AN INVESTIGATION INTO THE MORTALITY OF IMPAIRED LIVES

by

R. D. CLARKE, F.I.A.

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INTRODUCTION

1. In 1947 the company with which the author is associated decided to institute an enquiry into the mortality of impaired lives. From the first the venture was both medical and actuarial, and a leading part in the planning of the investigation was undertaken by the company’s Principal Medical Officer, T. W. Preston, M.D., who devised an impairment coding scheme and has since continued to supervise the coding of policies qualifying for inclusion in the data. While the present paper describes methods used in the statistical analysis of the results, the author wishes to place on record the major role played by Dr. Preston in the carrying out of the investigation. The work has, in fact, involved the combination of medical and actuarial skills and without the participation of the medical profession no actuarial investigation into the mortality of impaired lives would be practicable.

2. During the last decade the Joint Mortality Investigation Committee of the Faculty and Institute has had under consideration the possibility of instituting a combined investigation into impaired lives’ mortality, in which data would be supplied by the life offices operating in Great Britain. The company referred to in the preceding paragraph agreed that its experience might serve as a pilot enquiry for guiding the Committee, the profession generally, and the life offices concerned, towards a decision on the question whether a combined investigation was thought to be desirable and, if an affirmative answer should be given to this question, on the methods to be employed and the impairment groups to be included. The main purpose behind the present paper, therefore, is to report on the machinery of the investigation rather than to communicate statistical
information regarding the mortality of impaired lives—although the results produced are, within their limitations, of some general interest.

3. The period covered by the investigation runs from its institution in July 1947 to the end of 1958, i.e. 11½ years. Some of the impairments examined were introduced after the investigation had begun and for them, therefore, the period is shorter. The experience is restricted to policies issued since the start of the investigation (or, in the case of the groups introduced later, since the date of introduction of the impairment group). Consequently, the average duration of the exposed-to-risk is relatively short. This point is especially important because the data were not sufficient to permit analysis in select form. Thus, although the results are expressed in aggregate form, there is a heavy weighting in favour of the short durations. As will be described later, the "normal" mortality experience used as a basis for calculating expected deaths was chosen to approximate as closely as possible in duration to the experience of the impaired lives. The investigation will need to run for a much longer period before sufficient experience at later durations will become available for examination. It is then hoped that an analysis on a select basis, at least for some of the impairments, will prove possible.

IMPAIRED LIVES SELECTED FOR INVESTIGATION

4. It was not practicable to extend the scope of the investigation so as to include every impairment encountered in the course of underwriting. For impairments which occur comparatively infrequently, sufficient data would not have accumulated to provide useful results. Accordingly, the rarer conditions have, in general, been excluded. It was not, however, always possible to foretell the quantity of data which would be forthcoming and consequently certain groups were included where in the event the data have proved insufficient.

5. A list of the impairments covered by the investigation is given in Appendix A. A code of three digits is attached to each impairment. The first digit indicates the generic nature of the impairment, e.g. circulatory, digestive, respiratory, etc. Details of the particular condition are indicated by the second and third digits, the actual scheme employed varying according to the nature of the impairment. In addition to the three-digit code, a subsidiary letter code was adopted to indicate such subsidiary details as family history or duration since the observation of symptoms. So far the quantity of data has not justified analysis according to these subsidiary attributes,
but it is possible that, at a later date, such an analysis may prove feasible for some of the larger groups.

6. As may be seen from Appendix A, the impairment groups covered have been as follows:

- Arteriosclerosis
- Hypertension
- Hypotension
- Impairment of the coronary arteries
- Peptic ulcer
- Dyspepsia
- Cholecystitis
- Amoebic dysentery
- Hernia
- Varicose veins
- Epilepsy
- Head injuries
- Psycho-neuroses
- Migraine
- Attacks of unconsciousness
- Poliomyelitis
- Otitis media
- Tuberculosis
- Family history of tuberculosis
- Glycosuria
- Diabetes
- Goitre
- Underweight
- Overweight
- Bronchitis and asthma

Various urinary disorders (see Appendix A for details)

Tumours
Anaemia
Osteomyelitis

Lives exhibiting two or more major impairments have been excluded from the investigation. For this purpose an impairment has been regarded as "major" if it would warrant a surcharge in its own right even though unaccompanied by other adverse features. Inevitably, cases of doubt have arisen and these have been determined at the discretion of the Principal Medical Officer. For hypertension and tuberculosis the coding incorporates build, so that overweights with
hypertension and underweights with personal history of tuberculosis are coded separately from similar lives of standard weight. For hypertension there is also a subdivision by age at entry, since average blood pressure rises with increasing age. Respiratory diseases (other than tuberculosis) have also been subdivided by age at entry.

7. The coding system adopted has been criticised for the minuteness of classification. To this criticism there is the powerful answer that once the cards have been punched and the data tabulated, groups can always be combined but they can never be further subdivided. Thus, to take a specific instance, hypertension is classified according to three characteristics—build, systolic pressure and diastolic pressure—leading to eighteen individual codes. The need for using different standard blood pressures at different periods of life has led to a further subdivision into three groups of ages at entry, thus producing fifty-four individual codes altogether. For many of these codes the data have proved to be very scanty and in such cases it is possible that only limited use will be made of the resultant experience. But since it was part of the object of the investigation to discover in what manner and to what extent mortality varied with blood pressure reading, it is difficult to see how any combination of groups could have been effectually introduced. If the results are to have meaning, the experience should be as homogeneous as possible. To ensure this the detailed classification is essential, even though the data in some of the rarer groups may eventually have to be discarded. Moreover, a small group which may be uninformative by itself may be useful as part of a series.

8. It has been a basic principle of the investigation that the experience should be examined without reference to the terms of acceptance. If a life assured exhibited one of the listed impairments, the policy was included in the data whether it was surcharged or whether it was accepted at normal rates. The object of the investigation was not to test the accuracy of past underwriting but to provide a measure of the mortality within specified impairment groups as a guide for future underwriting. To have restricted the enquiry to surcharged cases would to some extent have been prejudging the issue. Thus, it might have proved that some impairments which have customarily been accepted at normal rates should in fact have been surcharged. Moreover, underwriting policy may change over the years and the consistency and homogeneity of the experience would be upset if a surcharge were made a criterion of inclusion.
An Investigation into the
within the data. At the same time it was decided to record the acceptance terms on the basic card, in case a subsidiary analysis should at any time be required for internal office purposes.

9. For an investigation into the mortality of impaired lives to be complete it would be necessary to embrace declined lives as well as lives accepted for assurance. Unfortunately this lies beyond the boundary of practicability. One cannot help wondering, however, how many people who have been rejected for life assurance might have been accepted if a suitable measure of the surcharge required had been available. Few risks are completely uninsurable. Many of those which are customarily declined owe their rejection either to ignorance of the risk involved or perhaps to a reluctance on the part of underwriters to impose an extra premium which appears high in relation to the basic premium. If, however, some machinery could be devised outside the life assurance ambit for examining the experience of impaired lives who cannot obtain cover, it might well be found that the benefit of life assurance could be extended to many categories which are at present excluded. In this connection it is interesting to note that one British reassurance office has in recent years instituted pools for medical risks that have commonly been considered uninsurable.

RECORDING OF DATA

10. For every policy included in the investigation a special card was punched which was additional to the cards needed for ordinary office purposes. The work of the investigation was thus rendered independent of other routine processes. It was, of course, necessary to punch a special hole on the normal office "in force" card to indicate that the policy was included in the impaired lives' investigation so that when the policy lapsed, matured or became a death claim, the information could be passed to the department handling the records of the investigation. The information recorded on the special cards was as follows:

1. Sex
2. Year and month of entry
3. Year of birth
4. Age next birthday at entry
5. Class of policy
6. Term (where appropriate)
7. Impairment code
8. Policy number
Most of the items listed above are self-explanatory. Under item 10 the information recorded shows whether the policy was accepted at normal rates, with a decreasing deduction, with an extra premium, or with a rating-up in age. The amount of the decreasing deduction, extra premium, or age rating, is also given. So far, however, none of this information has been used.

11. The cause of death codes employed are shown in Appendix B. One of the most interesting features of an investigation into the mortality of impaired lives is to discover which causes of death are particularly associated with specific impairments at entry. The code list may seem brief beside the far more elaborate analyses which are employed by demographers for population data, but the scale of the investigation did not justify a more elaborate classification. A careful scrutiny is maintained on “other causes” and if any noteworthy features were being masked by inclusion in this residual category they would quickly be detected.

**TABULATION OF DATA**

12. Within each individual impairment group the following data were tabulated:

- New business
- Withdrawals
- Deaths

Policies existing on 31st December 1958

For new business the ages employed in the tabulation were the ages next birthday at entry. For deaths and withdrawals the ages were derived by adding the mean duration (= year of exit minus year of entry) to the age next birthday at entry. For policies existing on 31.12.58 the ages were the ages next birthday at entry plus the difference between 1958 and the year of entry. Thus $E_x$, the exposed-to-risk from age $x$ to $(x+1)$, is obtained by the formula:

$$E_x = E_{x-1} + \frac{1}{2}(n_x + n_{x+1}) - \frac{1}{2}(w_x + w_{x+1}) - e_x - \theta_x$$

and the rate of mortality, $q_x$, is:

$$q_x = \theta_{x+1}/E_x$$
13. In practice the data were far too scanty to produce meaningful rates of mortality at individual ages and the only practicable means of analysis was a comparison of actual and expected deaths in broad age-groups. It was thus important to determine a suitable basis for calculating expected deaths. Ideally the experience within each impairment group should be measured against the experience of a corresponding group of first-class lives. Such purism was not possible in practice and it was necessary to devise a single basic experience which would produce a table of mortality rates which could be applied to the exposed-to-risk in all groups.

14. The data for the control experience were taken from the experience of first-class lives of the office concerned. It was necessary to approximate as far as possible to the conditions of the impaired lives data with regard to (a) the period of the investigation and (b) the duration of the exposed-to-risk (since the experience was being examined on an aggregate basis). As already stated, the period of the investigation ran from 1.7.47 to 31.12.58. However, during that period the data were steadily accumulating so that the heaviest weight fell at the end of the period. To have taken the first-class experience for 1947-58 or 1948-58 would have been inappropriate because it would have been spread evenly over the period. Examination of the data for the impaired lives showed that the weighted mean year of the experience was 1955 and it was accordingly decided to use as a control the experience of first-class lives during the period 1954-56.

15. As indicated earlier, the mean duration of the experience is short; examination in detail has revealed that it is in fact slightly under three years. It was necessary that the control experience used for calculating expected deaths should correspond fairly closely in duration and consequently a full aggregate experience of first-class lives based upon all durations would not be appropriate. It was decided that an aggregate mortality experience based on durations 0–4 would be the nearest practical equivalent. Accordingly, the rates of mortality employed for calculating the expected deaths were derived from the experience of the office concerned among first-class lives at durations 0–4 during the three years 1954-56. A table of these rates, which will hereafter be referred to as the Standard (0–4) Table, is reproduced in Appendix C.
16. It is interesting to compare the Standard (0–4) Table with other recent assured lives’ mortality. Some time ago the Joint Mortality Investigation Committee constructed a “Light” table (published in T.F.A. vol. 26, p. 122 and J.I.A. vol. 85, p. 57) from the data for the years 1952-55 at durations 2 and over from a group of offices exhibiting light mortality. This table shows rates of mortality at the youngest ages which are actually lower than the corresponding rates in the Standard (0–4) Table. Naturally the mean duration of data at young ages is always low and consequently the difference in mean duration between the two tables cannot be large. With increasing age the mean duration in the Light table also increases and, as expected, the rates of mortality become substantially heavier than in the Standard (0–4) Table. By coincidence the values of $q_x$ in the Standard (0–4) Table correspond very closely to the values of $q_{x+1}^{(0–4)}$ in the A1949-52 Table. This, of course, is entirely fortuitous. Rates of mortality at specimen ages from the three tables are shown below:

<table>
<thead>
<tr>
<th>Age $x$</th>
<th>Light (1952-55) Table $q_x$</th>
<th>Standard (0–4) Table $q_x$</th>
<th>A1949-52 Table $q_{x+1}^{(0–4)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>-0.0093</td>
<td>-0.0096</td>
<td>-0.0084</td>
</tr>
<tr>
<td>40</td>
<td>-0.0149</td>
<td>-0.0138</td>
<td>-0.0148</td>
</tr>
<tr>
<td>50</td>
<td>-0.0494</td>
<td>-0.0458</td>
<td>-0.0461</td>
</tr>
<tr>
<td>60</td>
<td>-0.1459</td>
<td>-0.1236</td>
<td>-0.1244</td>
</tr>
</tbody>
</table>

17. There are reasons for believing that the Standard (0–4) rates of mortality are somewhat heavier than would have resulted from data for first-class lives collected in a precisely analogous manner to the impaired lives’ data. Thus the results for certain minor impairments show mortality below Standard (0–4). This may be due to the different weighting of the durations within the two experiences, to the presence of a small number of female lives in the impaired lives’ data, or to both. As a consequence, however, it may be assumed that the extra mortality has been slightly understated. But as this paper is primarily concerned with the machinery of the investigation, no attempt has been made to adjust the percentages of actual to expected deaths. Moreover, when seen in perspective, the errors are small in comparison both with the random deviations arising from paucity of data and with the magnitude of the extra mortality in the major impairment groups.
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ANALYSIS OF RESULTS

18. The results of the investigation are given in Table I, which shows exposed-to-risk, actual deaths, expected deaths by the Standard (0–4) Table and the percentages of actual to expected deaths with corresponding standard deviations. (It is to be noted that the standard deviations are not theoretically correct because in calculating them the presence of duplicates in the data has been ignored. The additions required, however, would be small in proportion to the extra mortality being measured.) The degree of detail in which the statistics have been analysed has been determined by the quantity of data within the various impairment groups. Thus for hypertension an age subdivision has been possible and, in addition, statistics are shown for four individual code numbers. A considerable amount of subdivision has also been possible for peptic ulcer. For other impairments, however, it has been necessary to show the statistics in fairly broad groups.

