroke, who died subsequently, and whose death was thought to be caused by a stroke. Because of the similarities in the total numbers of these two tables and the similarities in the proportion in whom the diagnosis did change, it was decided to assume the two cancelled each other out and, for purposes of estimating the incidence of cerebrovascular disease in the general population, no attempts were made at correcting either the hospital morbidity or the mortality rate for changes in diagnosis.

In an attempt to relate the available data to the general population at risk, these other assumptions were made. First, it is improbable that transient ischemic attacks would gain admission to the hospital; thus, cases included here must have developed signs which lasted for some days.* Next, since the “home deaths” occurred in people who had not been in a hospital during the year of study, these could be added to the hospital discharge data. This gave a total of 630 new cases during 1963. The third and last assumption was that the reason that people had a disease as serious as a stroke which killed them, yet were not admitted to a hospital, was that they died in less than a month. On this basis it was possible to make estimates of both incidence and survival by ICD rubric, age and sex.

**Results**

Estimates of survival are given in table 5 and those of incidence in table 6. These tabulations are presented in such a way that they can be compared directly with the data collected in Middlesex County, Connecticut, by Eisenberg et al., who were concerned with patients whose physical signs lasted at least 48 hours. The data in tables 5 and 6 show some interesting differences between the sexes for cerebrovascular disease. While the male and female mortality patterns are similar, there is a tendency for incidence to be higher in middle-aged and older women than in middle-aged and older men. Moreover, it can be seen that the survival from subarachnoid hemorrhage (ICD 330) is consistently longer in women than in men.

Some information on bed usage by sex and marital status for all forms of cerebrovascular disease combined is given in table 7. However, it can be seen that there is little difference in duration of hospitalization per person per year among single people. Among the married, there is a tendency for women to be hospitalized a good deal longer than men. If an attempt is made to subdivide the married by age, the numbers become very small. The indications are that between the ages of 45 and 64 a married woman will spend twice as many days in the hospital with her stroke than a married man. One must assume that this difference can be ascribed to social reasons. While the middle-aged married woman can look after her convalescing husband at home, the man of the same age must go out and earn his living while his wife blocks a hospital bed.

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*There was no method of identifying the cases so mild that the person neither died nor was admitted to the hospital. Comparison with data collected by Joan Acheson, to be discussed below, indicates that inclusion of these might increase the incidence rates for cerebral ischemia by about fivefold or all age groups combined, though the difference tends to be greater than this among the middle-aged and less among the elderly.

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**TABLE 3**

<table>
<thead>
<tr>
<th>ICD code</th>
<th>Death certificate identical %</th>
<th>Death certified as another form of CVD %</th>
<th>Death certified as due to another cause %</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>330</td>
<td>25 62.5</td>
<td>10 40.0</td>
<td>5 12.5</td>
<td>40</td>
</tr>
<tr>
<td>331</td>
<td>85 68.5</td>
<td>37 27.0</td>
<td>24 16.5</td>
<td>146</td>
</tr>
<tr>
<td>332</td>
<td>41 40.6</td>
<td>18 17.8</td>
<td>42 41.6</td>
<td>101</td>
</tr>
<tr>
<td>334</td>
<td>8 14.8</td>
<td>10 18.5</td>
<td>36 66.7</td>
<td>54</td>
</tr>
<tr>
<td>All</td>
<td>159 46.6</td>
<td>75 22.0</td>
<td>107 31.4</td>
<td>341</td>
</tr>
</tbody>
</table>
Table 4 gives some information about hospital usage by social class in males using the Registrar General's Classification, in which class 1 consists of professional people and class 5 unskilled laborers. The other three classes are intermediate, and all five are graded according to probable income and general standard of living. The same tabulation is not attempted for women because meaningful social classification for them is much more difficult. Some are employed and some are not, and the standard of living of all of them...
### TABLE 6

Estimated Total Incidence of Cerebrovascular Disease in the Oxford Record Linkage Study Area in 1963 by Age, Sex, and ICD Classification Per 1,000 Population

<table>
<thead>
<tr>
<th>Age, yrs.</th>
<th>Males</th>
<th>Females</th>
<th>All</th>
<th>Males</th>
<th>Females</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 34</td>
<td></td>
<td></td>
<td>0.02</td>
<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
</tr>
<tr>
<td>35-</td>
<td>0.10</td>
<td>0.05</td>
<td>0.04</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>45-</td>
<td>0.13</td>
<td>0.22</td>
<td>0.04</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>55-</td>
<td>0.41</td>
<td>0.58</td>
<td>0.05</td>
<td>0.07</td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>65-</td>
<td>0.32</td>
<td>0.65</td>
<td>0.05</td>
<td>0.07</td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>75 &amp; over</td>
<td>6.94</td>
<td>11.43</td>
<td>4.9</td>
<td>23.27</td>
<td>0.68</td>
<td>7.51</td>
</tr>
</tbody>
</table>

### TABLE 7

Number of Hospital Admissions, Persons Admitted and Mean Duration of Stay in Hospital for All Persons with Cerebrovascular Disease by Sex and Marital Status in 1963

