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AN INVESTIGATION INTO THE MORTALITY OF IMPAIRED LIVES DURING THE PERIOD 1947-1963

by

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INTRODUCTION

1. This report presents the results of an investigation into the mortality of impaired assured lives during the period 1947-1963. A preliminary account, outlining the nature of the investigation, was given by the first author in his Presidential Address to the Assurance Medical Society in 1955, and a report on the results up to the end of 1958 was given in a paper by the second author, which was presented both to the Institute and the Faculty of Actuaries in 1961 (*J.I.A.* vol. 87, p. 196, and *T.F.A.* vol. 27, p. 20). Earlier this year the first author read a paper to the Assurance Medical Society which gave the statistical results up to the end of 1963. These same statistics form the basis of the present paper, but the text has been revised and expanded. Certain passages in the present paper, notably paragraphs 7, 8, 9 and 11, which describe the recording and tabulation of data, have been reproduced from Clarke's 1961 paper.

2. It will be apparent from the preceding paragraph that the conduct of the investigation has been a joint responsibility, being medico-actuarial in its nature and therefore possible only as a result of co-operation between the medical and actuarial professions. The classification of risks is essentially a matter for a medical officer, while the actuary's contribution lies in the analysis of statistical data. Co-operative enterprises of this kind have a long history in North America, and it is to be hoped that they may become more frequent on this side of the Atlantic.

SOURCE OF THE DATA

3. The data for the investigation were drawn from holders of life assurance policies effected during the period 1947 to 1963 in the

ordinary branch of an industrial-ordinary life office. Policies were included if the life assured exhibited one of the impairments listed in Appendix A. The terms of acceptance were not taken into account, so that the experience contains both lives who were surcharged and those who were accepted at standard rates. The investigation was designed to measure the mortality experienced within specified classes of impairment with a view to developing bases for assessing future ratings. Its purpose was not to test the underwriting decisions of the past—an objective which would have been difficult since underwriting policy is subject to modification from time to time, and the consistency and homogeneity of the experience would be upset if a surcharge were made a criterion for inclusion in the data. The acceptance terms were, however, recorded on the basic cards, in case a subsidiary analysis should at any time be required for internal office purposes.

4. Both medically examined and non-medical lives were included without discrimination, although it will be obvious that for all the more serious impairments a medical examination will have been carried out. Thus it would have been impossible to code hypertensives without blood pressure readings and these could only have been obtained as a result of medical examination. On the other hand, a family history of tuberculosis can be revealed on a non-medical proposal.

5. In general, lives exhibiting two or more *major* impairments were excluded. (For this purpose an impairment is regarded as " major " if it would warrant a surcharge in its own right even if unaccompanied by other adverse features.) To this rule there are the following exceptions :

(i) Combination of hypertension and overweight.
(ii) Association of certain impairments in the tuberculosis group with underweight and with a family history of tuberculosis.
(iii) Association of glycosuria or diabetes mellitus with both overweight and underweight.

6. Another class inevitably excluded from the investigation is that of declined lives. This is a cause for regret, since an investigation into the experience of declined lives could yield useful information. It may well be that life offices are declining certain classes of lives who, if suitably surcharged, could in fact be regarded as insurable.

However, as time goes on, it is likely that an increasing number of impairments now regarded as uninsurable will be brought within the ambit of life assurance—particularly as a result of the setting-up of reinsurance pools for some of the heavier risks.

RECORDING OF DATA

7. 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
9. Sum assured
10. Acceptance terms
11. Year and month of exit
12. Mode of exit
13. Cause of death

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.

8. 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.

CODING SYSTEM

9. 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.

10. There were originally five groups of impairments selected for study, viz

1. Arteriosclerosis ; hypertension ; hypotension.
2. Peptic ulcer ; dyspepsia ; cholecystitis ; amoebic dysentery.
3. Epilepsy ; head injuries ; psycho-neuroses ; migraine.
4. Tuberculosis.
5. Glycosuria and diabetes mellitus.

Subsequently four more groups were added, viz

6. Underweight and overweight.
7. Hay fever ; asthma ; chronic bronchitis ; emphysema.
8. Urinary disorders.
9. Neoplasms.

Further certain miscellaneous items were added to the main groups, viz

Group 2. Herniae ; varicose veins.
Group 3. Poliomyelitis ; otitis media.
Group 5. Disorders of the thyroid gland.
Group 9. Osteomyelitis ; anaemias.

For the various subdivisions of these classes of impairment, Appendix A should be consulted.

TABULATION OF DATA

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

New Business

Withdrawals
Deaths
Policies existing on 31st December 1963.

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 31st December 1963, the ages were the ages next birthday at entry plus the difference between 1963 and the year of entry. Thus E_x, the exposed-to-risk from age x to $(x+1)$, is obtained by the formula

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

and the rate of mortality, q_x, is

$$q_x = \theta_{x+1}/E_x.$$

CONTROL EXPERIENCE FOR CALCULATING EXPECTED DEATHS

12. The most appropriate basis for measuring the extra mortality experienced by the various classes of impaired lives would be the experience of healthy—or unimpaired—assured lives of comparable duration over the same period of time. There are, however, no suitable data for unimpaired lives as such. Data are recorded for the Continuous Mortality Investigation for policies issued at standard rates of premium. These include cases which exhibit impairments not considered serious enough to warrant a surcharge and which may accordingly be included both in the "standard" experience and in the impaired experience under investigation. However, the experience of lives accepted at standard rates is the only available source for constructing a control table and it has accordingly been used for this purpose.

13. As stated in the preceding paragraph, it is necessary that the control table should be based on policies of comparable duration and, in view of the steady improvement in mortality (at least at young and middle ages), that it should refer to the same period of time. The impaired lives' experience has been continually expanding since its inception in 1947, and the exposed-to-risk are accordingly more heavily weighted towards the end of the period 1947-63. The "weighted mean point of time" for the investigation corresponds fairly well to the end of 1957, and accordingly it was initially decided

to calculate expected deaths according to the mortality experienced by first-class lives over the two years 1957-58.

14. A complication of some intricacy is presented by the variation of mortality with duration. If the investigation had been carried out in select form (i.e. analysing each duration separately) no difficulty would have arisen. A fully select control table would have been constructed from the first-class experience and applied to the data at each duration within each class of impaired lives. However, such detailed analysis was beyond the bounds of practicability, and the investigation had to be conducted in aggregate form. This immediately raises two major difficulties :

(i) The impaired experience is more recent than the first-class experience ; hence it has a lower mean duration.

(ii) In most of the impairment groups the average age at entry is higher than among first-class lives. Hence, even if the impaired experience had been running as long as the first-class experience, the mean duration at particular ages would still be appreciably lower.

15. The experience for first-class male assured lives for 1957-58 was available in two duration groups, namely " 0-4 " and " 5 and over ", and two tables of q_x were accordingly constructed from these data by the application of Spencer's 21-term summation formula. It was originally thought that by a judicious blending of these two tables, a suitable basis could be derived which would give due effect to the lighter mean durations of the impaired lives. However, experiments in this direction proved unsuccessful, and it became apparent that up to quite a relatively high age even the " 0-4 " experience was too heavy to be a suitable control.

16. Any over-estimation of the normal level of mortality leads to an understatement of the extra mortality experienced by the impaired lives. In Clarke's 1961 paper he admitted that by using the " 0-4 " experience for first-class lives in 1954-56 he had overstated the expected deaths by perhaps some 10 per cent. As a result, he produced percentages of actual to expected deaths which were well below 100 per cent in certain groups such as family history of tuberculosis or varicose veins. It is quite clear that although these mild impairments might well show a normal level of mortality, there is no reason why they should display an abnormally light mortality,

and it is, therefore, essential to construct a control table which makes proper allowance for the low mean duration of the impaired lives' experience. In the end it was decided to construct a table based on the 1954-56 table used in Clarke's paper (which, in fact, varied *little* from the 0-4 table for 1957-58), by applying a series of ratios to the values of q_x starting at 70 per cent at ages up to 30, increasing to 100 per cent at age 60 and to 115 per cent at age 75. The 1954-56 table ceased at age 75, and thereafter the new table has been arbitrarily grafted on to the A1949-52 ultimate table so as to merge with it at age 85. As there is very little experience at ages over 75, the completion of the table at the higher ages is not, in fact, of any great importance.

17. On the basis of the control table so constructed, the percentage of actual to expected deaths was 101 for the major section of the family history of tuberculosis group and 104 for the varicose veins group. These percentages would have been considerably less without the special adjustments to allow for the shortness of the mean duration at the younger ages, and there can be no doubt that the adjustments have led to an altogether more satisfactory control basis.

18. The values of q_x in the control table will be found in Appendix C. Also reproduced are the two graduated tables derived from the 1957-58 experience (i.e. "0-4" and "5 and over"), the original 1954-56 table used in Clarke's paper and the A1949-52 ultimate rates of mortality. All these tables relate to male lives. For female lives, the values of q_x in the male control table were multiplied by ratios of female to male rates derived from English Life Table No. 11.

TABLE 1

Comparison of actual and expected deaths—male lives

Code	Description	Total no. of policies entering	Exposed to risk	Expected deaths	Actual deaths	100 A/E	σ	$\bar{q}$
100–103	Arteriosclerosis or atheroma	477	3,326	49·74	51	103	14	·0150
100–101	As above—mild or moderate with normal B.P.	310	2,408	36·00	34	94	16	·0150
102–103	As above—severe or moderate with raised B.P.	167	918	13·74	17	119	30	·0150
110–118	Hypertension, entry age under 40, standard weight	3,288	21,183	25·13	64	255	32	·0012
120–128	Hypertension, entry age under 40, weight+20% over standard	1,346	6,930	7·66	21	274	60	·0011
130–138	Hypertension, entry age 40-59, standard weight	5,173	34,633	251·11	480	191	9	·0074
130	As above—S.A.P. 155–170, D.A.P. < 95	1,550	11,322	90·41	159	176	14	·0080
132	As above—S.A.P. 155–170, D.A.P. 95–105	1,404	9,026	64·13	125	195	17	·0071
138	As above—S.A.P. < 155, D.A.P. 95+	1,357	9,665	62·94	110	175	17	·0065
140–148	Hypertension, entry age 40–59, weight+20% over standard	1,205	6,888	43·63	86	197	21	·0063
150–158	Hypertension, entry age 60 and over, standard weight	1,260	7,843	217·22	264	122	7	·0277
150	As above—S.A.P. 160–175, D.A.P. < 100	688	4,521	130·77	154	118	10	·0289
160–168	Hypertension, entry age 60 and over, weight+20% over standard	146	850	23·46	29	124	23	·0276
170	Hypotension	335	2,457	6·10	6	—	—	—
200–203	Peptic ulcer, short history, no operation	1,647	6,838	23·88	22	92	20	·0035
204–207	Peptic ulcer, short history, with operation	1,262	7,011	25·39	42	165	25	·0036
210	Peptic ulcer, long history, no complication, no operation	6,314	37,650	143·81	177	123	9	·0038
211–213	Peptic ulcer, long history, complications, no operation	707	4,149	21·81	30	138	25	·0053
214	Peptic ulcer, long history, no complication, operation	3,286	18,212	97·42	121	124	11	·0053
215–217	Peptic ulcer, long history, complications, operation	1,558	9,240	42·05	68	162	20	·0046

222	Dyspepsia, chronic, ulcer not suspected	1,886	11,573	39·15	40	102	16	·0034
223	Dyspepsia, suggestive of ulcer, but not proved	2,856	14,560	44·45	63	142	18	·0031
224	Dyspepsia, brief attack, no investigation	7,226	39,847	92·05	99	108	11	·0023
225	Dyspepsia, brief attack, investigation negative	3,254	15,987	43·64	49	112	16	·0027
230–233	Cholecystitis, all categories	1,049	6,324	45·99	60	130	17	·0073
233	Cholecystitis, with cholecystectomy	772	4,485	33·83	47	139	20	·0075
240–242	Amoebic dysentery	839	6,591	12·16	13	107	30	·0018
250–272	Hernia, all categories	29,783	179,998	680·02	740	109	4	·0038
280–287	Varicose veins, all categories	10,513	64,836	227·26	236	104	7	·0035
300	Epilepsy, petit mal	402	2,065	3·83	7	—	—	—
301	Epilepsy, grand mal	1,076	5,155	8·56	25	292	58	·0017
310–311	Cerebral concussion	3,547	18,041	37·30	44	118	18	·0021
312	Fracture of skull, no operation, no sequelae	1,607	8,659	16·94	26	153	30	·0020
313–314	Fracture of skull, no operation, sequelae	494	2,848	8·18	13	159	44	·0029
315–318	Fracture of skull, craniotomy	379	2,310	4·57	8	—	—	—
320	Psycho-neuroses, mild	4,478	23,493	58·46	74	127	15	·0025
321	Psycho-neuroses, moderate	3,653	19,446	45·71	64	140	17	·0024
322–323	Psycho-neuroses, severe	964	4,157	11·57	16	138	34	·0028
330–331	Migraine	2,127	9,409	16·11	7	—	—	—
350	Poliomyelitis	1,244	6,203	9·37	11	117	35	·0015
360	Otitis media, no operation	9,415	41,076	73·10	83	114	12	·0018
361	Otitis media, mastoidectomy	6,228	30,693	51·98	51	98	14	·0019
400–409	Tuberculosis (non-pulmonary)	3,037	16,882	34·86	36	103	17	·0021
410	Tuberculosis of two or more organs	275	1,208	2·49	4	—	—	—
420–423	Fistula in ano	871	5,782	20·96	30	143	26	·0036
430–433	Pleurisy with effusion	1,962	10,767	19·75	16	81	20	·0018
434–437	Pleurisy, dry or indeterminate	4,963	33,622	110·39	129	117	10	·0033
438–439	Spontaneous pneumothorax	932	4,430	7·86	8	—	—	—
440–443	Pulmonary tuberculosis, mild, sputum negative	2,399	10,897	19·33	27	140	27	·0018