19. Two points should be borne in mind when examining the results. The impaired lives' investigation contained a small proportion of female lives, whereas the experience from which the Standard (0–4) Table was derived consisted entirely of male lives. This will have the effect of slightly understating the extra mortality. The other feature is that the elimination of duplicate policies proved impracticable and consequently the true standard deviations of the percentages of actual to expected deaths are somewhat larger than the estimates given in Table 1. In an impaired lives' investigation, however, there is much to be said for not excluding duplicate policies since a later policy may not show the same impairment description as an earlier policy and may consequently be assigned to a different group. For hypertension, where there is a classification by age at entry, the exclusion of duplicates could lead to serious loss of data in the higher age groups.
### Table 1
Comparison of Actual and Expected Deaths within Impairment Groups
(Expected Deaths are based on the Standard (0-4) Table)

<table>
<thead>
<tr>
<th>Code</th>
<th>Nature of Impairment</th>
<th>Total no. of policies entering</th>
<th>Exposed to risk</th>
<th>Actual Deaths</th>
<th>Expected Deaths</th>
<th>100 A/E ± σ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Circulatory Impairments</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100-103</td>
<td>Arteriosclerosis or Atheroma</td>
<td>384</td>
<td>1,913</td>
<td>25</td>
<td>23-9</td>
<td>105±21</td>
</tr>
<tr>
<td>110-128</td>
<td>Hypertension, entry ages under 40</td>
<td>3,177</td>
<td>14,491\frac{1}{2}</td>
<td>33</td>
<td>18-2</td>
<td>181±32</td>
</tr>
<tr>
<td>130-148</td>
<td>Hypertension, entry ages 40-59</td>
<td>5,338</td>
<td>22,560\frac{1}{2}</td>
<td>246</td>
<td>145-5</td>
<td>169±11</td>
</tr>
<tr>
<td>130</td>
<td>Standard weight, S.A.P. 155-170, D.A.P. &lt;95</td>
<td>1,456</td>
<td>6,454</td>
<td>81</td>
<td>45-9</td>
<td>176±20</td>
</tr>
<tr>
<td>132</td>
<td>Standard weight, S.A.P. 155-170, D.A.P. 95-105</td>
<td>1,159</td>
<td>5,289</td>
<td>53</td>
<td>34-3</td>
<td>155±21</td>
</tr>
<tr>
<td>138</td>
<td>Standard weight, S.A.P. &lt;155, D.A.P. 95+</td>
<td>1,178</td>
<td>5,386</td>
<td>45</td>
<td>30-8</td>
<td>146±22</td>
</tr>
<tr>
<td>150-168</td>
<td>Hypertension, entry ages 60 and over</td>
<td>1,266</td>
<td>4,787\frac{1}{2}</td>
<td>134</td>
<td>110-3</td>
<td>121±10</td>
</tr>
<tr>
<td>150</td>
<td>Standard weight, S.A.P. 160-175, D.A.P. &lt;100</td>
<td>644</td>
<td>2,591</td>
<td>78</td>
<td>61-8</td>
<td>126±14</td>
</tr>
<tr>
<td></td>
<td><strong>Digestive Impairments</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200-203</td>
<td>Peptic ulcer, short history, no operation</td>
<td>706</td>
<td>2,416\frac{1}{2}</td>
<td>6</td>
<td>8-7</td>
<td>69±28</td>
</tr>
<tr>
<td>204-207</td>
<td>Peptic ulcer, short history, with operation</td>
<td>802</td>
<td>3,394</td>
<td>24</td>
<td>11-4</td>
<td>211±43</td>
</tr>
<tr>
<td>210</td>
<td>Peptic ulcer, long history, no operation, no complications</td>
<td>4,255</td>
<td>18,442</td>
<td>74</td>
<td>64-1</td>
<td>115±13</td>
</tr>
<tr>
<td>211-213</td>
<td>Peptic ulcer, long history, no operation, with complications</td>
<td>458</td>
<td>2,111\frac{1}{2}</td>
<td>15</td>
<td>10-4</td>
<td>144±37</td>
</tr>
<tr>
<td>214</td>
<td>Peptic ulcer, long history, with operation, no complications</td>
<td>2,111</td>
<td>8,213\frac{1}{2}</td>
<td>58</td>
<td>41-4</td>
<td>140±18</td>
</tr>
<tr>
<td>215-217</td>
<td>Peptic ulcer, long history, with operation, with complications</td>
<td>1,079</td>
<td>4,473</td>
<td>34</td>
<td>19-0</td>
<td>179±31</td>
</tr>
<tr>
<td>220-225</td>
<td>Dyspepsia, gastritis</td>
<td>11,748</td>
<td>46,843\frac{1}{2}</td>
<td>120</td>
<td>124-7</td>
<td>96±9</td>
</tr>
<tr>
<td>230-233</td>
<td>Cholecystitis</td>
<td>1,018</td>
<td>3,040</td>
<td>17</td>
<td>20-2</td>
<td>84±20</td>
</tr>
<tr>
<td>Code</td>
<td>Nature of Impairment</td>
<td>Total no. of policies entering</td>
<td>Exposed to risk</td>
<td>Actual Deaths</td>
<td>Expected Deaths</td>
<td>100 A/E ± σ</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------</td>
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<td>---------------</td>
<td>-----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>250-252</td>
<td>Hernia (unclassified)</td>
<td>16,654</td>
<td>54,226½</td>
<td>148</td>
<td>151·8</td>
<td>97 ± 8</td>
</tr>
<tr>
<td>260-262</td>
<td>Hernia (inguinal or femoral)</td>
<td>5,211</td>
<td>19,222</td>
<td>71</td>
<td>97·3</td>
<td>73 ± 9</td>
</tr>
<tr>
<td>270-272</td>
<td>Hernia (ventral, umbilical)</td>
<td>313</td>
<td>1,123</td>
<td>7</td>
<td>5·3</td>
<td>132±50</td>
</tr>
<tr>
<td>280-287</td>
<td>Varicose veins</td>
<td>8,821</td>
<td>27,098½</td>
<td>76</td>
<td>84·1</td>
<td>90 ± 10</td>
</tr>
</tbody>
</table>

**Impairments of Brain and Nervous System**

<table>
<thead>
<tr>
<th>Code</th>
<th>Nature of Impairment</th>
<th>Total no. of policies entering</th>
<th>Exposed to risk</th>
<th>Actual Deaths</th>
<th>Expected Deaths</th>
<th>100 A/E ± σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>Epilepsy Petit mal</td>
<td>361</td>
<td>974</td>
<td>6</td>
<td>2·0</td>
<td>—</td>
</tr>
<tr>
<td>301</td>
<td>Epilepsy Grand mal</td>
<td>606</td>
<td>2,920½</td>
<td>9</td>
<td>4·0</td>
<td>—</td>
</tr>
<tr>
<td>310-319</td>
<td>Head injuries</td>
<td>3,860</td>
<td>15,069</td>
<td>36</td>
<td>32·8</td>
<td>110±18</td>
</tr>
<tr>
<td>320-323</td>
<td>Psycho-neuroses</td>
<td>6,188</td>
<td>21,600½</td>
<td>51</td>
<td>51·1</td>
<td>100±14</td>
</tr>
</tbody>
</table>

**Otitis Media**

<table>
<thead>
<tr>
<th>Code</th>
<th>Nature of Impairment</th>
<th>Total no. of policies entering</th>
<th>Exposed to risk</th>
<th>Actual Deaths</th>
<th>Expected Deaths</th>
<th>100 A/E ± σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>360</td>
<td>Otitis media (without operation)</td>
<td>5,231</td>
<td>15,375</td>
<td>40</td>
<td>28·0</td>
<td>143±23</td>
</tr>
<tr>
<td>361-362</td>
<td>Otitis media (with mastoidectomy or perforated ear drum)</td>
<td>4,417</td>
<td>12,750½</td>
<td>14</td>
<td>22·1</td>
<td>68±23</td>
</tr>
</tbody>
</table>

**Tuberculosis**

<table>
<thead>
<tr>
<th>Code</th>
<th>Nature of Impairment</th>
<th>Total no. of policies entering</th>
<th>Exposed to risk</th>
<th>Actual Deaths</th>
<th>Expected Deaths</th>
<th>100 A/E ± σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>400-409</td>
<td>Non-pulmonary tuberculosis</td>
<td>2,187</td>
<td>7,866</td>
<td>16</td>
<td>17·0</td>
<td>94±24</td>
</tr>
<tr>
<td>420-423</td>
<td>Fistula in ano</td>
<td>662</td>
<td>2,806½</td>
<td>17</td>
<td>9·5</td>
<td>179±43</td>
</tr>
<tr>
<td>430-439</td>
<td>Pleurisy and spontaneous pneumothorax</td>
<td>6,063</td>
<td>24,921</td>
<td>59</td>
<td>68·3</td>
<td>86±11</td>
</tr>
<tr>
<td>440-443</td>
<td>Pulmonary tuberculosis, mild, not treated by special methods</td>
<td>1,274</td>
<td>4,163</td>
<td>16</td>
<td>8·6</td>
<td>186±47</td>
</tr>
<tr>
<td>444-447</td>
<td>Pulmonary tuberculosis, moderate or severe, not treated by special methods</td>
<td>1,495</td>
<td>5,113½</td>
<td>18</td>
<td>13·6</td>
<td>132±31</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td>Cases</td>
<td>Mortality</td>
<td>Rate</td>
<td>Standard</td>
<td>Unit of Measurement</td>
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<td>--------</td>
<td>-----------------------------------------------------------------------------</td>
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<td>----------</td>
<td>--------------------</td>
</tr>
<tr>
<td>450-457</td>
<td>Pulmonary tuberculosis, treated by special methods</td>
<td>1,872</td>
<td>5,942½</td>
<td>10</td>
<td>9·9</td>
<td>101 ± 32</td>
</tr>
<tr>
<td>460-465</td>
<td>Family history of tuberculosis</td>
<td>19,665</td>
<td>73,629½</td>
<td>153</td>
<td>188·1</td>
<td>81 ± 7</td>
</tr>
<tr>
<td></td>
<td><strong>Endocrine Impairments</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500-508</td>
<td>Glycosuria (not proved to be diabetes mellitus), no B.S.T.T.</td>
<td>495</td>
<td>2,624</td>
<td>23</td>
<td>13·4</td>
<td>172 ± 35</td>
</tr>
<tr>
<td>510-519</td>
<td>Glycosuria (not proved to be diabetes mellitus), B.S.T.T.</td>
<td>501</td>
<td>2,395½</td>
<td>11</td>
<td>8·3</td>
<td>133 ± 40</td>
</tr>
<tr>
<td>520-528</td>
<td>Diabetes mellitus</td>
<td>778</td>
<td>2,935</td>
<td>27</td>
<td>10·4</td>
<td>260 ± 50</td>
</tr>
<tr>
<td>500-508</td>
<td><strong>Underweight and Overweight</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500-508</td>
<td>Underweight</td>
<td>7,003</td>
<td>16,692½</td>
<td>70</td>
<td>74·0</td>
<td>95 ± 11</td>
</tr>
<tr>
<td>500-508</td>
<td>Overweight, 20-30% over Standard</td>
<td>15,627</td>
<td>54,377</td>
<td>162</td>
<td>137·4</td>
<td>118 ± 9</td>
</tr>
<tr>
<td>500-508</td>
<td>Overweight, 30-40% over Standard</td>
<td>4,037</td>
<td>13,444½</td>
<td>36</td>
<td>32·6</td>
<td>110 ± 18</td>
</tr>
<tr>
<td>500-508</td>
<td>Overweight, more than 40% over Standard</td>
<td>1,723</td>
<td>4,892½</td>
<td>23</td>
<td>12·3</td>
<td>187 ± 39</td>
</tr>
<tr>
<td></td>
<td><strong>Respiratory Impairments</strong> (excl. Tuberculosis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>700-724</td>
<td>Combined group including hay fever, asthma, bronchitis and emphysema</td>
<td>5,724</td>
<td>16,846½</td>
<td>61</td>
<td>37·2</td>
<td>164 ± 21</td>
</tr>
<tr>
<td></td>
<td><strong>Urinary Group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>800-804</td>
<td>Renal calculus</td>
<td>1,393</td>
<td>4,388½</td>
<td>16</td>
<td>13·5</td>
<td>119 ± 30</td>
</tr>
<tr>
<td>820-821</td>
<td>Cystitis, Pyelitis</td>
<td>1,174</td>
<td>2,992</td>
<td>9</td>
<td>7·3</td>
<td>123 ± 41</td>
</tr>
<tr>
<td>840-843</td>
<td>Albuminuria</td>
<td>816</td>
<td>2,643</td>
<td>10</td>
<td>6·4</td>
<td>150 ± 49</td>
</tr>
</tbody>
</table>
An Investigation into the
ANALYSIS OF DEATHS BY CAUSE

20. To analyse the causes of death in the various impairment groups has been an important object of the investigation. Although not of direct concern from the point of view of underwriting, such an analysis is nevertheless of considerable interest from a medical aspect. It is, of course, necessary to have a standard experience with which comparisons can be made. Ideally it would have been desirable for the deaths forming the basis of the Standard (0–4) Table to be analysed, but for administrative reasons this was not practicable. Nor did it seem that statistics based on sources other than assured lives of recent duration would be suitable. Fortunately an appropriate standard was found within the investigation itself. Two large groups, viz. hernia and family history of tuberculosis, revealed a mortality experience that was somewhat lighter than the Standard (0–4) Table. There was no reason to suppose that the lives in these two groups were different as regards proneness to specific causes of death from a representative sample of first-class lives. Accordingly, the distribution of deaths by cause in these two groups has been used as a control for comparing the causes of death in other groups.

21. The cause of death analysis for the control groups is shown in Appendix D, subdivided into two age-groups, viz. “under 50” and “50 and over”. More than 83% of the deaths fall into three broad categories, viz.:

<table>
<thead>
<tr>
<th></th>
<th>Under 50 %</th>
<th>50 &amp; over %</th>
<th>All Ages %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer (excluding leukaemia)</td>
<td>28·2</td>
<td>26·6</td>
<td>27·2</td>
</tr>
<tr>
<td>Circulatory diseases</td>
<td>24·5</td>
<td>49·6</td>
<td>40·6</td>
</tr>
<tr>
<td>Suicide and accident</td>
<td>31·2</td>
<td>7·0</td>
<td>15·6</td>
</tr>
<tr>
<td></td>
<td>83·9</td>
<td>83·2</td>
<td>83·4</td>
</tr>
</tbody>
</table>

22. Analysis of the causes of death in the impaired lives' experience has been possible only for the larger groups. In the following sections the various impairments are considered in turn and, where appropriate, an analysis of deaths by cause is appended to each section.
Mortality of Impaired Lives

CIRCULATORY IMPAIRMENTS

23. Arteriosclerosis and atheroma. Actual deaths were 25, compared with expected deaths of 23·9. Thus there was no significant extra mortality.

24. Hypertension. This important group showed substantial extra mortality throughout. For ages at entry under 40, the actual deaths (33) were 181% of the expected deaths (18·2). It is not altogether surprising that the youngest age group should show the heaviest proportionate extra mortality, since in this range the basic mortality rates for healthy lives are very low. For ages at entry 40-59, actual deaths (246) were 169% of the expected deaths (145·5). Here the data were sufficient to obtain significant results for some of the individual code numbers. As expected, the highest mortality is associated with the highest blood pressure readings. The other groups show little variation and, surprisingly, the experience among lives who were more than 20% above standard weight is no worse than in the standard group. For ages at entry 60 and over, actual deaths (134) were 121% of expected deaths (110·3). Here there was no significant variation within the sub-groups either by weight or by blood pressure reading.