<table>
<thead>
<tr>
<th>Marital status</th>
<th>No. of persons</th>
<th>No. of admissions</th>
<th>Total days</th>
<th>Days per person</th>
<th>Days per admission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not known</td>
<td>14</td>
<td>14</td>
<td>216</td>
<td>15.43</td>
<td>15.43</td>
</tr>
<tr>
<td>Single</td>
<td>31</td>
<td>40</td>
<td>2129</td>
<td>68.68</td>
<td>53.22</td>
</tr>
<tr>
<td>Married</td>
<td>223</td>
<td>273</td>
<td>8164</td>
<td>36.61</td>
<td>29.90</td>
</tr>
<tr>
<td>Widowed, divorced</td>
<td>61</td>
<td>72</td>
<td>6825</td>
<td>111.89</td>
<td>94.79</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>3</td>
<td>145</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>332</td>
<td>402</td>
<td>17479</td>
<td>52.65</td>
<td>43.48</td>
</tr>
<tr>
<td>Females</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not known</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>69</td>
<td>80</td>
<td>5385</td>
<td>78.04</td>
<td>67.31</td>
</tr>
<tr>
<td>Married</td>
<td>146</td>
<td>186</td>
<td>8103</td>
<td>55.50</td>
<td>43.56</td>
</tr>
<tr>
<td>Widowed, divorced</td>
<td>170</td>
<td>195</td>
<td>15521</td>
<td>91.30</td>
<td>79.59</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>4</td>
<td>760</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>390</td>
<td>466</td>
<td>29773</td>
<td>76.34</td>
<td>63.89</td>
</tr>
</tbody>
</table>

### TABLE 8


<table>
<thead>
<tr>
<th>Social class</th>
<th>Population at risk</th>
<th>No. of cases</th>
<th>Incidence per 10,000</th>
<th>Mean days hospitalization per person</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6,090</td>
<td>6</td>
<td>10.2</td>
<td>9.83</td>
</tr>
<tr>
<td>2</td>
<td>21,707</td>
<td>22</td>
<td>10.6</td>
<td>48.86</td>
</tr>
<tr>
<td>3</td>
<td>80,583</td>
<td>55</td>
<td>6.6</td>
<td>37.80</td>
</tr>
<tr>
<td>4</td>
<td>28,110</td>
<td>30</td>
<td>10.7</td>
<td>28.47</td>
</tr>
<tr>
<td>5</td>
<td>19,678</td>
<td>12</td>
<td>6.1</td>
<td>24.92</td>
</tr>
<tr>
<td>Other and unclassifiable</td>
<td>13*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>156,168</td>
<td>138</td>
<td>8.8</td>
<td>43.83</td>
</tr>
</tbody>
</table>

*These men were not gainfully employed, or were unclassified for other reasons; three of them (all in ICD 330) were "home deaths."
RECORD LINKAGE IN CEREBROVASCULAR DISEASE

Persons admitted to hospital 1963
- Males: 40.6%
- Females: 29.9%
- Total no. of observations: 391

Bed-days in hospital 1963
- Males: 34.7%
- Females: 11.0%
- Total bed-days: 25,923

Persons dying 1963 and 1964
- Males: 19.7%
- Females: 13.6%
- Total deaths: 859


depends as much upon their husband's occupation as on their own. It can be seen that in males there is no consistent pattern of hospital usage by social class, although the duration of stay may be a little shorter in class 1.

The last point to which we will draw attention is the extent to which cerebrovascular disease presents a problem in persons under 65 years. Three different approaches to answering this problem are shown in figure 1. It can be seen that if mortality data are considered, 20% of men and 14% of women come into this category. These proportions are closely similar to those which can be calculated from the United States Mortality Statistics. If bed days in a hospital are used as a measure of morbidity the pattern changes; the morbidity in men rises to 35% and in women falls to 11%. If, however, the number of persons admitted to a hospital from the defined population is used as a basis for the calculation, the proportions rise in both sexes; in men 41% are under 65 and in women the proportion is 30%. Table 9 gives the percentages by diagnosis of people under 65 for the sexes combined. It can be seen that the largest contribution in numbers is to be found among people with subarachnoid hemorrhage (ICD 330), but that the largest contribution in numbers is to be found among people with cerebral hemorrhage (ICD 331). Between them, these two diagnoses make up 43% of all persons admitted who were less than 65 years.