TABLE 1 —*continued*

Code	Description	Total no. of policies entering	Exposed to risk	Expected deaths	Actual deaths	100 A/E	σ	q
444–447	Pulmonary tuberculosis, moderate or severe, not treated by special methods	5,561	14,007	33·32	47	141	20	·0024
450–453	Pulmonary tuberculosis, treated by artificial pneumothorax	1,389	7,912	13·73	25	182	36	·0017
454–457	Pulmonary tuberculosis, treated by major surgery	1,704	7,876	12·52	20	160	36	·0016
460	Family history of tuberculosis, entry age under 40, standard weight	13,669	80,364	75·95	85	112	12	·0009
461–462	Family history of tuberculosis, entry age under 40, underweight	2,452	15,648	16·52	11	67	20	·0011
463–465	Family history of tuberculosis, entry age 40 or over	6,494	50,182	285·47	287	101	6	·0059
500–508	Glycosuria (not proved diabetes mellitus) No B.S.T.T.	561	4,365	24·40	32	131	23	·0056
510–518	Glycosuria (not proved diabetes mellitus) B.S.T.T.	423	2,647	11·84	18	152	36	·0045
519	Proved renal glycosuria	305	1,987	5·96	8	—	—	—
520–522	Diabetes mellitus, entry age under 30	395	1,750	1·20	10	833	264	·0007
523–525	Diabetes mellitus, entry age 30–50	751	3,994	10·51	37	352	58	·0026
526–528	Diabetes mellitus, entry age over 50	213	1,177	13·78	24	174	36	·0117
540–544	Simple goitre, non-toxic adenoma and myxoedema	456	2,390	8·44	10	118	17	·0035
550–552	Toxic goitre	491	2,439	7·71	8	—	—	—
600–605	Underweight, entry age under 30	1,192	5,187	3·54	3	—	—	—
610–615	Underweight, entry age 30–50	3,822	22,301	67·53	77	114	13	·0029
620–625	Underweight, entry age over 50	1,067	6,861	86·87	92	106	11	·0127
650–652	Overweight, entry age under 30, 20–30% over standard	8,683	39,421	27·08	42	155	24	·0007
653–658	Overweight, entry age under 30, over 30% over standard	3,217	13,872	9·49	12	126	36	·0007
660–662	Overweight, entry age 30–50, 20–30% over standard	11,284	70,576	149·39	229	153	10	·0021
663–665	Overweight, entry age 30–50, 30–40% over standard	3,023	18,072	37·14	71	191	23	·0021

666–668	Overweight, entry age 30–50, over 40% over standard	1,093	6,263	13·50	26	193	28	·0022
670–672	Overweight, entry age over 50, 20–30% over standard	1,454	9,406	129·13	140	108	9	·0137
673–675	Overweight, entry age over 50, 30–40% over standard	316	2,035	26·33	28	106	20	·0129
676–678	Overweight, entry age over 50, over 40% over standard	121	736	9·34	16	171	43	·0127
700 710–720	Hay fever (all ages)	3,051	12,536	14·43	17	118	29	·0012
701	Bronchial asthma, entry age under 30	3,797	14,729	9·78	27	276	53	·0007
711	Bronchial asthma, entry age 30–49	2,448	11,651	19·51	39	200	32	·0017
721	Bronchial asthma, entry age 50 and over	214	1,093	11·04	17	154	38	·0101
712	Chronic bronchitis, no emphysema, entry age 30–49	643	3,223	6·95	14	201	53	·0022
713	Chronic bronchitis and emphysema, entry age 30–49	273	1,536	4·37	20	458	102	·0028
722	Chronic bronchitis, no emphysema, entry age 50 and over	211	1,090	12·21	28	229	43	·0112
723	Chronic bronchitis and emphysema, entry age 50 and over	166	880	10·63	18	169	40	·0121
724	Emphysema without bronchitis, entry age 50 and over	68	485	8·91	11	123	37	·0183
800–804	Renal calculus	2,638	12,348	39·69	35	88	15	·0032
820–831	Cystitis and pyelitis	1,944	8,477	19·93	12	60	17	·0024
840–842	Albuminuria	609	3,037	8·17	12	147	42	·0027
843	History of nephritis	813	3,826	8·00	10	125	40	·0021
852–854	Nephrectomy (miscellaneous)	479	2,031	4·72	10	212	67	·0023
903 912 933 952 962	Malignant tumours	186	695	3·23	11	341	103	·0046
901–961 ex. above	Non-malignant tumours	1,525	6,600	19·93	19	95	22	·0030
963	Enlargement of prostate	173	894	16·96	23	136	28	·0019

Note $\sigma = \frac{100\sqrt{\text{Actual deaths}}}{\text{Expected deaths}}$ $\bar{q} = \frac{\text{Expected deaths}}{\text{Exposed to risk}}$

TABLE 1*a*

Comparison of actual and expected deaths—female lives

Code	Description	Total no. of policies entering	Exposed to risk	Expected deaths	Actual deaths	100 A/E	σ	$\bar{q}$
130–148	Hypertension, entry age 40–59	1,136	7,922	36·46	50	137	19	·0046
130–138	As above, standard weight	873	6,199	29·02	41	158	35	·0047
140–148	As above, over standard weight	263	1,723	7·44	9	—	—	—
150–168	Hypertension, entry age 60 and over	381	2,176	35·75	40	112	18	·0164
150–158	As above, standard weight	330	1,880	31·57	35	114	27	·0168
160–168	As above, over standard weight	51	296	4·18	5	—	—	—
210–217	Peptic ulcer, long history	372	2,313	7·94	11	139	42	·0032
222–225	Dyspepsia	553	3,750	9·20	14	152	41	·0025
230–233	Cholecystitis	525	3,240	13·03	13	100	28	·0040
252	Hernia, unclassified, operation performed	598	3,872	8·60	11	128	39	·0022
280–287	Varicose veins	1,392	9,285	31·50	31	98	18	·0034
320–323	Psycho-neuroses	1,221	7,356	14·47	18	124	29	·0020
460–465	Family history of tuberculosis	3,469	26,293	58·11	70	120	14	·0022
610–615	Underweight, entry age 30–50	3,002	22,979	45·89	56	122	16	·0020
620–625	Underweight, entry age over 50	904	6,247	38·70	39	101	16	·0062
660–668	Overweight, entry age 30–50	2,094	13,981	24·30	23	95	20	·0017
670–678	Overweight, entry age over 50	509	3,401	24·32	26	107	21	·0072
933	Malignant tumours of the breast	51	266	1·22	6	—	—	—
930–932, 934, 940–941, 943–944	Non-malignant tumours of the breast and genital organs	2,082	11,134	32·17	41	127	20	·0029

Note $\sigma = \dfrac{100\sqrt{\text{Actual deaths}}}{\text{Expected deaths}}$ $\bar{q} = \dfrac{\text{Expected deaths}}{\text{Exposed to risk}}$

ANALYSIS OF RESULTS

19. A comparison of actual and expected deaths is given in Table 1 (male lives) and Table 1*a* (female lives). These show, sometimes for individual codes and sometimes for groups of codes, the following data :

Number of policies entering the experience.

Number of years of exposure to risk.

Expected deaths.

Actual deaths.

Percentage of actual to expected deaths.

The function $\sigma = \frac{100\sqrt{\theta}}{q\mathrm{E}}$ where θ = actual deaths and $q\mathrm{E}$ = expected deaths.

The function $\bar{q}$ = Expected deaths ÷ Exposed to risk.

Owing to the presence in the data of duplicate policies on the same life the values of σ are not strictly valid estimates of the standard deviation of the percentage of actual to expected deaths. However, the additions that would be required to correct them are small in proportion to the extra mortality being measured. Moreover, the elimination of duplicates in an investigation of impaired lives' mortality has disadvantages. As an assured life grows older his health may change and later policies may be coded differently from earlier policies. To exclude these later policies could mean an important loss of data. For certain impairments, e.g. hypertension, the subdivision of data by age at entry has the effect of reducing the duplicate policies within individual codes.

20. The presentation of the results in the form of percentages of actual to expected deaths follows established actuarial practice and is no doubt the most readily comprehensible method of summarizing the experience of a specified group of lives by means of a single index. At the same time it has to be borne in mind that a given percentage extra mortality has a very different meaning at age 60 from what it has at age 30. An addition of two extra deaths per thousand at age 30 yields a percentage of actual to expected deaths of 400, i.e. an extra mortality of 300 per cent. At age 60 the same addition yields a percentage of actual to expected deaths of 116, i.e. an extra mortality of 16 per cent. This may seem a very obvious and elementary piece of simple arithmetic. But its implications must be fully appreciated when comparing percentages. It is, in fact, only to be expected that a young group of impaired lives will show a higher percentage excess mortality than an older group and, where there

is a difference in the age distribution of two groups, due allowance must be made for this feature before assuming that a higher percentage necessarily implies an inferior class of life. It is for this reason that the function $\bar{q}$, or the mean expected rate of mortality, has been shown in the final column of Table 1. The reader can then readily assess the effect of the percentage extra mortality in absolute terms.

ANALYSIS OF DEATHS BY CAUSE

21. Examination of the results for particular codes or groups of codes can be considerably illuminated if information is available about the causes of death. Table 2 shows an analysis of deaths by cause for some of the larger groups (male lives only) where the data were sufficient to yield results of statistical significance. The full list of codes for causes of death is given in Appendix B. In Table 2 a certain amount of condensation has been adopted in order to avoid listing causes for which the numbers of deaths were too trivial to be significant. Before commenting on the results, however, it is necessary to describe the method of estimating the expected deaths within each cause category.

22. In studying causes of death among impaired assured lives, the ideal basis of comparison would be a set of statistics for deaths occurring among comparable first-class lives at similar durations since entry and over a corresponding period of time. However, information in this precise form was not available. At the beginning of 1964 the Institute and Faculty of Actuaries instituted an investigation into causes of death among standard lives, to which the office conducting the impaired lives' investigation contributed data. It has been possible to analyse the deaths returned by the office concerned during the first nine months of 1964 and in Appendix D will be found the resultant statistics showing the relative frequencies for sixteen causes of death separately for two age groups, viz 35-49 and 50-74. In most of the impaired groups there are few entrants under age 35, and to have taken the complete range of all ages up to 49 would have resulted in an overstatement of deaths from suicide and accident. However, in a few groups (such as family history of tuberculosis) where the age distribution corresponds closely to that of standard lives, deaths at ages under 35 have been added into the control group for the purpose of calculating the expected deaths from particular causes. Deaths at ages over 74 have been ignored throughout, because the impaired lives' experience is still quite young and the data at these higher ages are negligible.

TABLE 2

Analysis of deaths by cause—male lives

Cause of death	Ages under 50		Ages 50 and over		All ages	
	Expected deaths	Actual deaths	Expected deaths	Actual deaths	Expected deaths	Actual deaths
Codes 110-168 (*Hypertension*)						
Cancer	14·8	18	143·4	153	158·2	171
Vascular lesions	3·9	14	41·8	130	45·7	144
Coronary artery disease	19·5	52	182·0	270	201·5	322
Other circulatory disease	4·5	25	39·8	141	44·3	166
Pneumonia	·6	3	7·4	30	8·0	33
Nephritis	1·0	4	3·6	13	4·6	17
Accident and suicide	8·2	12	16·1	21	24·3	33
Others	8·3	12	73·3	46	81·6	58
Total	60·8	140	507·4	804	568·2	944
Codes 200-217 (*Peptic ulcer*)						
Cancer	20·6	36	76·1	102	96·7	138
Cardio-vascular	38·9	41	140·0	144	178·9	185
Peptic ulcer	1·0	14	1·3	13	2·3	27
Accident	8·6	22	5·6	16	14·2	38
Suicide	2·8	11	3·0	4	5·8	15
Others	13·0	24	43·5	33	56·5	57
Total	84·9	148	269·5	312	354·4	460
Code 252 (*Hernia, unclassified, operation performed*)						
Cancer	30·9	39	67·1	85	98·0	124
Cardio-vascular	58·2	43	123·4	162	181·6	205
Accident	12·9	17	4·9	9	17·8	26
Suicide	4·2	10	2·6	5	6·8	15
Others	20·7	25	39·5	35	60·2	60
Total	126·9	134	237·5	296	364·4	430
Codes 320-323 (*Psycho-neuroses*)						
Accident	5·1	11	1·4	1	6·5	12
Suicide	1·6	17	·8	—	2·4	17
Others	42·5	49	64·4	76	106·9	125
Total	49·2	77	66·6	77	115·8	154