25. The following table shows an analysis of deaths in the hypertension group into the main causes of death:

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Under age 50</th>
<th>Ages 50 &amp; over</th>
<th>All ages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Expected deaths</td>
<td>Actual deaths</td>
<td>Expected deaths</td>
</tr>
<tr>
<td>Lung cancer</td>
<td>3·2</td>
<td>2</td>
<td>29·2</td>
</tr>
<tr>
<td>Other cancer</td>
<td>7·1</td>
<td>5</td>
<td>33·9</td>
</tr>
<tr>
<td>Vascular lesions</td>
<td>2·1</td>
<td>7</td>
<td>21·4</td>
</tr>
<tr>
<td>Coronary disease</td>
<td>5·2</td>
<td>25</td>
<td>75·0</td>
</tr>
<tr>
<td>Other circulatory disease</td>
<td>1·6</td>
<td>10</td>
<td>21·4</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>-6</td>
<td>2</td>
<td>6·9</td>
</tr>
<tr>
<td>Suicide and accident</td>
<td>1·4</td>
<td>7</td>
<td>16·5</td>
</tr>
<tr>
<td>All other causes</td>
<td>5·6</td>
<td>8</td>
<td>32·9</td>
</tr>
<tr>
<td>All causes</td>
<td>36·8</td>
<td>66</td>
<td>237·2</td>
</tr>
</tbody>
</table>

From this table it can be seen that the excess deaths were wholly concentrated in diseases of the circulatory system and pneumonia.
At ages under 50, deaths from coronary heart disease were five times the expectation. In total, out of 413 deaths from all causes, 269 were from diseases in the circulatory group, i.e. more than double the expectation of 126.7. The excess mortality from pneumonia is an interesting feature. The apparent normality of deaths due to the remaining causes (except for suicide and accident, where the rate is low) is also noteworthy.

IMPAIRMENTS OF THE DIGESTIVE SYSTEM

26. Peptic Ulcer. For all groups combined the actual deaths (211) were 136% of the expected deaths (155.0). The heaviest mortality (211%) was found in the group “short history with operation”. In the group “short history no operation” the mortality was 69% of expectation; but this result was non-significant, being based on only six deaths.

For the “long history” groups the percentages of actual to expected deaths were as follows:

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No operation, no complications</td>
<td>115</td>
</tr>
<tr>
<td>No operation, with complications</td>
<td>144</td>
</tr>
<tr>
<td>With operation, no complications</td>
<td>140</td>
</tr>
<tr>
<td>With operation, with complications</td>
<td>179</td>
</tr>
</tbody>
</table>

27. The following table analyses deaths in the peptic ulcer group according to cause of death:

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Under age 50</th>
<th>Ages 50 &amp; over</th>
<th>All ages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Expected deaths</td>
<td>Actual deaths</td>
<td>Expected deaths</td>
</tr>
<tr>
<td>Lung cancer</td>
<td>4.3</td>
<td>11</td>
<td>13.1</td>
</tr>
<tr>
<td>Other cancer</td>
<td>9.4</td>
<td>10</td>
<td>15.2</td>
</tr>
<tr>
<td>Circulatory diseases</td>
<td>11.9</td>
<td>20</td>
<td>52.9</td>
</tr>
<tr>
<td>Peptic ulcer</td>
<td>7.3</td>
<td>7</td>
<td>5.2</td>
</tr>
<tr>
<td>Suicide and accident</td>
<td>15.2</td>
<td>16</td>
<td>7.5</td>
</tr>
<tr>
<td>All other causes</td>
<td>7.3</td>
<td>14</td>
<td>15.8</td>
</tr>
<tr>
<td>All causes</td>
<td>48.4</td>
<td>78</td>
<td>106.6</td>
</tr>
</tbody>
</table>

The excess deaths from peptic ulcer call for no comment. There is some excess from circulatory disease at ages under 50; but it is barely significant statistically and, in the absence of a corresponding
Mortality of Impaired Lives

feature at ages 50 and over, no conclusion can be drawn from it. The excess deaths from cancer are interesting. The feature is present in both age groups and affects lung cancer as well as other forms. In all, there were 67 deaths from cancer compared with an expectation of 42.0, i.e. 160%. This may indicate a tendency among peptic ulcer sufferers to contract cancer—or a common cause for both. On the other hand it could possibly mean that some proposers may have had their condition diagnosed as peptic ulcer when they were in fact suffering from incipient cancer.

28. Dyspepsia. The system of classification of lives reporting dyspepsia in their medical history was altered during the period under review and for present purposes it was considered sufficient to aggregate all codes into a single group. Actual deaths (120) were 96% of expected deaths (124.7). Thus it appears that the lives in this group were, so far as mortality at early durations is concerned, virtually equivalent to first-class lives.

29. Cholecystitis. No extra mortality was revealed in this group, actual deaths (17) being 84% of expected deaths (20.2).

HERNIA AND VARICOSE VEINS

30. Hernia. Actual deaths (226) were 89% of expected deaths (254.4). As two-thirds of the data fall into the “unclassified” section, analysis by the type of hernia is not feasible.

31. Varicose Veins. Actual deaths (76) were 90% of expected deaths (84.1).

IMPAIRMENTS OF THE BRAIN AND NERVOUS SYSTEM

32. Epilepsy. Only 15 deaths were recorded in this group and, although they represented 250% of the expected deaths, it is hardly possible to draw conclusions from so small an experience.

33. Head Injuries. Actual deaths (36) were 110% of expected deaths (32.8). There are no special features deserving comment.

34. Psycho-neuroses. Actual deaths (51) exactly equalled the expected deaths. The outstanding feature was the occurrence of 9 deaths from suicide, whereas only 2 deaths from this cause
would have been expected on the basis of the control group of deaths. Thus mortality from causes other than suicide was below expectation. The extra mortality from suicide is interesting from a socio-medical point of view, although negligible in terms of underwriting losses.

**OTITIS MEDIA**

35. *Otitis media.* For the group "without operation" actual deaths (40) were 143% of expected deaths (28·0). For the group "with mastoidectomy or perforated ear drum" actual deaths (14) were 63% of expected deaths (22·1). The figures are small, but the difference is significant. A possible explanation is that proposers who have undergone an operation have been more stringently screened than those on whom no operation has been performed.

**TUBERCULOSIS**

36. *Non-pulmonary tuberculosis.* The quantity of data in the various categories of non-pulmonary tuberculosis has been too small to produce useful results. For all groups combined actual deaths (16) were 94% of expected deaths (17·0) so that, in so far as such small numbers are significant at all, the mortality experience has been light.

37. *Fistula in ano.* Actual deaths (17) were 179% of expected deaths (9·5).

38. *Pleurisy and spontaneous pneumothorax.* Actual deaths (59) were 86% of expected deaths (68·3). Thus the experience has been light and suggests that this impairment may be of little importance from an underwriting point of view.

39. *Pulmonary tuberculosis.* In all groups combined, actual deaths (44) were 137% of expected deaths (32·1). Paradoxically the "mild" cases not treated by special methods showed heavier mortality than the corresponding "moderate or severe" cases. However, this peculiarity is of little significance in view of the small amount of data. Of the 44 deaths, 8 were due to tuberculosis as compared with a nominal expectation of .2.

40. *Family history of tuberculosis.* Actual deaths (153) were only 81% of expected deaths (188·1). It thus appears that a family
history of tuberculosis is nowadays a non-significant feature—especially as only two of the deaths were actually caused by tuberculosis—and this group can be considered as equivalent to a group of first-class lives.

ENDOCRINE IMPAIRMENTS

41. Glycosuria. Actual deaths (34) were 157% of expected deaths (21·7). The mortality among lives on whom a blood sugar test had been carried out was lighter than among lives having no blood sugar test; but the numbers are too small for this inference to be statistically significant.

42. Diabetes. Actual deaths (27) were 260% of expected deaths (10·4). This is the heaviest extra mortality observed in any impairment group; but with mortality rates at their present-day level an experience equal to 260% of the normal is by no means uninsurable. Once again, however, it must be remembered that the data under examination relate mainly to short durations and the experience at longer durations has yet to emerge. Of the 27 deaths, 7 were attributed to diabetes as against a nominal expectation of less than ·1 and 9 to coronary heart disease. The remaining 11 deaths were widely distributed among the various causes.

UNDERWEIGHT AND OVERWEIGHT

43. Underweight. Actual deaths (70) were 95% of expected deaths (74·0). Only one death was due to tuberculosis, which is the cause of death traditionally most feared in connection with underweight persons.

44. Overweight. The experience was subdivided into three classes as follows:

<table>
<thead>
<tr>
<th>Weight category</th>
<th>Actual deaths</th>
<th>Expected deaths</th>
<th>100 A/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-30% over Standard</td>
<td>162</td>
<td>137·4</td>
<td>118</td>
</tr>
<tr>
<td>30-40% over Standard</td>
<td>36</td>
<td>32·6</td>
<td>110</td>
</tr>
<tr>
<td>More than 40% over Standard</td>
<td>23</td>
<td>12·3</td>
<td>187</td>
</tr>
<tr>
<td></td>
<td>221</td>
<td>182·3</td>
<td>121</td>
</tr>
</tbody>
</table>
The analysis by cause of death is as follows:

<table>
<thead>
<tr>
<th>Causes of Death</th>
<th>Under age 50</th>
<th>Ages 50 &amp; over</th>
<th>All ages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Expected</td>
<td>Actual</td>
<td>Expected</td>
</tr>
<tr>
<td></td>
<td>deaths</td>
<td>deaths</td>
<td>deaths</td>
</tr>
<tr>
<td>Lung cancer</td>
<td>7.2</td>
<td>3</td>
<td>12.5</td>
</tr>
<tr>
<td>Other cancer</td>
<td>15.6</td>
<td>11</td>
<td>14.5</td>
</tr>
<tr>
<td>Coronary disease</td>
<td>11.4</td>
<td>19</td>
<td>32.0</td>
</tr>
<tr>
<td>Other circulatory disease</td>
<td>8.4</td>
<td>18</td>
<td>18.2</td>
</tr>
<tr>
<td>Suicide and accident</td>
<td>25.2</td>
<td>37</td>
<td>7.1</td>
</tr>
<tr>
<td>All other causes</td>
<td>13.2</td>
<td>17</td>
<td>17.0</td>
</tr>
<tr>
<td>All causes</td>
<td>81.0</td>
<td>105</td>
<td>101.3</td>
</tr>
</tbody>
</table>

Circulatory diseases are responsible for most of the deaths in excess of expectation. There is also an excess of violent deaths, which further examination has shown to be mainly due to accidents other than motor accidents, although there was also some excess from suicide. This would seem to suggest that overweight people have an increased susceptibility to accident. For other causes of death, experience adheres closely to expectation.

**RESPIRATORY IMPAIRMENTS**

45. The impairments included in the respiratory group were hay fever, bronchial asthma, bronchitis and emphysema. For the whole group the mortality was fairly heavy, actual deaths (61) being 164% of expected deaths (37.2). The heaviest, and also the largest, group was bronchial asthma where actual deaths (32) were 211% of expected deaths (15.2). At ages under 50, where the bulk of the data was concentrated, actual deaths (26) were 239% of expected deaths (10.9); but at young ages the normal rate of mortality is low and extra mortality inevitably appears proportionately high. The extra deaths appear to be evenly spread over all causes. For bronchitis, actual deaths (20) were 159% of expected deaths (12.6). No difference was observable between "bronchitis with emphysema" and "bronchitis without emphysema". Data for hay fever, and for emphysema without bronchitis were inadequate to produce any useful results.
Mortality of Impaired Lives

URINARY IMPAIRMENTS

46. The quantity of data so far accumulated for urinary impairments is not sufficient to have produced results of much statistical value. Three impairment groups are shown in the table and it is satisfactory to note that in none of them has the experience been exceptionally heavy. Combining the data for these three groups, actual deaths (35) were 129% of the expected deaths (27.2).

GENERAL OBSERVATIONS ON THE RESULTS

47. The main outcome of the results of this pilot investigation would appear to be that the mortality experience at early durations of substandard lives included in the investigation under review has not revealed any heavy adverse experience. In many groups the mortality has been normal or lighter than normal. In almost all the remainder it has lain between 100% and 200% of the normal experience. In only three groups has the experience exceeded 200%, viz:

Peptic ulcer, short history, with operation
Diabetes
Bronchial asthma

In the third of these groups the explanation lies more in the young average age of the lives exposed than in the severity of the experience.

48. When the low level of current rates of mortality is recalled, the percentages recorded appear very moderate. It is salutary to recall the relative levels of the mortality of first-class assured lives a century ago (as reflected in the HM Table) and today (as reflected in the A1949-52 Table):

<table>
<thead>
<tr>
<th>Age</th>
<th>HM Table q_x</th>
<th>A1949-52 Table q_x</th>
<th>HM as percentage of A1949-52</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>-0.00572</td>
<td>-0.00111</td>
<td>515%</td>
</tr>
<tr>
<td>30</td>
<td>-0.00771</td>
<td>-0.00116</td>
<td>665%</td>
</tr>
<tr>
<td>40</td>
<td>-0.01001</td>
<td>-0.00188</td>
<td>532%</td>
</tr>
<tr>
<td>50</td>
<td>-0.01572</td>
<td>-0.00599</td>
<td>269%</td>
</tr>
<tr>
<td>60</td>
<td>-0.02983</td>
<td>-0.01720</td>
<td>173%</td>
</tr>
<tr>
<td>70</td>
<td>-0.0410</td>
<td>-0.04343</td>
<td>141%</td>
</tr>
</tbody>
</table>

49. There is perhaps at the present time a tendency to regard risks which produce deaths equal to 600% of expectation as uninsurable; but by this standard the "healthy" lives aged 30 of the year
1860 would be uninsurable today. It is, of course, quite practicable to transact insurance business among lives whose mortality may equal six times the normal level provided that the premiums charged are sufficient for the risk covered. At 3% interest, the premium for a £100 whole life policy at age 20 is 17s. 1d. on the A1949-52 ultimate basis and £1, 8s. 6d. on the H™ ultimate basis. Thus an extra premium of 11s. 5d. is adequate to cover mortality rates more than 500% of the current standard table during the first twenty years of the policy's duration. At age 50 the corresponding premiums are £2, 18s. 2d. on the A1949-52 basis and £3, 16s. 2d. on the H™ basis, i.e. an extra premium of 18s. 0d. to cover a mortality risk which initially exceeds 250% of the standard table. It is, however, important to bear in mind that, while heavy extra risks may be met by adequate extra premiums, the method of charging for them by a reducing percentage deduction from sum assured may not be practicable. For whole life policies the reducing percentage deduction is only suitable for minor extra risks; for heavy risks the initial deduction generally exceeds 100%. This is not so, of course, for short term endowment assurances.