Discussion

Comparing with other studies

In another report, the present findings are compared in detail with the survey of Middlesex County, Connecticut, by Eisenberg and his colleagues. The general estimates of incidence for all strokes were shown to be almost identical in women in the two popula-

<table>
<thead>
<tr>
<th>ICD code</th>
<th>Total number</th>
<th>Proportion under 65 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>330</td>
<td>45</td>
<td>73</td>
</tr>
<tr>
<td>331</td>
<td>130</td>
<td>43</td>
</tr>
<tr>
<td>332</td>
<td>124</td>
<td>25</td>
</tr>
<tr>
<td>334</td>
<td>92</td>
<td>35</td>
</tr>
<tr>
<td>All</td>
<td>391</td>
<td>35</td>
</tr>
</tbody>
</table>

FIGURE 2

As for figure 2—cerebral infarction and ischemia (ICD 332) only.

must be fortuitous because in a survey he is presently undertaking in the Rhondda Fach, a mining valley in South Wales, 60% of all strokes are cared for throughout their illness at home. Were this to be the case in Oxford, the assumptions upon which our estimates have been based could clearly be invalid. As we\(^5\) have pointed out in a reply to Cochrane, we believe that techniques in medical care in South Wales are substantially different from those in central England, partly because a survey undertaken in 1961 showed the Welsh to have...
a greater preference to be cared for by the family physician than have the English, and partly because Cochrane himself has been influential in encouraging the home care of such serious conditions as coronary heart disease.

A second reason for our belief that our assumptions, in the Oxford area at least, have helped us to obtain a reasonably accurate picture of the epidemiology of stroke is that our estimates of the survival patterns for all strokes together are almost identical with actual survival rates computed by Eisenberg and his colleagues. Survival, of course, measures a different aspect of natural history of disease from incidence.

Dr. John Fry, a general practitioner in Beckenham, Kent, who makes a special point of trying to manage his cases himself with the aid of diagnostic services, has cared for 224 persons with stroke over the past 20 years. Of these, 61 patients (27%) had signs and symptoms lasting more than two days, survived more than a month, yet never visited a hospital.

Neither he nor practitioners in the Rhondda Fach participate in the Oxford Record Linkage System, but his data do indicate that there are those in Britain whose primary care of stroke patients differs significantly from that in the Rhondda Fach. Support for this view is given by Dr. Adrian Semmence of Abingdon, Berkshire, whose patients are included in the Oxford study, and who writes that "in general terms... all cases of stroke in my practice under 65 are admitted to hospital and also the majority of the older ones."

Two further reports have come to our attention, comparison with each of which, in its own way, is helpful in indicating that the techniques used in Oxford do indeed give a reasonable estimate of cerebrovascular disease of sufficient severity to merit bedcare in the general population. Both are based on medical records. The first was conducted in two general
practices in Stoke-on-Trent, England, each diagnosis of a presumptive stroke being confirmed by a specialist in the local hospital.8, 17 This alone of the four studies included transient ischemic attacks. The other obtained its material from the Mayo Clinic and community hospitals in Rochester, Minnesota.2, 18 Comparisons of overall age-specific and sex-specific incidence rates estimated in the four are shown in figure 2. The Oxford-Rochester comparison is strikingly similar to the Oxford-Middlesex one; for again, while there is little difference in the rates for women, in Oxford rates are lower for men. In both sexes, however, the rates for Stoke-on-Trent are much higher than for the other three sets of data. This, as figure 3 shows, is in large part due to differences in incidence of occlusive phenomena. This in turn can be attributed to the inclusion in Stoke-on-Trent of transient ischemic attacks,8, 17 although in Stoke-on-Trent the rates for cerebral hemorrhage are also higher in males. In both sexes cerebral infarction is recorded far more frequently in Rochester16 than in Oxford, and the opposite tends to be true of cerebral hemorrhage in females, though not in males.14 In the older age groups the rates for hemorrhage in both sexes are higher in both the British studies than in Rochester (fig. 4). Interpretation of such differences is always difficult,6, 8 for there is presently no way of knowing whether they can be ascribed to diagnostic practice or whether they are a true reflection of epidemiology.

SUBARACHNOID HEMORRHAGE
Various aspects of the data for subarachnoid hemorrhage are of interest. To begin with, the Oxford data show a clear difference between the sexes in both incidence and survival (see tables 5 and 6); although middle-aged women are more likely to suffer subarachnoid hemorrhage than middle-aged men, they are also more likely to survive it.

Similarities are reported from Stoke-on-Trent17 where the crude incidence rate for women was higher than for men, but the opposite was true of the crude death rates. Moreover, the mean age at incidence was higher in women than in men. Crawford and Sarner18 also report a higher death rate in men than women in a study of middle-aged patients with subarachnoid hemorrhage in Surrey, England. Despite the tiny numbers in the Rochester study,17 it would seem that the incidence data there follow a similar pattern (see fig. 5). Small numbers make sex-specific survival comparisons between Oxford and Rochester impossible, and no such data are available for Stoke-on-Trent; however, for sexes together, the one-year survival rates of 31% in Rochester for nine survivors and 43% for 22 survivors in Oxford are broadly similar to each other. The Oxford follow-up period is not long enough to permit comparison with Keller’s five-year survival figure of 40% for veterans from the U. S. Armed Forces.19 The Rochester figure for five years is 27%, and it seems most unlikely that the mortality in Oxford in the second through the fifth year would have been as low as 3%. Therefore, Keller’s five-year survival seems high and it may be that some of his potential study population died before reaching a V. A. hospital.

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