TABLE 2—*continued*

Cause of death	Ages under 50		Ages 50 and over		All ages	
	Expected deaths	Actual deaths	Expected deaths	Actual deaths	Expected deaths	Actual deaths
Codes 434-437 (*Pleurisy, dry or indeterminate, not associated with pneumonia*)						
Cancer of lung	2·1	8	9·1	11	11·2	19
Other cancer	6·1	10	12·6	16	18·7	26
Cardio-vascular	15·4	11	39·9	36	55·3	47
Pneumonia	·3	2	1·1	4	1·4	6
Accident and suicide	4·5	8	2·4	1	6·9	9
Others	5·2	6	11·7	16	16·9	22
Total	33·6	45	76·8	84	110·4	129
Codes 440-457 (*Pulmonary tuberculosis*)						
Tuberculosis	·1	9	·2	6	·3	15
Cancer of lung	1·9	1	4·5	3	6·4	4
Other cancer	7·1	12	6·3	8	13·4	20
Cardio-vascular	14·2	19	19·9	27	34·1	46
Pneumonia	·4	5	·6	4	1·0	9
Accident	8·8	7	·8	—	9·6	7
Suicide	1·8	8	·4	2	2·2	10
Others	6·3	4	5·6	4	11·9	8
Total	40·6	65	38·3	54	78·9	119
Codes 500-519 (*Glycosuria*)						
Cancer	2·1	—	9·5	13	11·6	13
Diabetes	—	—	·2	2	·2	2
Cardio-vascular	4·0	6	17·4	25	21·4	31
Accident and suicide	1·2	6	1·1	—	2·3	6
Others	1·4	1	5·3	5	6·7	6
Total	8·7	13	33·5	45	42·2	58
Codes 520-528 (*Diabetes*)						
Cancer	1·5	2	5·5	2	7·0	4
Diabetes	—	9	·2	9	·2	18
Cardio-vascular	2·8	7	10·1	22	12·9	29
Accident	·6	6	·4	3	1·0	9
Others	1·2	7	3·2	4	4·4	11
Total	6·1	31	19·4	40	25·5	71

TABLE 2—*continued*

Cause of death	Ages under 50		Ages 50 and over		All ages	
	Expected deaths	Actual deaths	Expected deaths	Actual deaths	Expected deaths	Actual deaths
Codes 650-678 (*Overweight*)						
Cancer . .	34·2	38	70·0	81	104·2	119
Leukaemia . .	2·1	9	1·8	2	3·9	11
Cardio-vascular .	53·9	88	128·6	196	182·5	284
Accident . .	33·4	51	5·1	10	38·5	61
Suicide . .	6·8	15	2·8	11	9·6	26
Others . .	23·4	27	39·3	36	62·7	63
Total . . .	153·8	228	247·6	336	401·4	564

23. Of the deaths included in the control group, 83% were attributable to three main categories, i.e. cancer, circulatory diseases and violent death. The actual percentages for each of these three categories are as follows :—

	Ages 35-49	Ages 50-74
	%	%
Cancer (excluding leukaemia)	24·3	28·3
Circulatory diseases	45·9	51·9
Suicide and accident	13·5	3·2
	83·7	83·4

The full analysis is given in Appendix D.

24. In the sections which follow the results for male lives, as set forth in Tables 1 and 2, are discussed for the main impairment groups.

CIRCULATORY IMPAIRMENTS

25. *Arteriosclerosis and atheroma.* Actual deaths were 51 compared with expected deaths of 49·74. A subdivision into the less and more severe cases suggested a small (but statistically non-significant) excess for the latter.

26. *Hypertension.* Significant excess mortality was observed in all groups. Inevitably (see paragraph 19) the groups for young ages

at entry show higher percentages than those for older entry ages. It is interesting that individual codes within the group 130-138 (entry ages 40-59) show little variation among themselves. For all three groups of entry ages the overweight lives show only a slight excess mortality over lives of standard weight and in no case is the excess statistically significant. Combining the overweight with the standard weight cases, the percentage of actual to expected deaths in the three groups of entry ages are as follows :

	%
Entry ages under 40	260
,, ,, 40-59	192
,, ,, 60 and over	122

27. Analysis of the experience in the hypertension class according to cause of death shows that the majority of the extra deaths were attributable to cardio-vascular causes. Deaths from vascular lesions were over three times expectation and deaths from coronary disease were about 1·6 times expectation. Deaths from other circulatory diseases were nearly four times expectation. There was also an excess of deaths from pneumonia and nephritis.

IMPAIRMENTS OF THE DIGESTIVE SYSTEM

28. *Peptic ulcer.* The two groups showing the highest mortality are 204-207 : short history with operation (165%) ; and 215-217 : long history with complications and with operation (162%). Cases of short history without operation showed no extra mortality. Uncomplicated cases with a long history showed 124% with no differentiation between operated and non-operated cases. Analysis by cause naturally showed a heavy excess of deaths from peptic ulcer : 27 compared with an expectation of 2·3. There was some excess from cancer : 138 deaths compared with an expectation of 96·7. There was also a noteworthy excess from both accident and suicide.

29. *Dyspepsia.* The only group with significant extra mortality was code 223 : dyspepsia suggestive of ulcer but not proved. For this code the percentage of actual to expected deaths was 142—higher than some of the peptic ulcer codes themselves.

30. *Cholecystitis.* For all categories combined the actual deaths were 130% of expectation. Cases with cholecystectomy showed 139%. Other cases showed normal mortality (13 deaths compared with expectation of 12·16).

31. *Amoebic dysentery.* This group showed no extra mortality, although with only 13 deaths the data have only limited value.

HERNIA AND VARICOSE VEINS

32. *Hernia.* This is a large group—740 deaths—with a slight extra mortality (110%). Analysis of the largest code (252) by cause of death shows that the excess deaths were mainly due to cancer and to circulatory causes. There was also some excess from accident and suicide.

33. *Varicose veins.* There was no significant extra mortality in this group.

IMPAIRMENTS OF THE BRAIN AND NERVOUS SYSTEM

34. *Epilepsy.* Code 301 (grand mal) exhibited a heavy excess mortality, the actual deaths (25) being 292% of expectation. This is clearly an impairment which calls for caution in underwriting.

35. *Head injuries.* Actual deaths (39) among cases of fracture of skull without operation were 155% of expectation. There were only 8 deaths among cases with craniotomy, but these probably represent a more serious risk than the non-operated cases. Only when sufficient data have accumulated to permit analysis of the nine sub-groups into which head injuries are divided will it be possible to draw significant conclusions.

36. *Psycho-neuroses.* The differences between the mild, moderate and severe cases were not large enough to be statistically significant. The combined group experienced 133% of expected mortality. The analysis by cause of death showed 17 suicides as compared with an expectation of 2·4 and 12 accidents against an expectation of 6·5. Some of the accidents were possibly concealed suicides.

OTITIS MEDIA

37. *Otitis media.* Cases without operation showed heavier mortality than operated cases (114% compared with 98%), but the difference is barely significant statistically. On these results it can be said that this impairment gives little cause for concern.

TUBERCULOSIS

38. *Non-pulmonary tuberculosis.* For codes 400-409 combined (non-pulmonary tuberculosis) actual deaths (36) were close to expectation. This group of impairments thus appears so far to have presented no additional risk, but definite conclusions cannot be drawn until more material is available for analysis of the individual sub-groups.

39. *Fistula in ano.* Actual deaths (30) were 143% of expectation.

40. *Pleurisy and spontaneous pneumothorax.* Most of the data lie at codes 434-437 (pleurisy, dry or indeterminate), where actual deaths (129) were 117% of expectation. Analysis by cause of death shows excess both from lung cancer and from other cancer and also, not surprisingly, from pneumonia. The material accumulated here is appreciable and the low mortality is of considerable interest, especially in the case of pleurisy with effusion.

41. *Pulmonary tuberculosis.* The mortality rates are significantly raised in all groups. The figures suggest that although modern treatment has produced great improvement, pulmonary tuberculosis is still to be regarded by the underwriter as an impairment which must not be underrated. The results for the group treated by major surgery are of particular interest. The mortality shown by cases classified as " mild " (codes 440-443) was 140% of expectation, compared with 141% shown by " moderate or severe " cases (codes 444-447). This result suggests a degree of over-optimism in the allocation of cases to the " mild " category.

42. Table 2 shows that the excess deaths in the pulmonary tuberculosis group were attributable to tuberculosis itself (15 deaths compared with an expectation of 0·3), cardio-vascular causes, pneumonia and suicide. There was no excess from lung cancer and none from accident.

43. *Family history of tuberculosis.* None of the various codes included in this group showed any significant extra mortality. A separate analysis of cases coded " G " (contact within 2 years) showed no difference between these cases and those with no contact over this period.

ENDOCRINE IMPAIRMENTS

44. *Glycosuria.* Actual deaths (58) were 137% of expectation. The extra deaths were mainly due to cardio-vascular causes.

45. *Diabetes mellitus.* The experience has been very heavy. For entry ages under 30, there were 10 deaths against an expectation of 1·20, i.e. a percentage of 833. Too much importance cannot be attached to this result when the number of deaths is so small, but at the same time it cannot be ignored. For entry ages 30-50 the actual deaths (37) were 352% of expectation and for entry ages over 50 the deaths (24) were 174% of expectation. The experience is much less favourable than that recorded by Steeds in his paper to the Institute in March 1965.

46. From Table 2 it can be seen that a substantial proportion of the extra deaths among diabetics were in fact attributed to diabetes (18 against an expectation of 0·2). Deaths from cardio-vascular causes were more than double expectation and there were 9 deaths from accident against an expectation of 1·0.

UNDERWEIGHT AND OVERWEIGHT

47. *Underweight.* There was no significant extra mortality among underweight lives. It must be emphasized, however, that cases included in these codes were assumed to be otherwise unimpaired. Proposers who are grossly underweight, or who show recent loss of weight, should always be subject to investigation before acceptance.

48. *Overweight.* The extra mortality among overweight lives was substantial. In spite of some erratic results, it is broadly true that the heavier weight classes had also the heavier mortality. For entry ages 30-50, the mortality was 153% of expectation where the weight was 20-30% above standard, and 192% of expectation where the weight was over 30% above standard.

49. As would be expected, a large proportion of the extra deaths among overweight lives was due to cardio-vascular causes. There was a significant excess of deaths from accident and also, surprisingly, from suicide—particularly at ages over 50, where there were 11 suicides against an expectation of 2·8. Another odd feature is the occurrence of 9 deaths from leukaemia at ages under 50 against an expectation of 2·1.

RESPIRATORY IMPAIRMENTS

50. *Bronchial asthma.* Mortality for this impairment has been fairly heavy, the percentages of actual to expected deaths in the three entry age groups being as follows :

	%
Entry ages under 30	276
,, ,, 30-49	200
,, ,, 50 and over	154

51. *Chronic bronchitis.* The experience in this group has been heavy. At entry ages 30-49, the co-existence of emphysema more than doubled the mortality ratio. Paradoxically, however, for entry ages 50 and over the cases with emphysema had somewhat lighter mortality than those with no emphysema.

URINARY IMPAIRMENTS

52. Two of the urinary impairments, viz renal calculus and cystitis and pyelitis, show light mortality and would appear to involve no extra risk. It must be emphasized, however, that no case would have been accepted if there were active signs of cystitis or pyelitis at the time of entry. For albuminuria, actual deaths (12) were 147% of expectation. No conclusions can fairly be drawn without more detailed information, but the result suggests that a proposer with albuminuria cannot be accepted as a standard risk until the condition has been fully investigated. For history of nephritis the actual deaths (10) were 125% of expectation ; all cases in this category were free from albumen at the time of acceptance. The 10 deaths among cases with history of nephrectomy compare with an expectation of 4·72 and, in so far as conclusions can be drawn from such small figures, this would appear to be the heaviest of the urinary risks for which data have been obtained.

TUMOURS

53. The group of malignant tumours have so far yielded 11 deaths compared with an expectation of 3·23. More data must be obtained before the extra risk can be properly assessed, but it seems likely that with this type of impairment we are entering an exceptionally heavy risk area. Non-malignant tumours yield no extra mortality. For enlargement of the prostate the actual deaths (23) were 136% of expectations.

FEMALE LIVES

54. The experience among impaired female lives has been very favourable in comparison with the male experience, in spite of the exceptionally light rates of mortality employed for calculating the expected deaths. The results are contained in Table 1*a* and there are no special features calling for comment except, perhaps, to draw attention to the mortality among lives with a history of malignant tumour of the breast, where there were 6 deaths against an expectation of 1·22.

GENERAL OBSERVATIONS

55. In almost all the classes of sub-standard risk studied in this survey, the extra mortality observed has proved to be less severe than might have been expected when the investigation was launched in 1947. Of the risks most commonly encountered, hypertension and overweight have proved to be the most serious—a result which does not occasion any surprise. Psycho-neurosis, which in Clarke's 1961 paper was found to have a mortality experience equal to expectation, now appears to present a definite extra risk. Of the less common risks, diabetes mellitus has appeared in an unfavourable light although, as stated in paragraph 44, this finding is contrary to the results obtained by Steeds. It will be interesting to see whether the experience of the next few years shows any variation from the experience to date. Malignant tumours constitute another rare class of risk which calls for cautious treatment and for which further statistical data will be awaited with interest.

56. One result which may appear to call for comment is the occurrence in several impairment groups of an excess of deaths from suicide. In the psycho-neurosis group this excess is not surprising. But excesses also occur in the peptic ulcer, hernia, pulmonary tuberculosis and overweight groups. There may, of course, be a fortuitous understatement of suicides in the control group, which would lead to an artificial overstatement in the impaired lives. All the same, it does appear that certain forms of ill-health may be conducive to suicide, although too much importance should not be attached to this deduction from an underwriting point of view, since the numbers of deaths involved are very small compared with the total deaths from all causes. Thus, in the peptic ulcer group, there were only 15 suicides out of a total of 460 deaths ; and in the overweight group only 26 out of a total of 564.