50. The principal danger in the underwriting of substandard lives is not the heaviness of the risk attaching to a particular impairment but the exercising of deliberate adverse selection by the individual proposer. If in a group of lives all exhibiting the same impairment, the chances of survival are equal for everyone, insurance is practicable, however severe the extra mortality involved. But if some of the lives concerned possess a secret premonition of their own approaching demise, and this information is hidden from the medical examiner and the underwriter, a form of adverse selection is introduced which seriously interferes with the effective transaction of insurance. It is a feeling that this type of selection does in fact exist which probably accounts for the cautious attitude of life offices to the more serious impairments.

51. Another form of adverse selection which could be dangerous in the insurance of severely substandard lives is the lapsing of survivors after a few years. This deprives the insurer of additional premiums out of which he expects to be recompensed for heavy claims at short durations. To take an extreme example, if an office issued policies on lives actively suffering from tuberculosis, those who effected a satisfactory recovery would lapse in order to re-enter at more favourable rates. Clearly, insurance on such a basis would be
impossible. A similar difficulty in a milder form presents itself for lives who have recently undergone a serious operation and this no doubt is adequate reason for deferring insurance until major risks of this kind have subsided.

52. When allowance has been made, however, for all the foregoing considerations, it would still appear that a more liberal attitude to the underwriting of impaired lives could be justified in the light of the experience revealed in the foregoing pages. For an experimental period at least, the benefit of life assurance might be extended to various classes of lives which at present it is customary to reject. If after a few years the results showed that the experiment is unprofitable, the policy could be reversed. But there is no evidence at the moment to support the view that all the risks rejected are in fact uninsurable.

Project for a combined investigation by life offices operating in Great Britain

53. It is hoped that this paper may elicit views from the profession on the value of the type of investigation described, particularly when extended to a combined venture by a substantial number of life offices. Proposals for a combined investigation have been kept under review by the Joint Mortality Investigation Committee of the Faculty and Institute during recent years and the offices' views have been sought through the medium of a questionnaire. It has not, however, been possible to come to a decision, and opinion within the actuarial profession is divided. There are two very weighty reasons for hesitation, viz:

(1) In a combined investigation much difficulty can be expected in achieving the supremely important condition that impairments should be uniformly coded. As indicated at the outset, all the coding in the investigation described in this paper has been under the direct supervision of Dr. T. W. Preston throughout the whole of the period covered. This has been a major factor in ensuring consistency. Failure to achieve such consistency would go far to nullify the usefulness of the results.

(2) Inevitably a long time elapses before results emerge. During this time new methods of treatment are evolved which have a direct effect on the mortality experienced within the impairment groups concerned. Consequently, the results may be out of date before they are published.
An Investigation into the

54. The amount of work involved in preparing the data is very considerable and the greater part of it would of necessity fall on the offices. The question has been raised whether the work is justified if the usefulness of the results is to be in doubt. In this connection the Mortality Committee has had in mind the substantial additional work caused to the offices by the expansion of the investigations into the mortality of pensioners—a development which all agree is necessary in view of the growth of life office pension business.

55. Against these arguments is a feeling that the shortage of information about the mortality of impaired lives in Britain is a serious gap in actuarial knowledge which should be remedied. It is thought that apart from its usefulness to life assurance underwriting, a comprehensive investigation might provide helpful data for medical research. This, of course, comes straight back to the question whether the information would be available in time to be of value. It is hoped that the publication of the present paper may stimulate further discussion and lead to a consensus of actuarial opinion in one direction or the other.

ACKNOWLEDGMENTS

56. My thanks are due to the Board of Directors of the Prudential Assurance Company for allowing the data to be published. My great debt to Dr. T. W. Preston I have acknowledged in the text. My thanks are also due to Mr. G. G. Newton for supervising the tabulating and computing work which underlies Table 1 and to Mrs. M. Cherry for checking all the figures.
APPENDIX A

IMPAIRMENT CODING SYSTEM

1. CIRCULATORY IMPAIRMENTS

10-  *Arteriosclerosis or Atheroma*

100  Slight (palpable or thickened vessels) with normal blood pressure

101  Moderate (nodular or tortuous vessels) with normal blood pressure

102  Marked (hard or pipe-stem vessels)

103  Moderate or marked with raised blood pressure

11- to *Essential (uncomplicated) Hypertension (may include slight or moderate tachycardia or slight arteriosclerosis)*

<table>
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120 Under 40  Standard+20% or over 150-165 Under 95

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130 40-59  Standard±19% 155-170 Under 95

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An Investigation into the

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<tr>
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<td>Below 160</td>
<td>110 or over</td>
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</table>

170 Uncomplicated Hypotension (100 and below)

180 Impairment of the coronary arteries

Subsidiary codes applicable to range 100-180

E Family history, good
F Family history, fair with two or more deaths from cardio-vascular disease*
G Family history, poor, general tendency to early death
H Family history, poor, with two or more deaths from cardio-vascular disease*

* Deaths at age 70 and above to be disregarded.

2. STOMACH AND INTESTINES; VARICOSE VEINS

20 Peptic Ulcer (Gastric and Duodenal) short history (apparently acute)
200 No operation, no complication
201 No operation, history of haematemesis
202 No operation, history of perforation
203 No operation, other complications
204 With operation, no complication
Mortality of Impaired Lives

205 With operation, history of haematemesis or melaena
206 With operation, history of perforation
207 With operation, other complications

21- Peptic Ulcer (Gastric and Duodenal) long history (apparently chronic)
210 No operation, no complication
211 No operation, history of haematemesis
212 No operation, history of perforation
213 No operation, other complications
214 With operation, no complication
215 With operation, history of haematemesis or melaena
216 With operation, history of perforation
217 With operation, other complications

22-* Dyspepsia, gastritis
222 Dyspepsia, chronic or prolonged attacks, ulcer not suspected
223 Dyspepsia, suggestive of ulcer but not proven (duodenitis, etc.)
224 Dyspepsia, brief attack, apparently of no serious significance, no special investigations
225 Dyspepsia, brief attack, apparently of no serious significance, but investigations carried out with negative result

23- Cholecystitis
230 Without stones, no operation
231 With stones, no operation
232 With stones, cholecystotomy
233 With stones, cholecystectomy

24- Amoebic Dysentery
240 One attack, uncomplicated
241 Two or more attacks, uncomplicated
242 With hepatitis, etc.

25- Hernia (unclassified), no medical evidence
250 Hernia, unclassified, no evidence of treatment
251 Hernia, unclassified, support worn
252 Hernia, unclassified, operation performed

26- Hernia (Inguinal or Femoral)
260 Hernia, inguinal or femoral, not efficiently treated
261 Hernia, inguinal or femoral, efficiently supported
262 Hernia, inguinal or femoral, cured by operation

27- Hernia (Ventral, Umbilical, etc.)
270 Hernia, ventral, umbilical, etc., not efficiently treated
271 Hernia, ventral, umbilical, etc., efficiently supported
272 Hernia, ventral, umbilical, etc., cured by operation

* Codes 220 and 221 were discarded at an early stage of the investigation.

28- Varicose Veins
280 Varicose veins, slight, untreated
281 Varicose veins, moderate or severe, untreated
282 Varicose veins, efficiently supported
An Investigation into the

283 Varicose veins, efficiently treated by injection
284 Varicose veins, efficiently treated by operation
285 Varicose veins, complicated by phlebitis
286 Varicose veins, other complications (dermatitis, ulcer, etc.)
287 Varicose veins, no medical evidence

Subsidiary codes applicable to range 200-287
A Symptoms within 2 years
B Symptoms 2-4 years ago
C Symptoms 4-6 years ago
D Symptoms over 6 years ago

3. NERVOUS DISORDERS; HEAD AND EAR IMPAIRMENTS

30– Epilepsy
300 Petit mal
301 Grand mal (idiopathic)

Subsidiary codes for 300, 301
A Attacks within 2 years
B No attack for 2-5 years
C No attack for 5-10 years
D No attack for over 10 years

31– Head Injuries
310 Cerebral concussion without fracture or operation, mild
311 Cerebral concussion without fracture or operation, severe
312 Fracture of skull, no operation, no sequelae
313 Fracture of skull, no operation, subsequent symptoms but no epilepsy
314 Fracture of skull, no operation, subsequent symptoms and epilepsy
315 Fracture of skull, craniotomy, no sequelae, no gap in skull
316 Fracture of skull, craniotomy, no sequelae, gap present in skull
317 Fracture of skull, craniotomy, sequelae, no gap in skull
318 Fracture of skull, craniotomy, sequelae, gap present in skull

32– Psycho-neuroses
320 Psycho-neuroses, mild
321 Psycho-neuroses, moderate
322 Psycho-neuroses, severe
323 With features suggestive of psychosis

33– Migraine
330 Migraine, mild
331 Migraine, severe

340 Attacks of Unconsciousness of uncertain origin
350 Poliomyelitis

36– Otitis Media
360 Chronic suppurative otitis media (without operation)
361 Chronic suppurative otitis media (with mastoidectomy)
362 Perforation of drum without clear history of C.S.O.M. (trauma only)
Mortality of Impaired Lives

Subsidiary codes for range 310-362

A Symptoms within 2 years
B Symptoms within 2-5 years
C Symptoms within 5-10 years
D No symptoms for at least 10 years

4. TUBERCULOSIS

40- Tuberculosis, not pulmonary

400 Tuberculosis of spine
401 Tuberculosis of hip
402 Tuberculosis of other bones or joints
403 Tuberculosis of glands
404 Tuberculosis of intestines and peritoneum
405 Tuberculosis of skin (lupus vulgaris)
406 Tuberculosis of kidney (without operation)
407 Tuberculosis of kidney (with operation)
408 Tuberculosis of generative organs (testis, prostate, etc., Fallopian tubes, ovaries) (without operation)
409 Tuberculosis of generative organs (with operation)
410 Tuberculosis of other organs or of two or more organs

For brevity the following classification is used in code definition in the 420-457 range: —

Type I: Weight standard or over-standard, no tuberculosis in family history
Type II: Weight more than 10% below standard, no tuberculosis in family history
Type III: Weight standard or over-standard, one or more cases of tuberculosis in family history
Type IV: Weight more than 10% below standard, one or more cases of tuberculosis in family history

42- Fistula in ano

420 Fistula in ano, Type I
421 Fistula in ano, Type II
422 Fistula in ano, Type III
423 Fistula in ano, Type IV

43- Pleurisy and Spontaneous Pneumothorax

430 Pleurisy with effusion (not including post pneumatic empyema), Type I
431 Pleurisy with effusion (not including post pneumatic empyema), Type II
432 Pleurisy with effusion (not including post pneumatic empyema), Type III
433 Pleurisy with effusion (not including post pneumatic empyema), Type IV
434 Pleurisy dry or indeterminate (not associated with pneumonia), Type I
435 Pleurisy dry or indeterminate (not associated with pneumonia), Type II
An Investigation into the

436 Pleurisy dry or indeterminate (not associated with pneumonia), Type III
437 Pleurisy dry or indeterminate (not associated with pneumonia), Type IV
438 Spontaneous pneumothorax, no definite history of trauma
439 Spontaneous pneumothorax, definite trauma

44- Pulmonary Tuberculosis (not treated by special method of collapse)
440 Pulmonary tuberculosis, mild cases (discovered by mass radiography, etc., never sputum positive), Type I
441 Pulmonary tuberculosis, mild cases (discovered by mass radiography, etc., never sputum positive), Type II
442 Pulmonary tuberculosis, mild cases (discovered by mass radiography, etc., never sputum positive), Type III
443 Pulmonary tuberculosis, mild cases (discovered by mass radiography, etc., never sputum positive), Type IV
444 Pulmonary tuberculosis, moderate or severe cases, Type I
445 Pulmonary tuberculosis, moderate or severe cases, Type II
446 Pulmonary tuberculosis, moderate or severe cases, Type III
447 Pulmonary tuberculosis, moderate or severe cases, Type IV

45- Pulmonary Tuberculosis (treated by special methods)*
450 Pulmonary tuberculosis treated by artificial pneumothorax, Type I
451 Pulmonary tuberculosis treated by artificial pneumothorax, Type II
452 Pulmonary tuberculosis treated by artificial pneumothorax, Type III
453 Pulmonary tuberculosis treated by artificial pneumothorax, Type IV
454 Pulmonary tuberculosis treated by other special methods*, Type I
455 Pulmonary tuberculosis treated by other special methods*, Type II
456 Pulmonary tuberculosis treated by other special methods*, Type III
457 Pulmonary tuberculosis treated by other special methods*, Type IV

* e.g. Thoracoplasty, Phrenicotomy, etc.

Subsidiary codes for range 400-457

A Within 3 years
B 3-6 years ago
C 6-10 years ago
D Over 10 years ago

46- Family History of Tuberculosis

460 Age under 40, weight standard or over-standard
461 Age under 40, weight 10-20% below standard
462 Age under 40, weight more than 20% below standard
463 Age 40 or over, weight standard or over-standard
464 Age 40 or over, weight 10-20% below standard
465 Age 40 or over, weight more than 20% below standard

Subsidiary codes for range 460-465

E 1 case in family, no contact for 2 years
F 2 or more cases in family, no contact for 2 years
G Contact within two years
Mortality of Impaired Lives

5. ENDOCRINE GROUP

S = Standard

50- Glycosuria (not proved to be Diabetes Mellitus) No B.S.T.T.
  500 One test only, weight S±10%
  501 One test only, weight <(S—10%)
  502 One test only, weight >(S+10%)
  503 Inconstant, two or more tests, weight S±10%
  504 Inconstant, two or more tests, weight <(S—10%)
  505 Inconstant, two or more tests, weight >(S+10%)
  506 Persistent, two or more tests, weight S±10%
  507 Persistent, two or more tests, weight <(S—10%)
  508 Persistent, two or more tests, weight >(S+10%)

51- Glycosuria (not proved to be Diabetes Mellitus) B.S.T.T.
  510 One test only, weight S±10%
  511 One test only, weight <(S—10%)
  512 One test only, weight >(S+10%)
  513 Inconstant, two or more tests, weight S±10%
  514 Inconstant, two or more tests, weight <(S—10%)
  515 Inconstant, two or more tests, weight >(S+10%)
  516 Persistent, two or more tests, weight S±10%
  517 Persistent, two or more tests, weight <(S—10%)
  518 Persistent, two or more tests, weight >(S+10%)
  519 Proved renal glycosuria

52- Diabetes Mellitus
  520 Ages under 30, weight S±10%
  521 Ages under 30, weight <(S—10%)
  522 Ages under 30, weight >(S+10%)
  523 Ages 30-50, weight S±10%
  524 Ages 30-50, weight <(S—10%)
  525 Ages 30-50, weight >(S+10%)
  526 Ages over 50, weight S±10%
  527 Ages over 50, weight <(S—10%)
  528 Ages over 50, Weight >(S+10%)

Subsidiary codes for range 500-528

E Family history, no diabetes
F Family history, 1 or more cases of diabetes

54- Goitre (Simple or unclassified)
  540 Goitre (simple or unclassified), no operation
  541 Goitre (simple or unclassified), operation
  542 Thyroid adenoma, etc., no operation
  543 Thyroid adenoma, etc., operation
  544 Myxoedema

55- Goitre (Exophthalmic) (including toxic goitre, hyperthyroidism, Grave’s disease, thyrotoxicosis)
  550 No special treatment
  551 Surgical treatment
An Investigation into the

552 Other special treatment

Subsidiary codes for range 540-552

- A Within 3 years
- B 3-6 years ago
- C 6-10 years ago
- D Over 10 years ago

6. UNDERWEIGHT AND OVERWEIGHT

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</tbody>
</table>
Mortality of Impaired Lives

664 Age 30-50, weight 30-40% over S, girth unsatisfactory
665 Age 30-50, weight 30-40% over S, N.M.E.
666 Age 30-50, weight more than 40% over S, girth satisfactory
667 Age 30-50, weight more than 40% over S, girth unsatisfactory
668 Age 30-50, weight more than 40% over S, N.M.E.
670 Age over 50, weight 20-30% over S, girth satisfactory
671 Age over 50, weight 20-30% over S, girth unsatisfactory
672 Age over 50, weight 20-30% over S, N.M.E.
673 Age over 50, weight 30-40% over S, girth satisfactory
674 Age over 50, weight 30-40% over S, girth unsatisfactory
675 Age over 50, weight 30-40% over S, N.M.E.
676 Age over 50, weight more than 40% over S, girth satisfactory
677 Age over 50, weight more than 40% over S, girth unsatisfactory
678 Age over 50, weight more than 40% over S, N.M.E.

Subsidiary codes for range 600-678
E Family history good
F Family history indifferent
G Family history poor

7. RESPIRATORY GROUP
(EXCLUDING TUBERCULOSIS)

70– Entry ages under 30
700 Hay fever, simple
701 Bronchial asthma
702 Chronic bronchitis without emphysema
703 Chronic bronchitis with emphysema
704 Emphysema without bronchitis

71– Entry ages 30-49
710 Hay fever, simple
711 Bronchial asthma
712 Chronic bronchitis without emphysema
713 Chronic bronchitis with emphysema
714 Emphysema without bronchitis

72– Entry ages 50 and over
720 Hay fever, simple
721 Bronchial asthma
722 Chronic bronchitis without emphysema
723 Chronic bronchitis with emphysema
724 Emphysema without bronchitis

Subsidiary codes for range 700-724
A Symptoms within 3 years
B Symptoms 3-6 years ago
C Symptoms 6-10 years ago
D Symptoms over 10 years ago
An Investigation into the

8. URINARY GROUP

80– Renal Calculus
800 Renal calculus, no operation
801 Renal calculus, voided or removed per urethram
802 Renal calculus, removed by nephrotomy
803 Renal calculus, removed by nephrectomy
804 Renal Colic (indefinite origin)

81– Vesical Calculus
810 Vesical calculus, no operation
811 Vesical calculus, voided or removed per urethram
812 Vesical calculus, removed by cystotomy

82– Cystitis, Pyelitis
820 Cystitis, without calculus
821 Pyelitis, without calculus

83– Pyuria, Haematuria
830 Pyuria of obscure origin
831 Haematuria of obscure origin or unclassified

84– Albuminuria
840 Orthostatic albuminuria, ages under 30
841 Orthostatic albuminuria, ages 30 and over
842 Other forms of albuminuria
843 History of nephritis

85– Other Renal Disorders
850 Hydronephrosis, no operation
851 Hydronephrosis, operation
852 Nephrectomy for trauma of kidney
853 Nephrectomy for conditions other than trauma, tuberculosis, calculus or hydronephrosis or reason unknown

Subsidiary codes for range 800-853

A Symptoms within 3 years
B Symptoms 3-6 years ago
C Symptoms 6-10 years ago
D Symptoms more than 10 years ago

9. TUMOURS AND MISCELLANEOUS

90– The Skin and superficial tissue (including external genitalia)
900 Rodent ulcer
901 Innocent tumours (confirmed)
902 Innocent tumours (unconfirmed)
903 Malignant tumours (other than rodent ulcer)

91– Lips, mouth and salivary glands
910 Innocent tumours (confirmed)
911 Innocent tumours (unconfirmed)
Mortality of Impaired Lives

912 Malignant tumours
913 "Parotid" tumours

92– Lymphatic system
920 Enlarged lymphatic glands (other than tuberculosis)

93– The Breast
930 Chronic mastitis (confirmed)
931 Chronic mastitis (unconfirmed)
932 Non-malignant tumours (confirmed)
933 Malignant tumours
934 Non-malignant tumours (unconfirmed)

94– Female Genital Organs (internal)
940 Uterus, fibroids (confirmed)
941 Uterus, fibroids (unconfirmed)
942 Uterus, malignant tumours
943 Ovarian tumours, innocent (confirmed)
944 Ovarian tumours, innocent (unconfirmed)
945 Miscellaneous (non-malignancy confirmed)
946 Miscellaneous (non-malignancy not confirmed)

95– Male Genital Organs
950 Testicle, innocent tumours (confirmed)
951 Testicle, innocent tumours (unconfirmed)
952 Testicle, malignant tumours

96– Miscellaneous tumours (not previously classified)
960 Innocent tumours (confirmed)
961 Innocent tumours (unconfirmed)
962 Malignant tumours
963 Enlargement of the prostate

Subsidiary codes for range 900-963

A Tumour present at time of proposal
B Tumour removed by operation, radiotherapy to within 5 years
C Tumour removed by operation, radiotherapy to within 5-10 years
D Tumour removed by operation, radiotherapy over 10 years

98– Blood conditions
980 Pernicious anaemia
981 Other forms of anaemia
982 Anaemia unclassified

990 Osteomyelitis

Subsidiary codes for range 980-990

A within 3 years
B 3-6 years
C 6-10 years
D Over 10 years
APPENDIX B

Coding for Cause of Death

1. Tuberculosis
2. Cancer of lung, bronchus, trachea
3. Other cancer
4. Leukaemia
5. Diabetes
6. Vascular lesions, cerebral haemorrhage, embolism, etc.
7. Coronary disease, angina
8. Hypertension, arteriosclerosis, other circulatory or heart disease
9. Influenza
10. Pneumonia
11. Bronchitis
12. Peptic ulcer
13. Nephritis
14. Motor accidents
15. Other accidents
16. Suicide
17. Other causes
**APPENDIX C**

*Rates of Mortality by the Standard (0-4) Table*  
(Based on First-class lives' experience 1954-56. Durations 0-4)

<table>
<thead>
<tr>
<th>Age $x$</th>
<th>$q_x$</th>
<th>Age $x$</th>
<th>$q_x$</th>
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<tr>
<td>25 and under</td>
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<tr>
<td>26</td>
<td>-0.00095</td>
<td>51</td>
<td>-0.00515</td>
</tr>
<tr>
<td>27</td>
<td>-0.00095</td>
<td>52</td>
<td>-0.00578</td>
</tr>
<tr>
<td>28</td>
<td>-0.00095</td>
<td>53</td>
<td>-0.00645</td>
</tr>
<tr>
<td>29</td>
<td>-0.00095</td>
<td>54</td>
<td>-0.00715</td>
</tr>
<tr>
<td>30</td>
<td>-0.00096</td>
<td>55</td>
<td>-0.00785</td>
</tr>
<tr>
<td>31</td>
<td>-0.00096</td>
<td>56</td>
<td>-0.00861</td>
</tr>
<tr>
<td>32</td>
<td>-0.00097</td>
<td>57</td>
<td>-0.00943</td>
</tr>
<tr>
<td>33</td>
<td>-0.00097</td>
<td>58</td>
<td>-0.01034</td>
</tr>
<tr>
<td>34</td>
<td>-0.00098</td>
<td>59</td>
<td>-0.01130</td>
</tr>
<tr>
<td>35</td>
<td>-0.00098</td>
<td>60</td>
<td>-0.01236</td>
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<td>36</td>
<td>-0.00102</td>
<td>61</td>
<td>-0.01352</td>
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<tr>
<td>37</td>
<td>-0.00107</td>
<td>62</td>
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<td>38</td>
<td>-0.00115</td>
<td>63</td>
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<td>-0.01774</td>
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<td>40</td>
<td>-0.00138</td>
<td>65</td>
<td>-0.01944</td>
</tr>
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<td>41</td>
<td>-0.00153</td>
<td>66</td>
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<td>-0.00171</td>
<td>67</td>
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<td>46</td>
<td>-0.00278</td>
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</tr>
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<td>47</td>
<td>-0.00315</td>
<td>72</td>
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<td>48</td>
<td>-0.00356</td>
<td>73</td>
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</tr>
<tr>
<td>49</td>
<td>-0.00402</td>
<td>74</td>
<td>-0.04600</td>
</tr>
<tr>
<td>50</td>
<td>-0.00456</td>
<td>75</td>
<td>-0.05100</td>
</tr>
</tbody>
</table>
APPENDIX D

Distribution of deaths by cause among control group

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Ages under 50</th>
<th></th>
<th>Ages 50 and over</th>
<th></th>
<th>All ages</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of deaths</td>
<td>% of total</td>
<td>No. of deaths</td>
<td>% of total</td>
<td>No. of deaths</td>
<td>% of total</td>
</tr>
<tr>
<td>1. Tuberculosis</td>
<td>1</td>
<td>8.7</td>
<td>1</td>
<td>4.4</td>
<td>2</td>
<td>5.5</td>
</tr>
<tr>
<td>2. Respiratory cancer</td>
<td>12</td>
<td>8.9</td>
<td>30</td>
<td>12.3</td>
<td>42</td>
<td>11.1</td>
</tr>
<tr>
<td>3. Other cancer</td>
<td>26</td>
<td>19.3</td>
<td>35</td>
<td>14.3</td>
<td>61</td>
<td>16.1</td>
</tr>
<tr>
<td>4. Leukaemia</td>
<td>1</td>
<td>0.7</td>
<td>6</td>
<td>2.5</td>
<td>7</td>
<td>1.8</td>
</tr>
<tr>
<td>5. Diabetes</td>
<td>1</td>
<td>0.7</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>6. Vascular lesions</td>
<td>8</td>
<td>5.9</td>
<td>22</td>
<td>9.0</td>
<td>30</td>
<td>7.9</td>
</tr>
<tr>
<td>7. Coronary disease</td>
<td>19</td>
<td>14.1</td>
<td>77</td>
<td>31.6</td>
<td>96</td>
<td>25.3</td>
</tr>
<tr>
<td>8. Other circulatory disease</td>
<td>6</td>
<td>4.5</td>
<td>22</td>
<td>9.0</td>
<td>28</td>
<td>7.4</td>
</tr>
<tr>
<td>9. Influenza</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10. Pneumonia</td>
<td>2</td>
<td>1.5</td>
<td>7</td>
<td>2.9</td>
<td>9</td>
<td>2.4</td>
</tr>
<tr>
<td>11. Bronchitis</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>12. Peptic ulcer</td>
<td>1</td>
<td>0.7</td>
<td>5</td>
<td>2.0</td>
<td>6</td>
<td>1.6</td>
</tr>
<tr>
<td>13. Nephritis</td>
<td>1</td>
<td>0.7</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>14. Motor accidents</td>
<td>9</td>
<td>6.7</td>
<td>3</td>
<td>1.2</td>
<td>12</td>
<td>3.2</td>
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<tr>
<td>15. Other accidents</td>
<td>22</td>
<td>16.3</td>
<td>8</td>
<td>3.3</td>
<td>30</td>
<td>7.9</td>
</tr>
<tr>
<td>16. Suicide</td>
<td>11</td>
<td>8.2</td>
<td>6</td>
<td>2.5</td>
<td>17</td>
<td>4.5</td>
</tr>
<tr>
<td>17. Other causes</td>
<td>15</td>
<td>11.1</td>
<td>19</td>
<td>7.8</td>
<td>34</td>
<td>9.0</td>
</tr>
</tbody>
</table>

| Total                   | 135           | 100.0   | 244              | 100.0   | 379      | 100.0   |

2 + 3  28.2  26.6  27.2
6 + 7 + 8  24.5  49.6  40.6
14 + 15 + 16  31.2  7.0  15.6
SYNOPSIS

The paper describes an investigation which is being conducted by a life office into the mortality experienced by certain classes of impaired lives. The investigation was initiated in 1947 and the results for the period 1947-1958 are compared with a control experience of first-class lives.

It is emphasised that owing to the limited amount of data, and also to a certain lack of strict comparability in the control experience, the results must be regarded with some caution. The purpose of the paper is, in fact, not so much to communicate statistical information as to describe the methods followed in planning the investigation and to promote a discussion of the feasibility of setting up an investigation under the auspices of the Joint Mortality Investigation Committee to which all life offices operating in Great Britain would be invited to contribute data.

The paper presents a coding system for the impairments covered and discusses briefly the results so far obtained within the main groups. For some of the larger groups it has been possible to include a summary analysis by cause of death.
The President (Mr. D. A. B. Scrimgeour).—The business of our meeting tonight is a paper to which we have all looked forward for quite a long time. We are privileged to have the first opportunity to discuss the paper and for that we have to thank the courtesy of the Institute of Actuaries. The author needs no introduction to those of us who know the work of the Continuous Mortality Investigation and it is fitting that it should be Mr. Clarke who is introducing such a paper as this tonight. I have pleasure in calling on Mr. Clarke to introduce his paper now.

Mr. R. D. Clarke, introducing the paper, said:—It is a very great privilege to be invited to come here this evening to submit this paper to you. I do appreciate that privilege most warmly.

In the preparation of the paper I received much helpful advice from Mr. Redington. In an earlier draft of this paper there was an acknowledgment, but he asked me to take it out. Mr. Redington hoped to be here this evening but owing to a family bereavement he is not with us. It is, however, a great delight to me that Dr. Preston is here and, as you will realise from what I have written, this paper is really a joint enterprise. It is essentially a medico-actuarial enterprise, as any investigation of this kind must be.

I would like to underline two matters which I have already mentioned in the synopsis. This is not primarily a paper presenting the results of a statistical investigation. Its primary function is to expound methods which might be followed in setting up a combined all-offices investigation. The statistical purist may well find objections to the control experiences which I have had to use for calculating expected deaths. This is a feature which could no doubt be improved upon in a larger-scale investigation.

The other matter to which I should like to draw attention is that I hope to elicit views from the profession on whether a combined investigation is feasible and, if feasible, whether it is worth while.

Mr. J. B. Dow, opening the discussion, said:—I think we shall all agree that the paper before us this evening is an admirable piece of scientific reporting. It is clear, succinct, and factual: saying, in effect, “These things were done with these results.” It puts forward no theory: it argues no case: but it does ask a question: and I imagine from what the author has said in his introductory remarks that he will not feel offended—and may indeed feel that his purpose has been served—if we say more tonight about the question he has asked than about all the work he has done.