57. In conclusion it may be affirmed that the results of the investigation fully justify the policy followed in recent years of a more liberal approach to underwriting. The statistics now obtained will help to provide a basis for assessing appropriate surcharges in the future or, in some cases, a justification for accepting the risk at standard rates of premium.

ACKNOWLEDGMENTS

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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 16– *Essential (uncomplicated) hypertension (may include slight or moderate tachycardia or slight arteriosclerosis)*

Code	*Age at entry*	*Weight*	*S.A.P.*	*D.A.P.*
110	Under 40	Standard ± 19%	150–165	Under 95
111			Over 165	Under 95
112			150–165	95–105
113			Over 165	95–105
114			150–165	Over 105
115			Over 165	Over 105
116			150–165	Uncertain
117			Over 165	Uncertain
118			Below 150	95 or over
120	Under 40	Standard + 20% or over	150–165	Under 95
121			Over 165	Under 95
122			150–165	95–105
123			Over 165	95–105
124			150–165	Over 105
125			Over 165	Over 105
126			150–165	Uncertain
127			Over 165	Uncertain
128			Below 150	95 or over
130	40–59	Standard ± 19%	155–170	Under 95
131			Over 170	Under 95
132			155–170	95–105
133			Over 170	95–105
134			155–170	Over 105
135			Over 170	Over 105
136			155–170	Uncertain
137			Over 170	Uncertain
138			Below 155	95 or over

Code	*Age at entry*	*Weight*	*S.A.P.*	*D.A.P.*
140	40–59	Standard+20% or over	155–170	Under 95
141			Over 170	Under 95
142			155–170	95–105
143			Over 170	95–105
144			155–170	Over 105
145			Over 170	Over 105
146			155–170	Uncertain
147			Over 170	Uncertain
148			Below 155	95 or over
150	60 and over	Standard±19%	160–175	Under 100
151			Over 175	Under 100
152			160–175	100–110
153			Over 175	100–110
154			160–175	Over 110
155			Over 175	Over 110
156			160–175	Uncertain
157			Over 175	Uncertain
158			Below 160	100 or over
160	60 and over	Standard+20% or over	160–175	Under 100
161			Over 175	Under 100
162			160–175	100–110
163			Over 175	100–110
164			160–175	Over 110
165			Over 175	Over 110
166			160–175	Uncertain
167			Over 175	Uncertain
168			Below 160	110 or over

170** *Uncomplicated hypotension* (100 *and below*)

Subsidiary codes applicable to range 100–170

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*

** Discontinued 1961.
* Deaths at age 70 and above to be disregarded.

2. STOMACH AND INTESTINES

20– *Peptic ulcer* (*gastric and duodenal*) *short history* (*apparently acute*)

200	No operation :	no complication
201		history of haematemesis
202		history of perforation
203		other complications
204	With operation :	no complication
205		history of haematemesis or melaena
206		history of perforation
207		other complications

21– *Peptic ulcer (gastric and duodenal) long history (apparently chronic)*

210 No operation : no complication
211 history of haematemesis
212 history of perforation
213 other complications
214 With operation : no complication
215 history of haematemesis or melaena
216 history of perforation
217 other complications

22–* *Dyspepsia, gastritis*

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

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

23– *Cholecystitis*

230 Without stones : no operation
231 With stones : no operation
232 cholecystotomy
233 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 support worn
252 operation performed

26– *Hernia (inguinal or femoral)*

260 Hernia, inguinal or femoral : not efficiently treated
261 efficiently supported
262 cured by operation

27– *Hernia (ventral, umbilical, etc.)*

270 Hernia, ventral, umbilical, etc.: not efficiently treated
271 efficiently supported
272 cured by operation

28– *Varicose veins*

280 Varicose veins : slight, untreated
281 moderate or severe, untreated
282 sufficiently supported
283 efficiently treated by injection
284 efficiently treated by operation
285 complicated by phlebitis

286 Varicose veins : other complications (dermatitis, ulcer, etc.)
287 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 severe
312 Fracture of skull, no operation : no sequelae
313 subsequent symptoms but no epilepsy
314 subsequent symptoms and epilepsy
315 Fracture of skull, craniotomy : no sequelae, no gap in skull
316 no sequelae, gap present in skull
317 Fracture of skull, craniotomy : sequelae, no gap in skull
318 sequelae, gap present in skull

32– *Psycho-neuroses*

320 Psycho-neuroses : mild
321 moderate
322 severe
323 With features suggestive of psychosis

33– *Migraine*

330 Migraine : mild
331 severe

340 *Attacks of unconsciousness of uncertain origin*

350 *Poliomyelitis*

36– *Otitis media*

360 Chronic suppurative otitis media : without operation
361 with mastoidectomy
362 Perforation of drum without clear history of C.S.O.M. (trauma only)

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 hip
402 other bones or joints
403 glands
404 intestines and peritoneum
405 skin (lupus vulgaris)
406 kidney (without operation)
407 kidney (with operation)
408 generative organs (testis, prostate, etc., Fallopian tubes, ovaries) (without operation)
409 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 Type II
422 Type III
423 Type IV

43– *Pleurisy and spontaneous pneumothorax*

Pleurisy with effusion (not including post-pneumonic empyema) :
430 Type I
431 Type II
432 Type III
433 Type IV

Pleurisy dry or indeterminate (not associated with pneumonia) :
434 Type I
435 Type II
436 Type III
437 Type IV

438 Spontaneous pneumothorax : no definite history of trauma
439 definite trauma

44– *Pulmonary tuberculosis (not treated by special method of collapse)*

Pulmonary tuberculosis, mild cases (discovered by mass radiography, etc., never sputum positive) :

440 Type I
441 Type II
442 Type III
443 Type IV
444 Pulmonary tuberculosis, moderate or severe cases : Type I
445 Type II
446 Type III
447 Type IV

45– *Pulmonary tuberculosis (treated by special methods)*

Pulmonary tuberculosis treated by artificial pneumothorax :

450 Type I
451 Type II
452 Type III
453 Type IV

Pulmonary tuberculosis treated by major surgical procedures :

454 Type I
455 Type II
456 Type III
457 Type IV

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 (contact within two years)*

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

Subsidiary codes for range 460-465

E (Obsolete from 31st December 1961)
F (Obsolete from 31st December 1961)
G Contact within two years (i.e. all cases from 1st January 1962)

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 < (S − 10%)
502 > (S + 10%)

503 Inconstant, two or more tests, weight : S±10%
504 <(S−10%)
505 >(S+10%)
506 Persistent, two or more tests, weight : S±10%
507 <(S−10%)
508 >(S+10%)

51– *Glycosuria (not proved to be diabetes mellitus) B.S.T.T.*

510 One test only, weight : S±10%
511 <(S−10%)
512 >(S+10%)
513 Inconstant, two or more tests, weight : S±10%
514 <(S−10%)
515 >(S+10%)
516 Persistent, two or more tests, weight : S±10%
517 <(S−10%)
518 >(S+10%)
519 Proved renal glycosuria

52– *Diabetes mellitus*

520 Ages under 30, weight : S±10%
521 <(S−10%)
522 >(S+10%)
523 Ages 30-50, weight : S±10%
524 <(S−10%)
525 >(S+10%)
526 Ages over 50, weight : S±10%
527 <(S−10%)
528 >(S+10%)

Subsidiary codes for range 500-528

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

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

55– *Goitre (exophthalmic) (including toxic goitre, hyperthyroidism, Grave's disease, thyrotoxicosis)*

550 No special treatment
551 Surgical treatment
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

(S = standard, N.M.E. = not medically examined)

Age under 30, weight 20-30% under S :
600 chest expansion satisfactory
601 chest expansion unsatisfactory
602 N.M.E.

Age under 30, weight more than 30% under S :
603 chest expansion satisfactory
604 chest expansion unsatisfactory
605 N.M.E.

610 Age 30-50, weight 20-30% under S : chest expansion satisfactory
611 chest expansion unsatisfactory
612 N.M.E.

Age 30-50, weight more than 30% under S :
613 chest expansion satisfactory
614 chest expansion unsatisfactory
615 N.M.E.

Age over 50, weight 20-30% under S :
620 chest expansion satisfactory
621 chest expansion unsatisfactory
622 N.M.E.

Age over 50, weight more than 30% under S :
623 chest expansion satisfactory
624 chest expansion unsatisfactory
625 N.M.E.

650 Age under 30, weight 20-30% over S : girth satisfactory
651 girth unsatisfactory
652 N.M.E.
653 Age under 30, weight 30-40% over S : girth satisfactory
654 girth unsatisfactory
655 N.M.E.
656 Age under 30, weight more than 40% over S : girth satisfactory
657 girth unsatisfactory
658 N.M.E.

660 Age 30-50, weight 20-30% over S : girth satisfactory
661 girth unsatisfactory
662 N.M.E.
663 Age 30-50, weight 30-40% over S : girth satisfactory
664 girth unsatisfactory
665 N.M.E.
666 Age 30-50, weight more than 40% over S : girth satisfactory
667 girth unsatisfactory
668 N.M.E.

670 Age over 50, weight 20-30% over S : girth satisfactory
671 girth unsatisfactory
672 N.M.E.
673 Age over 50, weight 30-40% over S : girth satisfactory
674 girth unsatisfactory
675 N.M.E.

676 Age over 50, weight more than 40% over S : girth satisfactory
677 girth unsatisfactory
678 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

8. URINARY GROUP

80– *Urinary calculus* (*including both renal and vesical calculus*)

800 Urinary calculus : no operation
801 voided or removed per urethram
802 removed by nephrotomy
803 removed by nephrectomy
804 Renal colic (indefinite origin)

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
852 Nephrectomy for trauma of kidney
853 Nephrectomy for conditions other than trauma, tuberculosis, calculus or hydronephrosis, or reason unknown
854 Hydronephrosis with nephrectomy
855 Hydronephrosis with operation other than nephrectomy

Subsidiary codes for range 800-855

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

* Code 851 was discarded 31st December 1961.

9. TUMOURS AND MISCELLANEOUS

90– *The skin and superficial tissue (including external genitalia)*

900 Rodent ulcer
901 Innocent tumours : confirmed
902 unconfirmed
903 Malignant tumours (other than rodent ulcer)

91– *Lips, mouth and salivary glands*

910 Innocent tumours : confirmed
911 unconfirmed
912 Malignant tumours
913 " Parotid " tumours

92– *Lymphatic system*

920 Enlarged lymphatic glands (other than tuberculosis)

93– *The breast*

930 Chronic mastitis : confirmed
931 unconfirmed
932 Non-malignant tumours : confirmed
933 Malignant tumours
934 Non-malignant tumours : unconfirmed

94– *Female genital organs (internal)*

940 Uterus, fibroids : confirmed
941 unconfirmed

942 Uterus, malignant tumours
943 Ovarian tumours, innocent : confirmed
944 unconfirmed
945 Miscellaneous : non-malignancy confirmed
946 non-malignancy not confirmed

95– *Male genital organs*

950 Testicle—innocent tumours : confirmed
951 unconfirmed
952 Testicle—malignant tumours

96– *Miscellaneous tumours (not previously classified)*

960 Innocent tumours : confirmed
961 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 cancers
4. Leukaemia
5. Diabetes
6. Vascular lesions, cerebral haemorrhage, embolism
7. Coronary disease, angina
8. Hypertension, arteriosclerosis, other circulatory or heart disease
9. Influenza (merged with 17 on account of small numbers)
10. Pneumonia
11. Bronchitis
12. Peptic ulcer
13. Nephritis
14. Motor accident
15. Other accident
16. Suicide
17. Other causes

APPENDIX C

Values of q_x for male lives from :

(i) *The control table used in the present investigation*
(ii) *The* 1954-56 *table for durations* 0-4
(iii) *The* 1957-58 *table for durations* 0-4
(iv) *The* 1957-58 *table for durations* 5 *and over*
(v) *The* A1949-52 *ultimate table*

Age	Control table	1954-56 table durations 0-4	1957-58 table durations 0-4	1957-58 table durations 5 and over	A1949-52 ultimate table
29 and under	·00066	·00095	·00080	·00090	·00111*
30	·00067	·00096	·00080	·00090	·00116
31	·00068	·00096	·00080	·00090	·00118
32	·00070	·00097	·00080	·00090	·00120
33	·00071	·00097	·00083	·00096	·00123
34	·00072	·00098	·00087	·00104	·00127
35	·00074	·00098	·00093	·00114	·00132
36	·00078	·00102	·00101	·00124	·00139
37	·00082	·00107	·00109	·00136	·00147
38	·00090	·00115	·00119	·00146	·00158
39	·00099	·00125	·00131	·00157	·00171
40	·00110	·00138	·00145	·00170	·00188
41	·00124	·00153	·00161	·00185	·00208
42	·00140	·00171	·00177	·00203	·00231
43	·00159	·00192	·00195	·00226	·00259
44	·00182	·00217	·00213	·00255	·00292
45	·00209	·00246	·00237	·00289	·00330
46	·00239	·00278	·00267	·00328	·00372
47	·00274	·00315	·00303	·00374	·00420
48	·00313	·00356	·00350	·00425	·00474
49	·00358	·00402	·00404	·00480	·00534
50	·00410	·00456	·00465	·00539	·00599
51	·00469	·00515	·00527	·00602	·00671
52	·00532	·00578	·00589	·00669	·00750
53	·00600	·00645	·00654	·00745	·00837
54	·00672	·00715	·00726	·00833	·00931
55	·00746	·00785	·00807	·00937	·01035
56	·00827	·00861		·01062	·01148
57	·00915	·00943		·01206	·01272
58	·01013	·01034		·01366	·01408
59	·01119	·01130		·01536	·01557

* Value for ages 22 and under.