But even if we do not say much about the investigation and its methods, we can, and should, pay tribute to the thoroughness and skill with which it has been carried out. No two men—and certainly no two committees—would draw up the same schedule of impairments or adopt the same methods in a task of this kind, but personally I do not find any major point of comment or criticism in what has been done. Everyone can appreciate
the careful planning and sheer hard work that has gone to make this the first large-scale enquiry into the mortality of British lives assured according to cause of impairment.

I propose to comment only very briefly on the results of the investigation, interesting though many of these are. For example, the mortality for glycosuria not specifically associated with diabetes is significantly high. The low rate for dyspepsia and gastritis suggests that the selective processes of the office have successfully eliminated from this category most of the cases of genuine ulcer. To me, the figures for family history of tuberculosis are very interesting and suggest strongly that in today’s conditions we may take less trouble over this factor than we have done in the past.

Many of us, no doubt, turned with hopeful curiosity to the figures for hypertensives. The lowest blood pressure readings to be regarded as high—if I may so express it—are 150 systolic and 95 diastolic. This contrasts sharply with the 1959 American Blood Pressure Study where much lower pressures gave rise to significantly increased mortality. For example, in that investigation, in the age-group 30-39, lives with pressures in the range 128-137 systolic or 88-92 diastolic, and no other impairment, showed a mortality 152% of standard. Probably, if his data had been more extensive, the author would have extended his investigations further down the scale. Many fascinating enquiries of this kind suggest themselves, but probably the most important part of the paper, from the point of view of this discussion, is the question raised in paragraphs 53-55—put in colloquial terms—“Where do we go from here?”

The problem of investigating the mortality of impaired lives was discussed in this hall on Mr. Springbett’s paper in 1950 and again on the paper by the late Dr. Hewat and Mr. Penn in 1954. It was also discussed at the Institute of Actuaries in connection with Mr. Perks’ paper in 1952. On each occasion the results of the discussion could more or less be summed up in Macaulay’s lines: “Those behind cried ‘Forward’, and those in front cried ‘Back’”, the arguments for and against these opposing recommendations being as set out in the paper.

As we set out to cover the same ground again tonight, two questions naturally suggest themselves. Are there any new factors in the situation to be considered and what lessons can be drawn from the paper before us? To the first of these questions, I would say, “Yes, I think there are”. Since the previous discussions took place, there has been a general tendency for offices to relax their underwriting terms. The limits of non-medical business have been extended: many offices have given large amounts of free cover under endowment assurance schemes without evidence of health: and even where there has been full medical selection the level of extra premiums charged has, by and large, been reduced. Mr. Perks’ paper showed from the experience of one office that a reduction of this kind was justified and, from a different approach, the author tonight reaches the same conclusion. This has led, almost unconsciously, to the feeling that since one charges fewer and smaller extra premiums for medical reasons, the subject is less important than it was and, therefore, less worth the labour and expense of investigation. I think this feeling, though natural, is false, if, for no other reason, than that the rates of mortality in our premiums from first-class lives are also significantly lower than they were. Most offices are probably using mortality no worse than A1949-52, and it is important to remember in this context just how light that mortality is. For example, it means that among every 1,000 lives aged 30 we expect no more
than about 45 claims by death in 20 years. About one-third of these, as the author has shown us, may well be from violent causes—accident or suicide—which does not leave room for many mistakes in underwriting. The reduced charge for mortality included in ordinary rates of premium, compared with even a decade ago, seems to me to call for greater, rather than less, precision in underwriting and to strengthen the case for investigating the mortality of impaired lives as fully as we can.

In spite of distinguished opinions which have been expressed to the contrary, I do not see how one can decide what extra premiums to reduce or how far to reduce them without an investigation of the kind now before us. It is perfectly true, of course, as has often been said, that the results can be inconclusive and may lead us astray. I may be flattering myself, but I think I am quite capable of arriving at the wrong conclusions without any statistics to mislead me. Indeed, for all I know, or for all anybody else can tell me, that may very well be a fair description of the underwriting methods we have all been using in this country for a good many years. It is also true, as has been said, that the investigation will be laborious and, therefore, costly. Probably British life assurance spends less on research than most industries of its size and in pursuit of the well-recognised industrial aim of reducing the cost of the product to the consumer it seems able to afford the kind of expenditure involved in such an investigation.

Finally, what can we learn from tonight's paper? In the first place, I think the data are more extensive than might have been foreseen and, no doubt, with the growth of business, data similarly collected for the next period of 11½ years will be considerably larger. Secondly, reading between the lines of the paper, one can realise the great benefits of homogeneity that were achieved through drawing all the data from one source. With any schedule of impairments there are many coding decisions to be made and there are obvious advantages in referring all these to the same tribunal. The advantages are increased if the tribunal consist of three members, two of whom are permanently absent. If we extend the investigation to include other offices, we increase our data but lose much of value in this matter of homogeneity. In this context, it is perhaps worth remembering that the American Impairment Study of 1951 was based on data supplied by only twenty-seven companies and that twelve of these companies provided almost 90% of the total data. To some extent, a similar position might arise in this country, though the figures might not show such wide variation. If, therefore, a relatively small number of the larger offices could be persuaded to combine in a future investigation of this kind, the data might well be several times larger than was Mr Clarke's and it might still be possible to achieve a reasonably high degree of homogeneity in practice. If any further step is to be taken in this matter, as I hope it will, it seems to me that this is perhaps the most promising line to pursue. Whether any further steps are taken or not, there can be no doubt that the author and his Company have placed the profession heavily in their debt by showing both the scope and the limitations of an investigation of this kind.

Mr. A. J. Steeds.—I show unusual temerity in being prepared to follow Mr. Dow so soon and I assure you it is not my wish! I am very glad to be able to say how nice it is to be in Edinburgh again and to be a visitor at your meeting, Mr. President. Thank you for making us so very welcome.

I would like to be among the first to add my congratulations to Mr. Clarke for this paper which can probably claim, as Mr. Dow said, to be the
first of its kind presented either to the Institute or the Faculty. And con-
gratulations are certainly also due to Dr. Preston for his invaluable work
and to the great Company which sponsored the investigation. We in the
South realise that landlords are not necessarily the evil ogres that they
were supposed to be in Victorian times.

My feelings on reading this paper are chiefly of admiration and envy
which we must surely all share. We must all admire Mr. Clarke's skill at
marshalling his facts, his modesty in interpreting them and the lucid style
in which he writes. I also envy very much the ability of his office,
although it is a very large life office, to acquire as extensive an experience as
this, more or less as a by-product of its normal business. My own office,
which specialises in re-assurance and, indeed, transacts no direct business,
has tried hard to underwrite sub-standard business but we are still very
much hampered by having too little.

The author has made a specific reference to the pools organised by a
certain British life re-assurance office and I hope I may therefore be
allowed a few words upon them. The diabetic pool was the first and I am
afraid it could not claim to be offering insurance for the first time to
diabetics because there were several offices before us in the field. It did,
however, help to provide more general cover. I am afraid also, because
diabetes has become one of those impairments which offices are prepared to
handle on their own, that the growth of the pool has been rather small and,
up to date, the total number in force is only 875 and we have been blessed
with only 13 claims.

Our mortality results have been very much better—of course, they are
statistically quite insignificant. I do not know why Mr. Clarke's office
found such high mortality among their diabetics. I wonder whether there
is more in class selection than we realise and whether they are chiefly con-
cerned with a section of the population which is of the artisan class, whereas
we have been drawing more from the professional classes and whether this
may be particularly important where diabetes is concerned.

The blood pressure pool is much more interesting because there we were
trying to offer terms to lives who could not otherwise obtain life cover. We
do overlap with the blood pressures shown in the paper but most of our
blood pressures are higher than systolic 170 or diastolic 100 and we have
many systolic pressures of 200 or more and diastolic pressures of 120 or
more. The total number in the pool is still too small. It is rather like one
of the author's smaller groups—only 1,340, but we have been luckier, we
have 18 deaths: still far too few to enable us to sub-divide. Incidentally,
it might be worth while pointing out that the author's office does, I
believe, use the fifth phase diastolic pressure and that is by no means
general in this country where many offices still use the fourth phase. We
are still convinced that there is some positive correlation between blood
pressure and mortality.

One of the surprising results in the author's paper is the suggestion that
moderate overweight, coupled with hypertension, is relatively unimportant
That seems to contradict the results of the Build and Blood Pressure Study
published by the Society of Actuaries who found that one of their firmest
conclusions was that this combination resulted in very significantly raised
mortality. I wonder whether this is not due to the fact that author's
experience is still very much in the select stage.

I need not really add anything much about our coronary pool. It has
been going only four years: we have only 233 in force and we have already
An Investigation into the

had seven deaths. Unfortunately, some of these have been where the sums assured have been above the average.

These three pools are risk-premium pools. The risk is shared among a number of offices who share the risk premiums and the claims, of course, and we have used the same technique to investigate in a very arbitrary fashion a miscellaneous number of declined risks, of which we have about 5,000 in force; unfortunately, the combinations of impairments are so varied that a break-down is practically impossible.

Turning to another part of the paper, I would like to refer to Table I. I think you will find that the total exposed-to-risk amounts to about 570,000. Now, the author has very rightly included ordinary rate cases as well as rated cases—and that, of course, is correct—but looking down the groups, I reckoned that perhaps a half of those 570,000 exposed-to-risk might relate to cases accepted at standard rates, at least by a large number of offices. That leads me on to suggest that if a general investigation is carried out—and I certainly would support Mr. Dow in arguing that it is something which we should undertake—there should, nevertheless, be a considerable weeding out of the impairments. I would recommend a concentration on the cardio-vascular-renal group, adding to it peptic ulcer, and, perhaps, non-tuberculous respiratory complaints. Of course, a study by build would be desirable. There are some very important groups, such as, pulmonary tuberculosis, where treatment has changed so fast that it may not be worthwhile to include it. I would also like to see any investigation analysed separately by sex and I think perhaps it would be easier to start off by excluding females altogether.

When we study the results in Table I, we are probably, many of us, surprised at the very favourable mortality in some of the groups. Is not the explanation of the excellent mortality shown in such groups, as, for example, the group suffering from dyspepsia, that we are dealing with people who are typically underweight and their underweight will prove to be of great advantage when we come to look at the causes of death as we shall see that there are fewer deaths from cardio-vascular causes. This is one of Nature's compensations, no doubt.

There is a good deal more that could be said but I am sure there are many other speakers anxious to make their contribution and I shall leave it at that.

Mr. R. E. Beard.—Mr. Dow has, I should think covered about 90% of the notes I prepared and, in fact, I agree with about 90% of what he said. I do, however, disagree when he goes on to say that we ought to try and build up a collective experience. I will not cover all the arguments again, neither will I add my plaudits to the paper except to say that I think that Mr. Clarke and Dr. Preston have given us a first-class experience and, to my mind, if you analyse the philosophy of what we are doing in underwriting, they have provided us with practically all the information necessary to do the job properly. I think we should be very careful about regarding this sort of investigation as scientific. We may analyse the data in a scientific way but, still, we must be careful when we say we are applying science to our job. I have tried to explain these points at length elsewhere but we must not forget we are insurance companies; we are transacting insurance business. Our job is to average out risks at a certain level of premium that we think to be appropriate. As Mr. Dow has told us, the tendency is to take more and more people at standard rates of premium.
Each office decides on an average level of premium and it then tries to get all the lives within that average. For example, a case comes along which causes the office to say to itself, "Ah! I must look at this one, it is a bit abnormal"; if it is seriously abnormal, then the office says, "We must charge him a bit more because otherwise it will be unfair to the others"; in other words, he is outside our standard. I do not believe much precision is required for that sort of calculation. I think that for the acceptable sub-standard cases two or three groups are as much as our knowledge will permit us to put them into, and any attempt to try and be too precise is a meaningless application of statistics. It has been said, the real thing we need is a lie detector; if a man comes along with some sort of vague idea in his mind and he thinks he is really ill but does not tell you, then, of course, he is a bad moral hazard and, strictly speaking, uninsurable. The essence of the development should be that more and more people are taken at standard rates, with less and less medical ratings. Nevertheless people will ask, "How are we going to tell when the cases are abnormal?" This is where I think the investigation we have heard about tonight does help us as it gives us a broad and useful guide.

The next stage is to try and increase the extent of the data. Now, my feeling is—and I agree that we would like to have more information on the subject for reasons I will come to later—that if we multiply the data by bringing in other offices, we have got to try and get it homogeneous. That is very difficult when you start getting down to detail and it might well be that were we to double or treble the data by bringing in other offices we would lose a lot of the value because the experience would become fluffy. So really, although we have got more data, we have really got less real information. I think we should be anxious to know more about mortality—so that we can make reliable forecasts about the future—for example it is important to know whether we are likely to be insolvent in fifteen years' time or so because somebody has found a cure for coronary disease and seriously upset the annuity funds. Thus we should ascertain whether offices are prepared to spend a lot of money on carefully collating their data to provide a bigger sub-standard lives investigation. I would say there seems little doubt of that, but I would suggest that we should pool the available resources and with the help of our medical advisers and a few of our actuaries concentrate on specific areas of truly scientific research. Then I think we would get positive information which would help us to fill in the rest of the picture which cannot be provided for by an investigation on classical lines. To my way of thinking, that is the way to make progress. One example of the sort of thing that convinces me that it is the right sort of approach is the problem of hypertension. Now, those of you who keep in touch with your medical advisers or even read the medical journals yourselves will appreciate that, within the medical research field in recent years, there has been quite a controversy about the nature of hypertension. I have called it, "Platt v. Pickering"; one side says, "Hypertension is a specific disease" and the other says, "No, it is not. It is just a condition which develops", and they are arguing between themselves and making investigations into whether or not it is a tenable hypothesis that there is a specific disease which may be called hypertension. Now, supposing that that was true and that a proportion of our hypertensives are, shall we say, natural cases in the sense that it is the way they are made and, for the other proportion, it is a degenerative condition, then all the deaths might occur in one or the other of these groups and our
underwriting would be unsound in the sense that we would be rating all the
group because we cannot select the abnormal minority.