APPENDIX C—*continued*

Age	Control table	1954-56 table durations 0-4	1957-58 table durations 0-4	1957-58 table durations 5 and over	A1949-52 ultimate table
60	·01236	·01236		·01715	·01720
61	·01366	·01352		·01906	·01899
62	·01510	·01480		·02109	·02096
63	·01669	·01620		·02318	·02312
64	·01845	·01774		·02543	·02549
65	·02041	·01944		·02760	·02810
66	·02262	·02134		·02994	·03095
67	·02508	·02344		·03240	·03409
68	·02779	·02573		·03506	·03753
69	·03078	·02824		·03808	·04130
70	·03410	·03100		·04156	·04543
71	·03775	·03401		·04561	·04995
72	·04200	·03750		·05024	·05489
73	·04690	·04150		·05557	·06028
74	·05244	·04600		·06164	·06616
75	·05865	·05100		·06841	·07257
76	·06534			·07582	·07953
77	·07279			·08383	·08709
78	·08109			·09239	·09528
79	·09033			·10151	·10414
80	·10063			·11140	·11369
81	·11210				·12397
82	·12488				·13500
83	·13912				·14681
84	·15498				·15942
85	·17282				·17282

Note The 1957-58 tables were constructed with the aid of Spencer's 21-term summation formula. Consequently, reliable values of q_x could not be obtained in the 0-4 table beyond age 55.

APPENDIX D

Distribution of deaths by cause among male first-class lives aged 35 to 74

Cause of death	Number of deaths		Percentage of total	
	Ages 35 to 49	Ages 50 to 74	Ages 35 to 49	Ages 50 to 74
1. Tuberculosis . .	2	11	·47	·61
2. Lung cancer . .	26	213	6·15	11·85
3. Other cancer . .	77	295	18·20	16·41
4. Leukaemia . . .	4	13	·95	·72
5. Diabetes . . .	—	12	—	·67
6. Vascular lesions . .	27	148	6·38	8·23
7. Coronary disease . .	136	645	32·15	35·87
8. Other heart disease .	31	141	7·33	7·84
10. Pneumonia . . .	4	26	·95	1·45
11. Bronchitis . . .	3	89	·71	4·95
12. Peptic ulcer . .	5	9	1·18	·50
13. Nephritis . . .	7	13	1·65	·72
14. Motor accidents . .	14	14	3·31	·78
15. Other accidents . .	29	23	6·86	1·28
16. Suicide . . .	14	20	3·31	1·11
17. All other causes . .	44	126	10·40	7·01
All causes . . .	423	1,798	100·00	100·00
2+3	103	508	24·35	28·26
6+7+8	194	934	45·86	51·94
14+15+16 . . .	57	57	13·48	3·17

Note Code 9 was originally allocated to influenza, but deaths from this cause have proved so few that they have been merged with code 17.

SYNOPSIS

The paper is a sequel to an earlier paper by Clarke published in *T.F.A.* vol. 27, p. 20 and it brings up to date the results of an investigation into the mortality experienced by various classes of impaired lives.

For each impairment considered, percentages of actual to expected deaths are shown, the expected deaths being calculated from mortality rates applicable to a corresponding group of standard lives.

In a separate section of the paper, the deaths are analysed by cause with a view to establishing what causes of death are responsible for the extra mortality arising among lives suffering from specific impairments.

DISCUSSION

Mr. R. D. Clarke, introducing the paper, said :—The report which you have before you—the one which I am introducing—has one feature in common with six out of the seven reports which form the subject of the other part of this evening's proceedings. By this I mean it is a progress report on a continuing investigation. As time goes on and more data accumulate and, what is perhaps more important, the investigation matures, we hope to submit further reports and to analyse the results in greater detail. In particular, we hope that we can one day carry out a select investigation for some of the larger impairment groups. It would, for example, be surely of interest to pursue the later history of young men who enter the experience as hypertensives and to see whether, as a group, they show high mortality in middle life.

One aspect of the investigation which I should like particularly to emphasize is that it is the product of very complete co-operation between two disciplines—the medical and the actuarial. The written report inevitably contains a mass of statistics and this perhaps gives undue prominence to the actuarial element, but the initial planning of the coding system—what in the statistical world would be called " the experimental design "—was the sole responsibility of Dr. Preston, who also, with the assistance of lay underwriters, has coded the individual policies. But the important fact to bear in mind is that the job is a combined operation from start to finish. Tonight, for example, I am introducing and Dr. Preston is to reply to the discussion. Next week, in a warmer latitude, Dr. Preston will be introducing and I shall be replying.

Mr. A. R. N. Ratcliff, introducing the mortality reports, said :—As a junior member of the Joint Mortality Investigation Committee, it gives me great pleasure to have the opportunity to come to Edinburgh tonight and to introduce these seven reports. These have been published simultaneously in order to facilitate comparison between the various tables and in order to give a forum for a critical discussion of the work contained therein. It is, I think, of great help to the Committee that its labours should, from time to time, be put before the actuarial profession as a whole, and that the profession should have an opportunity of commenting on these and putting forward ideas for improvements in them. Indeed, it is obvious that the bringing together of the seven reports at the same time does show up a number of respects in which presentation, at any rate, can be improved for the future. The first five reports cover the period 1959 to 1962, the report on pensioners under works schemes covers 1961 to 1963, and the group life assurance scheme investigation covers 1958 to 1961.

The first report concerns assured lives' mortality, and the first report and the fourth report can conveniently be considered together, the fourth report splitting up the results of the investigation into assured lives into medical and non-medical mortality. The general trend towards improved mortality, which was already evident over the period 1953 to 1958, has by and large continued, as will be seen from the tables, except at the very youngest ages where, as one would expect and the cause of death investigations show, the effect of accidental death rates is beginning to show itself in the British experience, in the same way as it has already shown itself in the Australian and South African experience. As mortality is driven down towards the accidental death rate at these younger ages, the actual statistics themselves

become more and more subject to fluctuation in any event, and the results so far produced may not be significant, but it is a trend which I think will need watching.

In the fourth report the comparison between medical and non-medical experience has not been carried very far, but it evinces a similar pattern to the 1953-58 investigation. In this report, incidentally, it is stated that analysis by individual durations is not available after duration 1; offices do in fact submit data which would permit the analysis to be broken down into longer durations but, because of a general pattern which has emerged, the Committee felt that it would not be a valid exercise to continue to break the data down further in this particular analysis.

In my personal opinion, the second report on the mortality of annuitants is perhaps the most interesting of the lot. Certainly, to my way of thinking, it is the most important, because in this field the general trend towards improved mortality, which is evidenced not only in the insurance companies' results but also in the general population statistics, is one which, if continued, is going to cause some strain on our funds, having regard to the assumptions on which much of our business was written and is, indeed, today still being valued. Towards the top of page 223, it is suggested that the sharp fall might have been due to a change in the class of life entering the experience. This is not intended to refer to social class, but to the type of person buying annuities. Prior to the Finance Act 1956, annuities were sold largely on the basis of annuities-certain plus deferred annuities, at any rate to those lives where tax might be a significant factor, and the lives included in our experience as annuitants came more and more to be those where annuities were being compulsorily purchased under wills or court orders, where initial selection—the initial annuitants' selection observed always in the past—was perhaps less powerful. Indeed, analysis of the tables in the second report shows, if you look at the actual deaths occurring, that there seems to be a gradual falling off of the business as between the 1955 and the 1959 experiences, and this seems to me to indicate that in the main age groups the data are now more mature. It is still, I think, an open question whether the observed trends according to duration in this experience are due to a change in the type of person buying annuities or whether there is some evidence here of temporary selection taking a long time to wear off. For this reason, this investigation will be extended through time in order to break down the durations further and further till we see, at the end of the day, whether in fact this is a significant variation as a result of a new type of life now buying annuities.

When we come to the third report on mortality of pensioners under life office pension schemes and the sixth report which deals with the selected experience of " works " pensioners, there is one important point to be borne in mind. This investigation refers specifically to persons drawing pensions under life office schemes. Now, if you look at the National Insurance statistics, you see that about 40% of all lives attaining normal pension age—65 males, 60 females—in fact defer drawing their pensions and, from my personal observation, I would say that there is an equally high percentage deferring retirement under our insured pension schemes. If this is the case, these particular lives are not entering this experience until they actually retire at an age perhaps nearer 70 than 65. Just as the tables show that lives retiring early have a very much heavier mortality rate than the expected, so it would be fair to suggest that lives deferring retirement have a lighter mortality experience than the expected. If some allowance is made for this factor, I think one will find that the q_x's from age 65 onwards

of people insured under pension schemes, whether they retire or not, are significantly lower than one might assume from the published figures here. There is another very important factor here which these tables bring out, and that is the difference between the mortality when analysed by the number of lives and that analysed by the amounts at risk. If we allow in our minds for the fact that the mortality by amounts is so much lighter, and that itself may well be overstated by late retirements, I think we will find that the people who are drawing the biggest pensions must be experiencing mortality very close to that of ordinary annuitants. To my mind, this calls in question the non-selection theory put forward in justifying improved rates of annuity for " Hancock " purchases and compulsory purchases under Section 388 schemes.

The remaining two reports, on retirement annuities and group life assurances, are of great interest but of somewhat restricted relevance to the conduct of our business. The report on retirement annuities is of great interest in that here we are dealing with one case where we have got a closed group : we can have no withdrawals from this experience and therefore we are able to observe these lives from the day they enter until the day they die. But the experience is very small and I suspect it is a very mixed bag. Retirement annuities under the Finance Act 1956 have appealed primarily to the very heavy surtax payer on the one hand and to the employer arranging a very small pension scheme on the other, and it seems to me, if what we have seen in the foregoing report about variation with social class and with amounts of annuity is valid, then in this respect here we may well be " cloaking " a similar variation because we are bringing these two widely diverse classes together for the purposes of one investigation. Similarly, in relation to the group life assurance schemes' investigation, we have to remember that this investigation was a " one-off job " covering a specific number of years ; it concerns a very limited number of offices and, in those offices, only a limited number of those schemes. Certainly some of these offices, for convenience in furnishing data, merely put in the data for their biggest schemes and, therefore, we have here mortality experience which is particularly " big scheme " experience and this, to my mind, may imply the inclusion of quite a number of " works " lives. I, myself, find that the rates shown here between ages 50 and 65, which are after all the critical ages as far as group life assurance is concerned, are somewhat surprisingly high when measured by reference to the A1949-52 Table, and I should think that a larger scale investigation might show substantially different results.

Mr. T. M. Springbett, opening the discussion, said :—It is sometimes said that the actuarial profession pays insufficient attention to research. This evening, we have the reports on the results of two major research projects and this gives us the opportunity to acknowledge the great debt we owe to Dr. Preston and Mr. Clarke, the Joint Mortality Investigation Committee and the Continuous Mortality Investigation Bureau for the arduous work they have undertaken in collecting, collating and interpreting the data required for these investigations. Not only is Mr. Clarke concerned with the impaired lives' investigation, but also with the C.M.I., as he is Secretary of the Joint Mortality Investigation Committee. I should also like to thank them all for letting us have the benefit of their expert knowledge through the extremely lucid, succint and illuminating reports they have prepared on the results of the various investigations.

I particularly welcome the simultaneous publication of the seven C.M.I.

reports. These enable us to see in perspective the whole spectrum of mortality rates from annuitants at the one extreme, through assured lives and active service group life mortality, to " works " pensioners at the other extreme. The reports bring to the fore various fundamental points. Why, for example, do annuitants experience lighter mortality than assured lives ? Again and again, the results indicate the great importance of class selection, especially that due to lives being of different social classes. I, myself, have no doubt that the light mortality of annuitants during 1959-62 at the early durations will persist because they represent a new class of annuitants since the Finance Act 1956. The results of the investigation into the mortality under split annuities during 1948-56 (*T.F.A.* vol. 26, p. 378) showed that their mortality was lighter than that of ordinary annuitants, and I would feel hesitant in quoting at the present time annuity rates for purchased annuities which assumed mortality higher than $a(55)$ select less half a year in the age.

The mortality of group pensioners, not surprisingly, shows lighter mortality for amounts than for lives and again demonstrates the importance of class selection as an influence affecting mortality rates. The table on page 229, in conjunction with that on page 227, suggests that for present male pensioners an addition of about two years to the age would be appropriate for lives, but that for amounts the addition should be only one year. The comparison of works and non-works schemes on page 243 suggests that, for a works scheme, pensioners' mortality at present is running at about three years over $a(55)$.

The question of whether to quote different pension rates for works schemes and staff schemes is a difficult one and is bound up with the rates charged under group life schemes. Most offices, I think, would feel that the differential between the mortality under staff group life and works group life schemes is even greater than that suggested by the table on page 249. To some extent, the heavier mortality under works group life schemes is offset by a saving on the pensions side, both through a portion of the premium being non-returnable on death before pension age and the mortality after pension age being rather heavier than under a staff scheme, although the normal five-year guarantee offsets this benefit to some extent. All the same, a works group life scheme should be able to stand on its own feet without the support of a works pension scheme, and appropriate rates should be quoted for a works group pension scheme underwritten without a corresponding group life scheme.