Then there is another example I would like to mention as food for thought —the question of blood cholesterol and subsequent death from heart
trouble. Now, very little statistical information is available on this. I
think the most extensive investigation is the Framingham Study where a
few hundred cases were carefully studied. The analysis seems to me to
show that blood cholesterol concentration was a much better discriminant
of subsequent mortality than blood pressure readings would be. In other
words, it has a much steeper gradient and so it would be a better way of
picking out sub-standard lives. And, yet, we do not want to use blood
cholesterol readings if we can avoid them, at least until the doctors and our
lives assured get wise to the position, because, if a man does not know he
has got a high cholesterol reading, then we can charge him an average
premium. If, on the other hand he discovers he has a high cholesterol,
what do we do? Charge him a premium and let the others go free because
we have not taken a reading from them? We are in danger of becoming
completely inconsistent in our approach by having a little more informa-
tion. All this suggests to me that there is scope for actuaries and the
medical profession to get closer together and to develop useful investiga-
tions which would not only help the companies in the problems of their
own mortality needs but would also be of help to the community at large
in throwing light upon the nature of various complaints. We all want to
reduce mortality but, in so doing, we might well set problems for ourselves
in the future. In other words, if somebody says, "We can defer the age at
death by ten years in fifteen years' time" , then, with our current spread of
business, particularly annuity business, we ought to start setting up the
additional reserves now in anticipation of the change. I think that we
should not neglect our social duty but it is all stimulated by this paper. I,
for one, would thank the author's Company for the great deal of work that
has been done and I would like to see a continuation of this by the one
Company and to see all the other offices getting together to supplement this
investigation; not by extending the data but by the sponsoring of special
research studies.

Dr. J. G. M. Hamilton.—I have two comments that I should like to make
on the paper and on the discussion. As I see it, Mr. Clarke is inviting the
actuarial profession and the life offices to pursue investigations of this kind
and I wish to say that I hope and trust that either this investigation or
another like it will indeed be pursued in the general manner of this one
described to us today. Mr. Clarke in his last paragraph expresses some
doubt as to whether an investigation of this kind will have a usefulness for
life assurance underwriting commensurate with the trouble and the
expense of the investigation. I do not feel qualified to comment on that
aspect of the matter but I do wish to say this. It has seemed to me that
there is no little measure of danger and risk in the apparent utter de-
pendence of British life assurance upon American experience. The de-
pendence seems to me to be very close and questionable for the Americans
are racially, constitutionally, and by habits very different from the in-
habitants of this country, and it is highly desirable that we should have—
and as soon as possible—comprehensive experience from British life offices
for the purpose of setting underwriting standards so that we are no longer
so closely dependent upon American experience and can use the American
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experience properly as it should be used for comparison rather than as a foundation.

Mr. Clarke writes again, in the same paragraph, that the results of such a comprehensive investigation as this might provide helpful data for medical research. Now this, of course, is not a might at all. It would. This is very true. It is, I think, an important aspect of work of this kind. The charge has been made against the British life assurance industry—if "industry" is the proper word—that too little, vastly too little, support has been given by life offices to medical research. After all, the claim is made, and with some justification, that life offices and their policyholders have benefited enormously as the result of medical research in a variety of different fields, and the corresponding—or one would suppose corresponding—support which life offices have given to further medical research has been exiguous in the extreme in this country. I think that investigations of this kind have value in respect of medical research and I am going to pick out one simple, single, and possibly even rather naïve, example.

There is wide-spread a belief—ill-founded, it seems, but nevertheless wide-spread—that the increased mortality experienced by people suffering from peptic ulcers is due in part to a higher than normal incidence of cardio-vascular illnesses and cardio-vascular causes of death. Mr. Clarke’s paper shows that this, in so far as the limited experience analysed here is concerned, is not so. Now, this is a matter of great interest—of special interest just now to medical people—in particular in connection with the current controversy to which reference has been made about the place of dietary fats and especially animal fats and dairy fats in the genesis of vascular degenerative processes and coronary disease. Of course, we all know that people with confirmed and established peptic ulcers virtually live on dairy fat. The implications of this finding to which Mr Clarke does not make further comment except a note that it is there are, I think, of great importance and I trust that things of this kind would come out of an extension and continuation of this investigation.

In Mr. Clarke’s 55th paragraph, he, I think very properly, asks the question whether information obtained from a continued study of this kind might not arrive too late to be of use. Well, of course, I take his point that there may be in the interval between the start and the completion of such a study some striking, dramatic, medical advance which might wash out some of these impairments as impairments. It would be delightful if this happened. The prospect, however, of any large proportion of this very large number of impairments disappearing, or being so modified as to become unimportant, in the course of the next fifteen or twenty years seems to me so small that this ought to be accepted as a risk so far as the pursuit of an investigation of this kind is concerned.

May I end, and I know I have trespassed on your hospitality too long, by asking Mr Clarke if he could enlighten me about a sentence or the part of a sentence in his paragraph 50. Mr. Clarke writes, "But if some of the lives concerned possess a secret premonition of their own approaching demise," now this, of course, is lovely stuff, but perhaps Mr. Clarke would tell me what he means and whether he put in this crystal-gazing sentence as the result of any direct experience which he possesses, because if he has information on this matter then I trust it will be possible for him to share it.

Mr. J. L. Anderson.—I am not going to enter the argument about the desirability or otherwise of extending this investigation to an all-offices
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investigation. But reading over Mr. Clarke's paper, the side of it which interested me most was the analysis “by cause of death” which, as Dr. Hamilton has just said, may throw some useful light on problems which are at present obscure. Arising out of that I would like to ask a question. I notice that in two impairments—otitis media (without operation) and fistula in ano—the extra mortality seems surprisingly high. Of course, it may be that it is not significant because the numbers involved are not large, but I wonder if Mr. Clarke can tell us whether the causes of death in these particular groups suggested any warning which might be useful to underwriters? I do not know whether he has the information with him. If not, perhaps he would be able to answer this question in his written reply.

Sir George Maddex.—May I take the words out of the mouth of the President of the Institute and express the hope that there will be an invasion of London a week hence to carry on the discussion.

As an ignoramus in this subject, I rise only to ask a few questions. They are questions which I am sure have an easy answer known to everybody who has experience in the field of life assurance underwriting, but I think the answers will have a considerable bearing on the lines of investigation of this subject in future. I am quite sure that the investigation ought to be carried on. I am not at all sure what sort of scope it will be found to have in two or three years time, but certainly it is more necessary now than it was a generation ago and it should be very much easier to develop it with the means now at hand.

The few questions I want to ask are these: What in this context is an impaired life? Is an impaired life in one office the same thing as an impaired life in another office? What is a first-class life? I was puzzled to see that lives exhibiting one of the listed impairments were included whether the case was surcharged or accepted at normal rates, and I wondered what sort of blot—or how many blots—there had to be on the medical sheet, for a case to be accepted at normal rates as a first class life or accepted at normal rates as an impaired life or to be accepted with some kind of surcharge or other penalty. Apart from that, I would like to know whether there is any serious difficulty in the way of investigating the mortality of impaired lives, by reference to the various types of surcharge or penalty. I feel that without a sub-division into those accepted at normal rates and those accepted at certain types of other rates, the benefits of the investigation will be limited.

One more point. I know, of course, the limitations due to the size of the experience but I do feel that without more sub-division by age than is given here—a sub-division which, of course, will as a matter of necessity vary with the particular disease or impairment—one is left not quite knowing what is the explanation of some of the results obtained.

Mr. C. S. Penn.—I did not come here today prepared to speak. I have been out of the underwriting business for five years now and my information is rather out-of-date. However, there seems to be plenty of opportunity for speakers at the moment so I have just one or two points to raise.

First of all, I understand from a word I had with Dr. Preston before the meeting that the experience includes not only medically examined lives but also, in some categories, non-medically examined lives, and I should be
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Mr. J. H. Gunlake.—I hoped to follow Sir George immediately—but I was slightly forestalled—to say how very heartily welcome any of you will be who are able to come to London next Monday to hear a continuation of this discussion.

Sir George took the words out of my mouth in one or two other respects, and I have only a few small points to contribute on the paper itself. On the important question that it asks, namely (as it was put by the Opener of the discussion) “Where do we go from here?” I must be silent. We both, no doubt, have the same desire and that is to learn, whatever our own views on this particular point may be. There are one or two points, however, on the experience recorded in the paper, as such, on which I would like to comment. It does seem to me that as a statistical investigation the results need to be interpreted with very great care indeed. It is a highly immature experience, the average duration being of only three or four years. It is a truncated experience, because the declined lives are not in it. This seems to me to be most important, both from the underwriting point of view and from the point of view of medical research, in so far as statistical enquiries of this kind are helpful in that field. The control, which has been called Standard (0-4), includes, as I understand it, a number of the impaired lives, and it is not, therefore, a wholly dissociated control. Furthermore, it consists of those lives accepted by the office in question at ordinary rates, and it is, therefore, not a wholly objective control.

I did wonder also about the other control for causes of death. It may be reasonable to assume the two large classes—the sufferers from hernia and family history of tuberculosis—are not to be supposed to be very specific in any way as regards causes of death. I wondered, however, whether there were any statistical links between hernia and some of the sites of cancer. Cause of death is something that has always appealed to me as a statistical source of enquiry—not only because I happen to be the son of a doctor. I think it might be worth considering, if we are going to turn over in our minds the possibility of the offices joining together in pursuing investigations in this field, whether there would be anything to be said for investigating the causes of death amongst all the lives accepted at ordinary rates.

I have only one other point to suggest, and that arises on paragraph 27, where Mr. Clarke draws attention to the rather high mortality rate from cancer of the peptic ulcer cases and comments that this feature is “in-
It is indeed interesting to note that the high mortality from cancer includes lung cancer as well as cancer at other sites. I wondered whether the link here with the peptic ulcer diagnosis at the outset—and I am careful to avoid any such word as "causation"—whether the link here might be the heavy smoking to which the previous speaker referred?

Mr. H. A. R. Barnett.—I do a certain amount of work for the Joint Mortality Investigation Committee, in that I help to supervise the work done by the computing centre and I would like to say, first, purely from that angle, that there is no reason why the sort of investigation that Mr. Clarke and other speakers have in mind should not be carried out. Like Mr. Gunlake, I am not myself associated with a life office and I should therefore avoid perhaps expressing too firm an opinion. But I would like to follow up certain of the comments at the end of Mr. Clarke's paper in his final section before the appendices.

He mentions the difficulty of obtaining consistency between offices, but I think that that is probably something which would come with time—and with not very much time. I think that after a few years the offices would get used to their classifications of various impairments and of causes of death. This would obviously be particularly so if the number of offices were limited as the Opener suggested. But it does seem to me that if we are going to have an investigation it would be a good thing if those impairments for which Mr. Clarke has found insufficient data to deduce any conclusions were, in future, to be the subject of larger data.

Another speaker has already referred to Mr. Clarke's suggestion that the results may be out-of-date, but I too doubt whether in the case of any particular set of results that are submitted they would have become out-of-date in respect of all impairments at the same time.

Mr. Beard, I think it was, mentioned that data supplied by different offices will be subject to a certain amount of heterogeneity but we already swallow that one in our investigation of lives accepted at ordinary rates. I was very glad that Mr. Gunlake mentioned the possibility of an ordinary investigation according to cause of death. This is something which I have been trying to plug away at Institute Meetings for several years and so far nobody else has taken up cudgels and I was very pleased to hear somebody else speak on those lines. I think that it would be particularly valuable in following trends—and just to give a very simple and extreme case—if from one period to another we were to have a sharp decrease in mortality from one cause only with no change in the mortality from any of the other causes, the one particular cause having been completely eliminated by a medical break-through, it would be absolute nonsense to project that improvement into the future. Yet without a cause of death investigation we would not know that the improvement had been entirely due to the one medical break-through.

Finally, I would say that if another investigation such as this is carried out—and I hope it will be—I do not think I would mind very much whether it is done by one office or by a dozen large offices, but there is the one point that if it is done by one office only, we would have the advantage that we could look forward to future papers by Mr. Clarke.

Dr. T. W. Preston.—I must express my gratification for the privilege you confer on me asking me to join in this discussion and I feel you have
been most generous to Mr. Clarke and myself; it is Mr. Clarke’s paper but you have been very generous in your allusions to me.

I feel that the statistics on which we rely are faulty for two reasons. Reference has already been made to our reliance on American statistics, and as Dr. Hamilton pointed out, American mortality may not be exactly the same as our own. Secondly, in the Impairment Study of 1951 of the American Society of Actuaries, differentiation is made between standard lives and substandard lives; in our investigation we have been very careful to eliminate any kind of selection. Mr. Gunlake referred to this when he queried our inclusion of lives which we had taken first class and those which we had taken loaded. We have tried not to bring any bias into it at all, and that is the reason why it should not be impossible for other companies to add their quota. Although I and my immediate colleagues have done most of the classification, we have tried to keep very closely to this classification as laid down. We have tried not to influence it with our opinion. A particular impairment is there and we have given it the code number we think appropriate. Perhaps it is a misnomer to call it a study into impaired lives; it is rather a study of lives deviating from standard.

Secondly, we rely on statistics derived from medical investigations. Now I think all medical officers will agree that doctors doing clinical research are up against the difficulty of lack of adequate follow-up machinery. We find that patients do not answer questionnaires; they move out of the area and we lose touch with them, and so almost every medical investigation is too short and every year that goes by there is an increasing number of cases which the doctors have not been able to follow up. Now insurance companies have a ready-made follow-up scheme. The agents will keep in touch with them to see that they pay their annual premium and when they die their representative may be relied on to let us know so that they can collect the money!

I would like to say a few words particularly about blood pressure. I think that is a group in which our work can be very valuable, perhaps more to underwriters than to the medical profession. There is, as you all know, a great divergence of opinion between the medical profession and actuaries as to what blood pressure we should regard as significant. Mr. Beard referred to the amount of research which has been done in medical circles on blood pressure. Unfortunately a good many useful investigations are not usually available to insurance companies—for example blood cholesterol estimations. The underwriter has to make an assessment on the information before him. So far I think that all blood pressure studies, particularly in younger lives, have not been followed up long enough to be really of significance from our point of view. Blood pressure readings used in our present investigation are often criticised because they may not be accurate. People say “You have just one reading which may be taken under conditions of stress. That is not the true blood pressure. If several readings were taken when the man was sufficiently relaxed you might find a very considerable fall.” Now that is a very pertinent criticism from the medical point of view but I am not sure that we should disregard it from the underwriting point of view. Most people are under tension whilst being examined but in most cases there is no significant rise in blood pressure. If a person shows a big rise in blood pressure under the stress of medical examination, it may well go up also when he has important business negotiations; when he has some domestic trouble; when he is in his car in a traffic jam and has an important appointment to keep. So
that I think that the man who shows a labile blood pressure today, as he grows older, more and more frequently will be the occasions when his blood pressure will go up and there is a grave danger that the labile blood pressure of today may in twenty years, or thirty years, have become an established hypertension which may well be significant. We really have no answer to this question; no medical statistics are of sufficiently long duration and therefore I do very much hope that we shall continue the study of the blood pressure group.

A speaker expressed surprise that our figures did not show a higher mortality for overweights with high blood pressure. Well, I would just like to make this comment about these and other figures which have struck speakers as surprising. One is reminded of the father looking at his boy's report who said "Well, anyhow there is this in your favour, it is clear you have not been cheating!" I think we can claim that much for this investigation if some of the results are not what you would expect! Some unexpected results may be due to the fact that lack of sufficient data has not enabled us to sub-divide these cases into sufficient sub-groups. That is the great weakness of this investigation. Mr. Gunlake referred to it being immature and too short. That is very true. What worries me is that we have collected quite a considerable amount of material but when you try to break it down into really worthwhile sub-groups you have not enough data to be statistically significant at all; that is why I am so anxious to try and get more information. Incidentally, although it may be surprising that the overweights with high blood pressure do not show a higher mortality it does confirm a theory which I hold and that is that although overweights are more liable to have a high blood pressure than underweights, if a man has a high blood pressure the risk is not necessarily greater because he is heavy. A very thin person with a high blood pressure may have serious cardio-renal disease and be a very bad risk.