Homogeneity is of fundamental importance and anything that could be done to improve this would be welcome. Since the annuitants' and assurance investigations were started, there have been many changes and it may well be that the data include some staff assurance schemes in the assurance mortality and some retirement benefit schemes, " Hancock " annuities or annuities guaranteed for a minimum period in the annuitant experience. The instructions are that such cases should be excluded, but it is desirable that the instructions should be consolidated and re-drafted in the light of present practice so as to ensure that all offices adopt a uniform procedure. The opportunity might also be taken to discontinue the use of the expression " non-medical " in connection with the investigation of retirement annuities under Section 22 of the Finance Act 1956. On page 241 reference is made to lives accepted without medical examination, but the very large majority of these lives have probably proposed for deferred annuities with merely a return of premiums on death before pension age and have therefore not been selected by the office but by themselves. I, myself, feel that

the experience of all Section 22 retirement annuities should be treated as a single group, but if it is thought worth while investigating the mortality of those who have been medically examined in connection with, say, a parallel widow's annuity, this should be done by a separate investigation.

In the past, the interpretation of the results of the investigation of the mortality of annuitants has been difficult, more especially in the case of male annuitants, and it may be that an examination of annuitant mortality to see whether there are light and heavy offices may throw some light on whether there is a lack of homogeneity in some cases.

Retirement benefit annuities form an increasingly important part of immediate annuity business, but they are a heterogeneous class of lives and I am doubtful whether it would be worth while collecting statistics for them. Each office needs to quote what it considers suitable rates for such annuities, and the underlying rates of mortality will almost certainly lie somewhere between that of annuitants and of the population, and the mortality of group pensioners may be a rather more definite pointer. Whether appreciably heavier mortality is experienced under contracts where there is a guaranteed minimum period is a moot point. In view of the very varied nature of these contracts, it seems that the most that can be done is for each office to compare its actual and expected release of reserves for what it considers to be each homogeneous category of its retirement benefit scheme annuitants. Computer data-processing will assist in this, but, even so, random fluctuations, due to small numbers, are likely to make interpretation of the results difficult.

There is a mass of figures to digest in the reports. Indeed, the reader can hardly be blamed if his first reaction on seeing them is that of Impairment Code No. 224—*Dyspepsia : brief attack, apparently of no serious significance.* Even so, he should make a quick recovery and be able to digest, and even enjoy, the strong meat of figures *en masse*. Nevertheless, it is natural that we should seek to pin-point the salient features by looking at the results in groups. The Committee are well aware of the dangers in doing this, but others may be taken unawares. For example, in Table 1 on page 221, the ratio of actual to expected deaths for assured lives, for all ages, durations 2 and over, is 93 for 1953-58 and 89 for 1959-62. As the summary on page 219 shows, the ratios are smaller at the younger ages than at the older. If the ratio for all ages had been based on sums assured and not on lives, the weight at the younger ages would have been heavier because of the rise there has been in the amount of new business over the last few years. The ratios for all ages would therefore have been lower than 93 and 89, even though there may have been no difference in the mortality by lives and amounts. If the results had been weighted by strains instead of sums assured or lives, the ratios would have been even smaller. This hardly improves the reader's confidence in his attempts to understand the results and it underlines the fact that, if there is to be any grouping, it is advisable that the shape of the actual and expected curves of mortality should be roughly the same. For the last ten years the shape of the mortality curve has been different from A1949-52 in that the mortality at the young ages has been low and the increase at the middle ages has become more steep. I therefore feel that there is a strong case for future comparisons to be with 1959-62 mortality. It is preferable that the comparison should be with a standard table, but this could be a hypothetical table, and a table derived from the equation for 1959-62 mortality given on page 220 might well be suitable. This table could be published merely as a table of q_x.

Each office probably obtains from its valuation its own figures for the ratio of actual to expected claims and strain, but more and more offices are using computers for valuation and are probably valuing on several different bases. One of these bases may well be a gross premium experience basis, perhaps using the hypothetical 1959-62 table, and, if so, the office will have available, as a by-product of such a valuation, a comparison of actual to expected claims and strain on the basis of 1959-62 mortality.

If premiums were calculated on the hypothetical 1959-62 mortality, they would show only small differences from the A1949-52 premiums, except for assurances where the death cover predominates, such as family income benefits and decreasing temporary assurances in connection with house-purchase mortgages. Mr. F. B. Gibbins has calculated for me on our computer the 3% select premiums for age 30 next birthday on hypothetical 1959-62 mortality. For a whole-life policy, the A1949-52 net premium of £1, 4s. 4d.% is reduced by 1s. 2d.: for an endowment assurance maturing at age 65, the reduction is 7d. in a premium of £1, 15s. 11d.%: but, for a family income benefit of £100 per annum with a term of twenty years, the reduction is 5s. 11d. in a premium of £1, 7s. 3d.—a reduction of over 20%.

With computers available, it is hardly necessary to publish extensive tables of commutation columns and other monetary functions, for calculations of these can readily be carried out by each office at the rates of interest they require. Offices without computers could probably make arrangements with other offices for the tables they need.

The use of the A1949-52 table as a standard for comparison also affects the comparison of the medical and non-medical mortality on page 237. For example, the fact that for ages up to 44½, durations 2 and over, the ratio is 79% in each case is contrary to the impression one gets from comparing the ratios for the five-year age groups in Tables 1 and 2 on pages 238 and 239. Similarly, the comparison for all ages of 88% and 90% is misleading. I have re-calculated these latter figures, using hypothetical 1959-62 mortality as the standard, and the ratio of actual to expected deaths then becomes 98% for medical and 103% for non-medical, a difference of 5%, which is more or less as one would expect.

In annuity business also there is the possibility of weighting by lives, amounts or expected release of reserves, but as Table 3 on page 227 shows, there has been no very pronounced change in the shape of the mortality curve and the ratios for groups should not therefore be misleading.

I should now like to turn to the impaired lives' investigation. The purpose of this investigation is not to see if the underwriting has been right in the past but to obtain statistics as a guide for future underwriting. Up to now the underwriting has probably been on the stiff side, but investigations into the mortality of impaired lives are useful only if offices take note of the results and give effect to them by reviewing their underwriting practice and adjusting it where necessary. I am sure that Dr. Preston and Mr. Clarke would consider such action to be a very definite indication of the high regard in which their work in this field is held.

The choice of the control experience is a difficult one and all, I think, would agree with what is said in paragraph 12. I feel, however, that the solution reached is not entirely satisfactory, as it appears to be based on the assumption that those with a family history of tuberculosis or with varicose veins experience almost normal mortality. This, to some extent, prejudges the issue. There is a strong case for a control experience based on paired lives whereby, when an impaired life is included in the investigation, a corresponding normal life is included in the control group. This gets

over the difficulty of differing durations in the control and impaired lives experiences and also provides a control distribution of causes of death.

I know that Mr. Clarke is aware of the merits of an experience based on paired lives, as he commented on this in his reply to the discussion on his 1961 paper at the Institute (*J.I.A.* vol. 87, p. 246), but he then felt that such an investigation was not possible because of the additional work it would cause. With a computer, however, such an investigation should be reasonably easy to arrange. Any office which has reached the stage of producing its C.M.I. figures by computer will realize the ease with which such statistics can be produced once the necessary planning has been carried out. However, the possibility of introducing a paired control experience has to be borne in mind at an early stage in the planning of life assurance electronic data-processing, for programmes tend to be rather rigid once they have started to get off the ground, let alone when they have gone into use on production runs.

The impaired lives' investigation has been based on the data of a single, large, industrial/ordinary life office and the question arises whether the results will be equally applicable to other offices. It seems likely that this will be the case for a large proportion of the impairments, but as the average sum assured is probably lower than in some other offices, there may be a difference in social class, and the extra mortality arising from cardiovascular causes may underestimate that which will be experienced by offices with larger average sums assured.

Several times in the report on the impaired lives' experience, phrases occur such as " more data must be obtained ". More data will certainly make the results of even greater value and I, myself, feel that it is very desirable that other offices should contribute data so as to enlarge the experience. A workable list of impairment codes has been successfully drawn up, and now that the National Health Service enables us to obtain fairly reliable information about impairments, there should be no great difficulty in, say, a dozen of the larger offices contributing data and classifying their own impairments.

Finally, I have already expressed my appreciation of the work that has been done in the field of mortality by Dr. Preston and Mr. Clarke and the Joint Mortality Investigation Committee, and my view of the importance of this work can best be expressed by a question. What would our standing be as a profession and what self-respect would we have left if there were no C.M.I. and no investigation into the mortality of impaired lives?

Mr. J. M. Macharg.—I should like to add my tribute to that already paid by Mr. Springbett to the authors of the paper on the mortality of impaired lives. We are very much indebted to them for all their work, and for presenting the results to us and giving us the opportunity to discuss them. They manage to make it all sound so easy. Mr. Springbett aptly used the word " succinct " to describe their presentation, and I am sure that their brevity conceals a great deal of hard work and some very difficult decisions.

The selection of the control table has obviously proved exceedingly difficult, and it is very clear that they must have had to put a great deal of thought into this. It must be very little consolation for Mr. Clarke to know that this problem will continually recur as the experience matures.

Turning to the results of the investigation, one is still rather surprised at the comparatively normal mortality exhibited by sufferers from arteriosclerosis and atheroma. One wonders whether, perhaps, this has something to do with the comparatively short duration of the experience. The same

cause has been suggested for the apparent irrelevance of weight when associated with hypertension. I had thought that variations in diastolic pressure within the groups might have had a masking effect in this respect, but the lack of variation among the codes 130 to 138 would seem to disprove this. Perhaps the exclusion of declinatures and of those with other complications may have had a levelling effect, but on the whole the theory which Dr. Preston put forward at the last meeting seems to be standing up very well—the theory, if I express it correctly, that overweight is a cause of hypertension, but that when hypertension is present overweight itself does not increase the mortality risk.

Some groups exhibit heavier mortality than one might have expected. The authors refer to the two peptic ulcer groups: short history with operation and long history with complications and operation. Also there are the group with a history of cholecystectomy and the pulmonary tuberculosis groups, particularly those with a history of artificial pneumothorax or of major surgery. The fourth group exhibiting heavy mortality is nephrectomy, but here the data are very scanty.

These various impairments are what one thinks of as being early extra risks, and I wondered if perhaps here also we might be seeing the effect of the comparatively short duration of the experience. Some support is lent to this theory by the fact that, as far as the two peptic ulcer groups are concerned, the previous figures were 211% and 179%—rather higher than now shown—but I am afraid that the pulmonary tuberculosis groups are not so obliging.

The high mortality exhibited by dyspepsia, suggestive of ulcer but not proved, is probably not surprising. There seem to be a great many ulcers which do not show up on the screen but are there nevertheless.

An interesting point is the number of extra cardio-vascular deaths among those with a history of glycosuria. I wonder if perhaps there were some cases here of diabetes which were not revealed. As far as diabetes itself is concerned, the results of the authors are again at variance with those found by Mr. Steeds. Following the previous meeting Mr. Clarke rather rejected the suggestion of Mr. Steeds that there might be some correlation between social class and death from diabetes. I wonder if he still holds this view or whether he thinks perhaps it might be revised?

Turning now to Appendix D, the new table for estimating the expected deaths in each cause category, there are some interesting differences here from the table which was previously used. The percentage mortality from circulatory diseases before age 50 is nearly double what it was before, whereas the percentage mortality from violent deaths is less than half in both the large age groups concerned. The previous table was, of course, based on those with a history of hernia or with a family history of T.B., and one wonders if these groups can be regarded as less liable to circulatory diseases before age 50 but always more accident and suicide prone! I do not suppose it is entirely fanciful to imagine that there may be a lower tendency to circulatory diseases among those with a family history of tuberculosis. They may, for example, be tall and thin. And it is interesting to note that the features previously noted do persist in the results for hernia in the current investigation. The authors do draw attention to the fact, however, that, as far as the new table is concerned, deaths from suicide may be fortuitously understated, and certainly one has a feeling that this may be so. Nevertheless, if the current Appendix D is regarded as being, on balance, the more reliable table, there is no doubt that some of the earlier results were rather distorted.

A senior colleague of mine remarked the other day that one of the troubles with this sort of discussion was that the doctors present always talked about statistics, whereas the actuaries always tried their hand at medicine. I therefore cannot resist a small postscript on the subject of the fourth and fifth phases in blood-pressure readings. Dr. Preston at the previous meeting explained why his office uses the fifth phase, and we know that Mr. Steed's office also uses that phase as does the largest office up here. Nevertheless, I understand that students in Edinburgh are taught to take the diastolic pressure at the point when the sound changes and I wonder what the practice is in medical schools down south. Does this mean, coming back again to the subject of life assurance, that we must always specify in our medical report forms which phase we wish to have recorded, or does it mean that we simply have to ask for them both to be on the safe side ?

Mr. D. N. Doull.—At one time it was fashionable in this hall to start one's remarks with a quotation. Might I be permitted to start with a mis-quotation ? " Doulls rush in where angels fear to tread." This, then, is my excuse for speaking, albeit very generally, on the paper.

To an underwriter, the figures brought out in Mr. Clarke's two papers will be of considerable assistance, though they do not enable him, owing to the data not being by age at entry, subdivided by duration, to fix the actual level of theoretical extra net premiums for impairments. The figures do, however, show that some of our historical and preconceived theories are now out of date and that the necessary changes should be made. The important thing is that a series of these papers will give indications of trends which will prove most helpful, provided a conservative approach is maintained in their interpretation. Since the last paper, I feel the underwriter's task has become increasingly difficult. He is under more pressure to cut extras than ever before, to raise (*a*) non-medical limits (*b*) the maximum age for non-medical business (*c*) the minimum sum for which a routine P.M.A. is required and also, finally, to cut down the number of questions in his non-medical forms, and offices doing all these things are constantly put before him. He is asked for these concessions at a time when his first line of defence, the branch selection, is, owing to the increase of business, not nearly as effective as before and when he is forced to use doctors of whom he has little or no knowledge, and this is a most important fact. He, himself, will not see more than a fraction of the proposals and therefore will require to lay down rules of procedure for less senior personnel, but he must, by sample scrutinies, ensure that there are no undue deviations from the laid-down, traditional approach to underwriting in his office. These junior underwriters may tend to err on the side of safety by, amongst other things, asking for further evidence in cases where it may not be absolutely necessary, and this must be kept under strict review. He will require to be mindful, however, that mortality surplus is still a very important source of profit, and too lenient underwriting, even on the small proportion of proposals on impaired lives, can eat into this surplus to a surprising extent, and the percentages of extra mortality shown in the paper are of assistance to him in adopting a correct attitude to the main classes of impairment.

Turning now to one of our major impairments, namely overweight, my personal approach is not in the " percentage increase of mortality " system. It is actually based on the theory that diseases associated with overweight tend to assume greater importance with an increase in age and that the curve of extra mortality is likely to be a more speedily increasing one than a curve reflecting a constant percentage increase. In the Society of Actuaries'

Build and Blood Pressure Studies, the tables by groups of issue ages, subdivided by five-year policy-year groups, seem to support this view, and it is difficult to escape the feeling that the young man of 30 at, say, 20% overweight may well be at 55 in much worse shape and of a higher order of overweight, and this curve of mortality cannot be represented by a single mortality rating. The best therefore we can do, in my opinion, is to divide proposers into wide groups by percentage overweight above laid-down tolerances by age within which groups there could well be a wide range of assumed extra mortality. We then try to ensure that over the group as a whole extra premiums charged cover the excess risk, with the proviso that the premiums charged should contain a margin over the theoretical premiums because of the small numbers involved.

As far as another major impairment—blood pressure—is concerned, the American tables appear to support the view that duration is not unduly significant, except for the highest readings, and a percentage addition to mortality would appear reasonable, although from a comparison of the two papers by Mr. Clarke, the higher percentage increases shown in the second paper might seem to contradict this, as the experience is of longer duration.

Finally, is the field of blood pressures on its own not a vital one for inter-company investigation ? It is objective and would provide considerable statistics fairly quickly, and a break-down into various sub-headings should be possible.

I shall now close with another quotation : " Quot homines, tot sententiae ", which, for the non-classical members present, who are in the majority I should imagine, means, " You have to make up your own mind about underwriting".

Mr. W. B. McBride.—I too should like to make reference to Mr. Clarke's paper. The very substantial increase in the data over that used in the 1961 paper, about 1¼ million years of exposure and 5,000 deaths now involved, as compared with over ½ million years and 2,000 deaths, has given much more significance to the figures in Table 1 in respect of the less common impairments and has permitted a greater subdivision by impairment code than was previously possible. Average durations incorporated are also longer. The new data, however, now relate to a period of 16½ years as opposed to 11½ years, and secular change may well make itself felt if the period is extended in subsequent investigations. This point illustrates the particular difficulties which the authors had to tackle throughout the entire investigation. If a sufficiently long period of time is taken to collect adequate data, those data will be heterogeneous, but if the data relate to too short a period, they will be inadequate for any substantial amount of subdivision to produce significant results. Previous speakers have mentioned that the size of the data used in the present paper has still not permitted an analysis by duration and, as in 1961, the expected deaths have been calculated on an aggregate basis.

The authors have tackled the problem of duration by applying various percentages to the aggregate rates of mortality applicable to the years 1957-58, and the control table so found, given in Appendix C, was tested against a substantial impaired class. The results demonstrate that the durations for that class have been satisfactorily accounted for. I wonder how durations amongst other impaired classes correspond with codes 460 to 465, and I presume from the authors' silence on the point that they have not found any variation material. There is, however, no doubt at all that over all the allowance for duration has had a broadly satisfactory effect. The authors

are aware that the earlier paper overstated expected deaths and, in fact, the ratio of actual to expected for all impaired groups combined in 1961 was only 113·6. This ratio calculated on the new data is 126·4, an answer which has a much greater intuitive appeal.

Accounting properly for the masking effect of duration is also a major problem in analysing by cause of death on an aggregate basis. For this purpose the authors have used a control taken from actual deaths among certain standard lives during the first nine months of 1964 as statistics for causes of death among a body of first-class lives fully comparable to the impaired lives are not available. For any such control to operate satisfactorily, a variety of conditions must be fulfilled, and of these conditions the authors are perfectly well aware. However, I shall enumerate them.

First of all, the exposed-to-risk which gave rise to the control deaths should be identical as to sex, presence of duplicates, age distribution and duration at each attained age to the exposed-to-risk in the impaired lives' data. Secondly, for any given age and duration, the mortality rates applying to both sets of exposed-to-risk should be the same with the control actual deaths corresponding precisely to expectation. And thirdly, both experiences should relate to the same period of time. This last condition obviously cannot apply since the impaired lives' exposed-to-risk relates to the 16½ years ending December 1963 and the control exposed-to-risk to 1964, but this requirement is, of course, reflected in the need for identity as to mortality rates. We know that these rates are improving over all, and it seems clear that the age-duration rates underlying the mortality control table in Appendix C are almost certainly different from those operating on the 1964 exposed-to-risk. However, if the improvement represents a uniform percentage decrease in each age-duration rate then, of course, a percentage distribution by cause of death would not be affected. The latest Continuous Mortality Investigation results show that improvement is not uniform at all durations, with no improvement at all, it would appear, at duration 1 over the periods examined. However, Appendix C—Control Table—relates effectively to the period 1957-58, so that the improvement in question is over a period of about six years only and, therefore, any distorting effect on the cause of death percentages is probably small.

With regard to duplicates, these will be present to a different extent in the impaired lives' exposed-to-risk than in the 1964 data. The authors do not say how they analysed the 1964 deaths with regard to duplicates, but I imagine they worked on lives, not policies. However, this factor and the deviation of actual 1964 deaths from expected, can, I think, safely be ignored. Age-distribution compatibility is implicitly referred to by the authors in paragraph 22, where they say they have excluded deaths under 35 and over 75 from the 1964 control group when applying its percentages to the exposed-to-risk among the majority of impaired code groups. They mention also that, in a few sub-groups of the impaired lives, the exposed-to-risk, including lives under age 35, corresponds closely to that of standard lives and they issue a warning in paragraph 20 concerning possible errors of interpretation of Table 1 if the various age distributions are not taken into account. It does seem to me, however, that they have not taken their own warning entirely to heart. Looking at Table 2, expected deaths at ages under 50 in the code groups 110-168 amount to only about one tenth of the total. By comparison, such deaths form over one third of the total in code group 252 and over one half in groups 440-457. Even allowing for the fact that in some groups, the authors do not say which, deaths at ages under 35 were added into the control before the percentages were applied,

there is still a substantial degree of difference indicated among the various age distributions. I think this must lead to an understatement of expected deaths from such causes as coronary artery disease among code groups with a higher average age than the control, and conversely in younger groups.

A similar type of error could be introduced if the durations in the 1964 exposed-to-risk did not correspond to those present in the impaired lives' data. In the absence of any information in the paper on this point, I assume that Appendix D was constructed by aggregating all deaths by class irrespective of duration, so that the control durations will not be those of the impaired lives. The 1961 " cause of death " control group can be used to examine the implications of this difference, as Mr. Macharg has already pointed out, as it was, of course, based on lives with minor impairments and therefore exhibited the correct durations for the purpose. Furthermore, the age distribution of the exposed-to-risk for minor impairments corresponds closely to that of standard lives. The 1961 control included female lives but this will offset the higher rates of mortality operating as compared with the 1964 control. Therefore, the percentage distribution by cause in the 1961 control should vary significantly from the distribution in the 1964 control only to the extent that different durations are present among the respective exposed-to-risk. I looked at somewhat different figures from those that Mr. Macharg examined, but we came to much the same conclusion. Taking first of all the two sets of percentages for all ages together, the 1961 percentage for deaths due to coronary disease was 25, the corresponding 1964 percentage being 35. By contrast, the 1961 percentage for accidental deaths—that is codes 14, 15 and 16 taken together —was 15; the 1964 percentage was 5. Now, these figures only illustrate the fact that the 1961 control includes deaths under age 35, whereas, of course, the 1964 control does not, and so the two controls are not comparable over the full range of ages ; but the figures for ages 50 and upwards incorporate the bulk of the data and these are directly comparable. In this area, the 1961 percentage for coronary disease was 31·6, the corresponding 1964 figure being 35·9. Taking codes 2, 3, 6, 7 and 8 together, that is cancer excluding leukaemia and circulatory diseases, the 1961 and 1964 percentages were 76·2 and 80·2 respectively. Again, we see a shift in accidental causes— 7% in 1961, 3·2% in 1964. Considering the deaths from bronchitis among the over 50's, 1964 gives a percentage of 4·9 which corresponds to 89 deaths out of 1798, whereas 1961 showed ·8%, relating to two deaths out of 244. Even allowing for the smaller amount of data in the 1961 control, I think this also indicates a real duration distortion : deaths from bronchitis can play little part among first-class lives at short durations.

The conclusion I form, therefore, is that the 1961 control is to be preferred from the point of view of the mortality it embodies and from the point of view of a proper allowance for duration, and when applied to the numerically more significant causes of death it should give a more realistic picture of the excess mortality shown by the impaired class. For example, in Table 2, codes 110-168 show 270 actual deaths over age 50 from coronary artery disease, compared with 182 expected. This indicates an excess percentage of 48. Had the 1961 control been used, the percentage excess would have been 70.

However, there is no doubt that the greatly increased data used to construct the 1964 control give a far higher degree of precision to those areas where deaths are less numerous and it is to be preferred on that score. In addition, the error introduced by the age-distribution variation, if there

is such an error, operates in the opposite direction from that introduced by the duration discrepancy. To what extent there is a cancellation, I cannot say, but it may be that the Table 2 results are not so very far from the truth over all.

I should not care to end on too critical a note. I have no doubt whatever that the paper produces results which no underwriter can afford to ignore—I have simply concentrated on one minor aspect of it—and we must feel especially grateful to the authors for the massive amount of work they have put into this investigation.

Mr. A. Scobbie.—I should also like to comment on the investigation of impaired lives and, in particular, on the period covered by the investigation. The changes in mortality rates applicable to both standard and impaired lives, even within the relatively short period covered by the investigation, give rise to doubts as to whether the relatively wide range of entry years should not have been curtailed. I should have thought it preferable, for instance, to have limited the period of entry of new entrants from 1947 to, say, 1954 which would certainly have had the effect of increasing the average number of years' exposure of the data. By maintaining the wide range of entry years, it is surely being assumed that impaired lives' mortality has borne a constant relationship to the standard mortality throughout the whole of the period of the investigation. This is almost certainly not the case. During the period 1947-63 there has been an appreciable improvement in both standard and impaired lives' mortality, but they are not necessarily progressing at the same rate. If, as appears likely in some instances, the standard mortality is improving more rapidly than the impaired lives' mortality, then the extra mortality applicable at the end of the period will be in excess of the average extra mortality shown by the investigation. If it had been possible to subdivide the years of entry, it might also have allowed two investigations to be carried out, one based on entrants for the years 1947-54, for instance, and another for the period 1955-63. This second investigation would, of course, yield experience only for a very short-term exposure, but it could have been compared with the previous investigations carried out by Mr. Clarke in 1961. However, I appreciate the difficulties of the authors and have no doubt at all that the reason for not carrying out such investigations is paucity of data.

Turning to the investigations as they were actually carried out, I also should like to comment very briefly on the choice of the control experience. It is not terribly clear from the explanation given in paragraphs 12 to 18 as to why, in arriving at a suitable control table, the authors went back to the 1954-56 table and adjusted it instead of using the 1957-58 table. In addition, I felt that some explanation of how the percentage adjustments were arrived at might have been given. I take it that over all the authors felt that the method adopted somehow did ensure that the average term of exposure for the control table was comparable with that for the impaired lives' data.

Considering now the impressive impairment coding system given in Appendix A, I notice that such descriptive terms as " mild ", " moderate ", " severe ", " good ", " fair ", " poor ", are utilized. No doubt this is unavoidable but, presumably, it must lead to some difficulty in achieving and maintaining consistency in coding by the Chief Medical Officer and his associate underwriters. In the overweight codings, which always interest me particularly, girth is considered as being satisfactory or unsatisfactory.

I wondered if, for my own personal satisfaction, I might ask where the line is drawn! While commenting on overweight codings, I should also like to ask what volume of data, if any, falls into the codings 668 and 678, that is, the age groups 30-50 and 50 and over, where the weight was more than 40% above standard and the lives were not medically examined. I should have thought that in these instances medical examination would have been carried out to ascertain whether, amongst other things, the blood pressure was within normal limits. While on the subject of blood pressure, I think it is perhaps relevant to comment, as someone else has done, on how these readings are coded. Blood pressure readings at medical examinations for life assurance often leave something to be desired and very often several readings are taken. Which reading is coded ? Is it the lowest obtained or the average ?