Mr. Steeds referred to the fact that we took the diastolic pressure at the "fifth phase". We do that for practical reasons. I quite agree that the fifth phase is not accurate but we found that some of our referees, if we asked them to use the "fourth phase" gave us such extraordinary readings that we could not make any use of them; the fifth phase is less accurate but much easier to detect.

Two speakers raised the important question of heavy smoking. I think Mr. Gunlake may have made a most relevant point when he suggested a connection between the high incidence of cancer of the lung in heavy smokers and the high incidence of cancer of the lung in our peptic ulcer group. Unfortunately statistics on heavy smoking in our study seem impracticable owing to the difficulty of getting reliable information.

Mr. R. Ll. Gwilt.—I had no intention of entering into discussion of the detail of Mr. Clarke's paper and I still have no such intention. I came here as Chairman of the Mortality Committee to listen carefully to what was said by every speaker in order to form a view as to whether or not the Committee should go ahead in an attempt to carry out an impaired lives investigation on conventional lines.

I think it is fair to say that the members of the Mortality Committee as a whole have had growing doubts as they got closer to the problem, about the value and perhaps the interpretation of such results as might emerge from a full-scale investigation affecting all the offices. When I first came to mortality work, which is a good many years ago now,
I was strongly in favour of some kind of investigation for impaired lives, but over the years my views have changed. Perhaps that is merely anno Domini! But I do now have grave doubts whether it is fair to the offices to ask them to undertake a great deal of complicated and difficult work to produce statistics in order that the Committee may eventually publish some results which may be of doubtful value and will certainly be extremely difficult to interpret. I think that in an investigation of this kind the characteristics of consistency and homogeneity are of the greatest importance. Someone has already mentioned that and I think the possibility of achieving these characteristics in an investigation affecting a large number of offices is very small indeed. We are most indebted to Mr. Clarke and to Dr. Preston for all the work that has been done in this investigation which has been put before us and we are particularly grateful to the "Prudential" for having permitted Mr. Clarke to submit the results obtained so far. They are most valuable to us, and the "Prudential" have gone further and agreed to place their investigation at the disposal of the Mortality Investigation Committee in order that it might be regarded as a pilot investigation in considering whether to proceed with something on a full scale. My own feeling is that if the "Prudential", who have already put us very deeply in their debt, were willing to increase that debt still further and permit later results of the investigation to be submitted to the actuarial bodies for discussion in years to come, I think that would probably give the best information we could get in the form of a medico-actuarial investigation on conventional lines.

Reference has been made to paragraphs 53, 54 and 55 of Mr. Clarke's paper and I feel that the difficulties involved in making a specialised investigation and the factors that lead the Committee to hesitate summarised in paragraph 53, greatly outweigh the possible advantages referred to in paragraph 55. So my own view is that we should not attempt to carry out a full-scale investigation affecting a large number of offices if the "Prudential" would be prepared to continue their investigation and let us have the results from time to time in future. It may well be, and I think Mr. Beard mentioned that earlier on, that it should be possible to conduct some other and more valuable form of investigation on behalf of the offices.

Mr. G. M. Fairlie.—I realise my temerity in arguing against the previous speaker. I am bound to agree with him that the prospects of getting all the offices to conduct a full investigation to produce useful results must be quite negligible, but it does seem to me that there are two categories of impairment in which it should not be impossible to achieve a fair measure of consistency—the categories of high blood pressure and overweight. These attributes are measured by a large number of doctors all over the country and there does not appear to me to be any good reason why the weights or heights submitted to one office should be biased—either higher or lower than the weights or heights submitted to any other office. If by including, say, the half-dozen largest offices, we could double or even possibly treble the amount of data at our disposal, we could certainly hasten the emergence of some reasonably significant results in these two categories. They cover about a fifth of the exposure in tonight's paper and about a third of the deaths, representing quite a considerable proportion of the rateable cases, and if we could get some rather more reliable figures for these impairments we might be able to extend, gradually,
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the limits of our acceptance. I think we might also be in a better position to see whether our experience agrees with that of the American Build and Blood Pressure Study which, as several speakers have mentioned, has quite an influence over here. At present, on the results in the paper, one would say that the figures for overweight look very much the same but the figures for hypertension do not look particularly compatible, for which, of course, there may be a number of reasons; one feels one would like further investigation of this. Perhaps the largest office could continue its own investigation and the next half-dozen could produce another experience, so that we should not ruin the one really homogeneous experience that we have.

A lot is said about the cost of these investigations but nobody ever mentions a figure. I wonder if anybody is in a position to say just what these investigations cost? The figure would be interesting because we could compare it with the extra profit we might make by extending our business over a wider field.

Mr. J. M. Denholm, closing the discussion, said:—I think I am correct in saying that in this Hall we expect—and generally we get, and we have had tonight—a very full and interesting discussion on medico-actuarial topics. We have a fine tradition here of co-operation between the two professions, a co-operation which has borne fruit in published contributions to the art of selection of lives, notably by L. P. Orr and by C. S. Penn, whom we heard tonight, and by the late Dr. Hewat.

We have awaited this paper with keen anticipation and read it with much concern. While its main significance must be as a signpost to the future, the author has, in my view, been modest in his reading of the interest and importance of his findings despite the inevitably short duration of the experience. The author pays tribute to the leading part played by his Company’s principal medical officer, Dr. Preston, whom we are very glad to have heard tonight. There is, it is true, a large bulk of underwriting where, by reason of the straightforward and uncomplicated nature of the impairment, the actuary can select and classify under the general guidance of the doctor. But I must confess that so far as I am concerned, at the slightest sign of complication I call upon the wisdom and judgment of the doctor, and this, I think, must always be so, whatever the impairment and whatever statistical aids develop. There will always be a large area of medical evidence which is not within the province of the actuary to interpret and I think we can all call readily to mind cases of that kind. What do you do with a proposer who has recorded a blood pressure of, say, 160-100 on several occasions in the past, comes up for a new proposal, and records a perfectly normal reading of 120-80? Or a proposer who records a high blood pressure under examination by an independent examiner, but a perfectly normal reading on subsequent examination by his own physician? We ask the doctor what is the significance of such findings and when we have the answer we attempt to classify for statistical purposes.

It is, I think, a truism to say that we select proposers only on the evidence we can get as to their health and habits and with more detailed enquiry and fuller knowledge, we might well alter our views of some risks. Should the day ever come when we can readily recognise the potential candidate for early coronary disease, in the light of a normal medical examination, we shall certainly save ourselves a number of early claims from lives to all intents and purposes acceptable on examination and history, although...
clearly in the event not first-class lives. For all the spectacular developments in medicine and surgery there is still, and probably always will be, a subjective element of varying degree in the classification and underwriting of impairments and the author has dealt with this as far as possible in the presentation of his results.

What our investigations into normal or impaired lives give us are results relative to our standard of underwriting. If we vary our standards, we would not necessarily reproduce an identical experience in future, even if all other factors were unchanged, and it goes without saying that considerable care and judgment is called for in the interpretation of the findings of an investigation of this kind. With that qualification, I am whole-heartedly in favour of continuing the investigation, very largely in the form already established. Whether it would be feasible to combine the experience of either a small or a large number of offices, each with its individual approach to the acceptance or rejection of risks, is another matter. This point has been aired many times before. In particular, it will be recalled that in the discussion on A1924-29 experience, the late A. E. King made specific reference to it, drawing attention not only to the difficulty of combining on any homogeneous basis the experience of under-average lives, but even of combining the experience of lives accepted at ordinary rates where we well know the variation can be extremely great. I feel that it would be wise to continue the present investigation on a parallel course for a further period for comparative purposes. If it is thought desirable to bring in the experience of other offices, we can then at least assess and judge for ourselves the value of the experience so produced in addition to extending the merits of this very excellent paper.

I would, in closing, like to commend the brevity and conciseness in the presentation of the findings. If the enquiry continues, the profession would, indeed, be interested to know not only the level, but possibly also the incidence, of extra risk, but I put in a plea for the continuance of the excellent principles which the author and Dr. Preston have established, so that we can, within the limitation of the data, at least try to see the wood apart from the trees.

Mr. R. D. Clarke.—I am very grateful for the generous reception which my paper has received this evening.

I would like first to deal with the logical point raised by Sir George Maddex. The term "first-class life" denotes a life accepted at normal rates of premium. Consequently, first-class lives include some who, though exhibiting a minor impairment for which they are included in the impaired lives' investigation, have not been surcharged for the impairment.

In the American Build and Blood Pressure investigation the data were subdivided in two different ways which were independent of each other. There was a subdivision into standard and substandard cases, i.e. between lives accepted at normal rates and lives surcharged. There was also an independent subdivision between lives without minor impairments and lives with minor impairments, and this subdivision had no reference to the terms of acceptance. Thus the Americans got the best of both worlds. I do not know how they were able to work this in detail, but I can only say that the machinery at our disposal did not permit a comparable analysis. Thus we are faced with this logical dilemma—if you can call it so—that the two classes, first-class and impaired, are not mutually exclusive. I do feel quite strongly, however, that in an investigation of this kind the classification
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should depend upon the medical report and not upon the underwriter's decision as to how the risk should be treated; because if we are accepting at normal rates a condition which should be surcharged, we can only discover the fact if we make the medical report the basis of classification and ignore the underwriter's decision. On the other hand, as I have pointed out in the paper, the characteristic as to whether a case has been accepted at normal rates or not is punched on the card, so that we could at some future time analyse by the terms of acceptance. That might be an interesting thing to do. This question of the definition of "first-class" and "impaired," which both Sir George Maddex and Mr. Gunlake raised in the course of their remarks, I have singled out for priority treatment because I think it is basic.

The President.—Mr. Clarke has been very modest in assessing the results of his investigation. We shall all agree, however, that it has taken us a great step forward in settling the question which we as a Faculty—along with the Institute—have to decide, namely whether we should advise the offices that a combined investigation into impaired lives mortality would justify the labour which would have to be devoted to it. The President of the Institute has pointed out that this is not the place—nor is it the time, considering that the discussion is to be continued next week—to decide the matter finally. One may be allowed to express the hope that if a combined investigation is not to be made Mr. Clarke and his office will feel that the results of his work justify their continuing to "go it alone".

Our thanks tonight must be threefold—firstly to the great Office which has enabled the investigation to be made; secondly to Dr. Preston whose collaboration has been so valuable, and thirdly, and not least, to the author himself. The amount of work which has gone into the preparation of the paper is obvious and the profession owes a debt of gratitude to Mr. Clarke which I would ask you to acknowledge by a resounding vote of thanks.

Mr. Clarke subsequently wrote as follows:—I should like to thank the many speakers for their interesting contributions to the discussion, all of which I have studied with profit. In a number of instances speakers made comments with which I am in wholehearted agreement and I have not felt any need to refer to these in my reply to the discussion.

Mr. Dow referred to the high mortality revealed in the American Blood-Pressure Study among lives registering blood pressures only slightly raised above average, thereby suggesting that a systolic reading of 150 is rather high at the younger ages to be the threshold between first-class and impaired risks. This high American experience is indeed interesting and it may well be that if we were planning our investigation again we should choose a lower threshold. One interesting reflection is that, pace those experts who resist the suggestion that a raised blood pressure should be regarded as anything other than a statistical deviation from the mean, our American colleagues have obtained results which definitely justify an attitude of wariness by underwriters when dealing with hypertensives.

Mr. Steeds thought that the mortality shown in the diabetic group was surprisingly high. On the other hand I have had a private communication from Mr. Lew of the Society of Actuaries, in which he expresses the view that our experience has been light in comparison with the American statistics for diabetics. I should be hesitant in attributing the differences between Mr. Steeds' statistics and mine to variations in social class. I agree with Mr. Steeds that a certain amount of pruning of the investigation
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would be advantageous and I think that we should cease adding new entrants to some of the groups where the experience has been light. We should, however, continue to observe the existing lives in these groups until we have adequate data at longer durations. I was interested in Mr. Steeds' suggestion that sufferers from dyspepsia might show a low average weight and consequently a light mortality experience from circulatory causes. This line of thought would doubtless repay further enquiry.

Dr. Hamilton has referred to the question whether the results of this type of investigation may arrive too late to be of use. In bringing this objection forward for discussion I had in mind not only a dramatic medical advance resulting in the disappearance of an impairment—at least in any lethal sense—but also changes in treatment over the period of observation which might introduce elements of heterogeneity into the data. I am convinced myself that this is a risk that should be taken but I think that there may be more substance in the objection than Dr. Hamilton was prepared to allow. My remark about "a secret premonition of...approaching demise" was, of course, an extravagant figure of speech. But I think there can be no doubt that some people feel themselves to be poor risks and seek life cover on that account. Whether their secret intuitions are, in fact, the product of actual impairments, or mere imaginings, is quite another question, to which I do not claim to know the answer.

Mr. Anderson asked for the main causes of death in the groups "otitis media" and "fistula in ano". In the first of these two groups the extra deaths appear, on the whole, to be well spread over the various causes. Two possibly noteworthy features, however, are the presence of three deaths from cerebral abscess and four deaths from suicide. All 17 deaths in the "fistula in ano" group were caused either by cancer or by vascular lesions or by coronary disease. It may be that fistula in ano is symptomatic of a low general state of health and thus renders the sufferer more vulnerable to the main causes of death.

Mr. Penn asked for more information about the inclusion of lives entering under the non-medical scheme. In general, there will be very few such lives included in the data for the more serious impairments; but for the light impairments—family history of tuberculosis is an obvious instance—non-medical policies are likely to predominate. If the investigation is to be pruned—as I have already suggested—by closing some of the lighter impairment groups, the number of non-medical policies in the investigation is likely to become very small. It would indeed be interesting if Mr. Penn's suggestion that the mortality of heavy smokers be investigated could be carried out. Perhaps this could form one of the special research projects which Mr. Beard would like the offices to sponsor.

I fully sympathise with Mr. Gunlake's misgivings on the standard employed in the paper for the cause of death analysis and I should welcome an investigation based on causes of death among a representative group of first-class assured lives. Ideally the same control should be employed both for calculating the expected deaths and for the analysis by cause, and it should correspond as closely as possible to the experience being examined.

Mr. Fairlie asked if any estimate were available of the cost of a comprehensive investigation. I think it is true to say that in terms of money the cost is not likely to be very great. But the demands on manpower and machine time are another matter and this, I think, is where some offices may be likely to hesitate when considering the arguments for and against participation.