Turning now to the results shown in the paper, many of the statistics were not particularly surprising, and some may even have been pleasantly reassuring in that they confirm on some sort of statistical basis what was thought from knowledge and experience. It is for this reason that underwriters from all offices are particularly indebted to the authors for producing this paper. While each office has different underwriting standards and views of impairments, it is very useful to compare views with the results produced in the paper.

The results in respect of hypertension, as expected, showed significant excess mortality especially at the younger ages. However, as the authors comment, it is rather surprising that when overweight is associated with hypertension there is no statistically significant excess mortality over uncomplicated hypertension. I agree with the suggestion, which I think has already been made this evening, that the experience is probably still too select and that later investigations may reveal a different result.

The authors also comment on the results of the experience of the diabetic investigation, stating that their results are materially poorer than those quoted by Mr. Steeds in his recent paper to the Institute. I should have thought the reason was, as pointed out by Mr. Steeds in his paper, that his diabetic pool had much stricter limitations imposed in the selection of diabetics. For instance, nobody markedly overweight, nobody with hypertension, and the diabetes was required to be stabilized.

The present investigation makes some provision for the association of overweight with diabetes, but would it not also have been advisable to consider a coding differentiating between the amounts of insulin intake? This is a subject on which there are differences of opinion and I wondered just what the authors felt on this matter. The lesson to be drawn from the results, however, is that great care must be taken in rating those cases where diabetes is associated with other impairments.

No matter how much information the authors give us, we always wish that we had something more and I think it particularly unfortunate that it has not yet been possible to investigate the subsidiary codes. This is particularly so in relation to the duration codes for certain impairments such as T.B., epilepsy and peptic ulcers. The results for T.B., for instance, show appreciable extra mortality, and an investigation by duration since cessation of all activity would seem to be essential. For peptic ulcers, it would also have been useful to investigate the experience for ulcer with operation by differentiating between the actual operations performed. Medical and surgical opinion has varied from time to time as to which operation is preferable, and an investigation by type of operation and duration since operation would be valuable.

Pursuing this wishful thinking a bit further, I noticed that 83% of the deaths included in the control group were attributable to three main categories, and the one which interested me particularly was suicide and accident, where the authors point out that several impairments show an excess of death from suicide or accident. I am not sure that the whole story lies in correlation with only the various impairments. It would seem to me that you would also have to investigate by class of policy, size of policy and perhaps by occupation of the proposer. In fact, I wondered whether the authors had at any stage considered including occupational codings in their list of codings.

Finally, gentlemen, I wish to join with other speakers in thanking the authors for this paper. We have cause to be grateful to them for the great deal of work which has gone into the preparation of this paper and for the interesting results produced.

Mr. F. M. Redington.—First, as to the paper by Dr. Preston and Mr. Clarke. The paper speaks for itself as to the work involved. My own name is quite unjustifiably mentioned in the credit titles, because I have had no part whatsoever in the paper or any of the work and, indeed, my own office is even more grateful to the authors than perhaps other offices are. It is often suggested that the C.M.I. should organize a wider investigation for all offices. I think the demand for that is less than it was. While it would be wrong for me to vote on that issue, I can say that my office is very glad to sponsor the pilot investigation. Speaking quite selfishly, I think we would rather stay as a pilot than have to keep in line with other offices who could not be relied on not to have minds of their own.

Turning to the C.M.I. papers, I had my chance to comment in London where I had to close the discussion, but there are one or two things I would like to say as Chairman of the Committee. First, we are very grateful indeed to the contributing offices who are always very co-operative. I wish I could say the same for some of their computers. It is sometimes important that adherence should be 100% to some investigation we are making for comparative purposes with the main investigation, and the offices always respond extremely well to that appeal. The second point is that it is often suggested to the Committee that we should use computers. The work of the C.M.I. is done office by office and is then amalgamated and when, in fact, the results of the last office come in the work is completed almost as quickly as a computer could do it. Also there are staff and staff loyalties involved. We would, of course, make use of a computer if there was any very extensive investigation that required it.

We are sometimes criticized for not engaging more extensively in scientific research. The essence of scientific research into matters such as this is that there should be random sampling. The essence of our work is that our sampling is not random : it is what is given to us by the offices and we must never forget the heterogeneity of all the data we have. There are occasions when the Committee is diffident about the results it is putting forward because it is so acutely aware of the heterogeneity. The " works " scheme data that we have before us are little more perhaps than a curiosity, because it is not easy to take any other scheme and say that this mortality applies to that scheme.

The only contribution, if it is a contribution, I would like to add to the discussion is that in London Mr. Perks made a good point on the Table on page 223 on the mortality of annuitants. The Committee said, a shade loosely, that there is a strong likelihood that there has been a change in the

class of life purchasing annuities since 1956. Well, that is begging the question. There has been some change, it is quite apparent, but we do not know whether there has been a change in the class of life. It could be—Mr. Perks said he thought it probably was—that there was merely a different initial selection and nothing more than that. But I find this table fascinating: it finishes like an old-fashioned film serial, at the critical point when we are just about to identify the villain. For male lives, years 1961-62, duration 4, which is the longest duration where we have got evidence of the new mortality, the figure of 90 leaves us poised in ambiguity.

Mr. A. D. Wilkie.—The reports we have before us this evening, particularly those of the Continuous Mortality Investigation Committee, seem to me to be essentially summary reports; even Dr. Preston and Mr. Clarke's paper is a summary of the information which they have accumulated. When I picked up the comparable American reports, I found that they are about ten times as weighty and are produced every year instead of only occasionally. I am not suggesting that we necessarily want all the enormous quantities of data that the Society of Actuaries produces, but I think it is a point that it might be useful to consider. In the Continuous Mortality Investigation reports we publish the mortality for assured lives for only two select durations. The Committee in fact collects information from the offices for five select durations, and it has been decided by the Committee in the past that it was not worth while continuing to publish these. The Americans, on the other hand, collect and publish data for 15 select years: whether they get any more useful results that we do, I am not sure, but at least somebody interested can go and look, whereas here we simply do not know what the results of selection are for durations after 2; this applies both to the assured lives and to the medical and non-medical reports.

In one or two of these reports we have mortality analysed by "lives" and by "amounts", but not in all of them. It is quite possible that the differences in mortality by amount as opposed to mortality by life appear in every one of these investigations; it may be that it does not matter whether we consider an assured life, or an annuitant, or a pensioner, we find that people with higher amounts are those in higher social classes and have better mortality. From the published statistics, we do not know if this is true except for pensioners and group life assurance people.

Similarly, Dr. Preston and Mr. Clarke's paper gives necessary summaries, but it is nothing like comparable in volume with the American investigations. The very obvious thing, as Mr. Springbett has said, is that we could, by co-operation among all the offices, produce about four or five times the volume of data. There are difficulties about heterogeneity, but the Americans have the same difficulties; they produce the figures and analyse them by duration. Mr. Doull when he is doing his underwriting tells us that he goes and looks at them. It might be useful to have the same figures at least available for Britain with lots of asterisks all the way down saying: "These are not statistically significant, but use them if you like".

Another point I notice about Dr. Preston and Mr. Clarke's paper is a purely statistical one. The item σ which is given represents (if I remember the little statistics I know correctly) the standard deviation on the hypothesis that the actual deaths are the correct mean of the distribution. I would rather have seen simply $100/\sqrt{E}$ instead of $100\sqrt{A}/E$ so that one could see more quickly whether the actual deaths were significantly different from the expected, rather than the other way round. And rather than σ,

I would have preferred to see published $(A-E)/\sqrt{E}$ which enables you to get the ratio of actual deviation to standard deviation, and you can quickly look down this and see the ones that are above 3 and above 2 and the ones that are under 1; the ones that are under 2 you probably cross off as showing 100 A/E not statistically significantly different from 100. I do not see why we do not publish exactly the same figures, i.e. $100/\sqrt{E}$ and $(A-E)/\sqrt{E}$, for all the Mortality Committee reports instead of having to go and do the calculations ourselves.

In many of the Mortality Committee reports we are also short of the exposed-to-risk. I know these are summary reports and it is sensible to reduce the space used, but Mr. Ratcliff mentioned that in the annuitants' investigation the exposed-to-risk at later ages was less in the later investigation than in the earlier one. From the figures I have in front of me I cannot see straight away that that is the case, without doing a lot of multiplications. If we had rather more information, perhaps rather more often, even if it was rather more bulky, I think that some actuaries could make use of it.

Another very little point. I remember in the old investigations into assured lives there was a comparison with the A1924-29 Tables for each separate year for each age group. There was a big table showing, I think, actual over expected, and this showed fairly easily what trends were taking place and what fluctuations there might be in any one year. I cannot look at any of these reports at the moment and see exactly how the trend has been since 1949-52 and see whether the years have been going up or down individually. And looking at those older reports, I could. I wonder whether it would be worth while publishing that sort of thing again.

Dr. W. Lindsay Lamb.—I would like first of all to thank you and your Faculty for asking me and some of my colleagues here this evening. As a physician with little or no knowledge of statistics, I wonder if I might be allowed to make one or two rather disjointed remarks and to ask for clarification about some statements, all of which appear on page 272 of the paper on the investigation into the mortality of impaired lives.

In paragraph 51, the authors refer to the presence of emphysema. I would like very much to know how this was determined and on what the basis for this diagnosis rested. This is not perhaps as easy to decide about after a purely clinical examination as it might sound. In advanced cases, of course, it should be easy enough, but I just wonder how they decided this. A previous speaker has referred to the importance of medical examinations being careful and accurate. We all know that many medical examinations are far from this.

The next point, Sir, is paragraph 53. They refer to malignant tumours. The statement here would seem to me to be an understatement: "It seems likely that with this type of impairment we are entering an exceptionally heavy risk area." I wonder what types of malignant tumours they would accept at all and under what circumstances.

Lastly, Sir, I note with interest in paragraph 52 that renal calculus, cystitis and pyelitis show light mortality. I think this is of interest to the medicals amongst us here tonight because it is rather against the modern trend of medical thought.

Dr. T. W. Preston, replying to the discussion on the paper, said:—I should like to say first how very much I appreciate the privilege of appearing here tonight. One speaker remarked that at these meetings doctors preferred to speak like actuaries and actuaries like doctors. Well, I

hope I shall not fall into that error. On the contrary, some of these questions I am going unashamedly to pass on to my colleague, Mr. Clarke, so I am not going to attempt to reply to them, but I will endeavour mainly to confine myself to the medical questions that have been asked.

First of all, I would like to express my appreciation for the complimentary remarks which have been made by Mr. Springbett and several other speakers. Mr. Springbett referred to the interesting point whether, if other companies had been included, including companies who deal with perhaps larger proposals than the "Prudential" does, the figures might have been more unfavourable in the case of elderly lives with hypertension. That is a very interesting suggestion. I cannot reply to it, but, of course, it is a well-known fact that elderly people who are executives, company directors, and so on, are more likely to die of coronary thrombosis and so on than men doing heavy manual work—labourers and so on. It may be that the " Prudential " has a higher proportion of manual workers than some companies. I don't know, but it is quite a possibility.

A speaker expressed surprise at the low mortality for atheroma. I can only say that I share in his surprise. I just can't explain it but there it is. Those are the results. I would have expected them to be higher, but I think my physician friend would probably agree that, like emphysema, atheroma depends to some extent on the judgment of the examiner. We have got to take the reports as we have them. One physician may imagine that he feels much more atheroma than another by feeling the pulse. That may account for part of it.

Two speakers referred to the fact that the high blood pressures associated with obesity do not show a much higher mortality than those cases without obesity, and the first speaker referred to my answer to that question when it came up in 1961. I have always maintained very strongly that people who are overweight are more likely to show high blood pressure than people underweight and, therefore, for an overweight you very particularly look for high blood pressure. But if you find high blood pressure, I don't know that it necessarily matters whether he is overweight or underweight. Some of the most malignant cases of hypertension that I have come across have been in very thin individuals. A man who is very much underweight is not so likely to have a high blood pressure, but if he has, he may have advanced kidney disease and be a very poor life indeed.

One speaker referred to the experience of the peptic ulcer group and particularly to the question of heavy mortality among the doubtful cases, i.e. cases not proved to be peptic ulcer. I could not agree more than I do with what the speaker suggested. I think some of these X-rays are very unreliable, or, at least, when I say they are unreliable that is not any criticism of the radiologist, but it is the diagnosis by barium meal that is extremely difficult, and I am constantly deploring the report: " X-ray showed no ulcer, therefore he has not got an ulcer ". You should confine yourself to the fact : " X-ray shows no ulcer ". That does not necessarily mean that he has not got an ulcer. You sometimes get these extraordinary cases where a man has had a large haematemesis and the X-ray is negative, and therefore the inference is drawn that he has not got an ulcer. The X-ray does not show it, but I think a large proportion of these people have got an ulcer. Some people just dismiss it because the examinee has taken a dose of aspirin or something like that. Maybe in some cases, but simply to say because the X-ray is negative he has not got an ulcer is quite wrong. I think that accounts for the high mortality among these doubtful cases.

Another speaker referred to the inclusion of both gastric ulcer and duodenal ulcer in the peptic ulcer group and thought it a pity that we cannot break them down. Of course, that does bring so very much up the question of the limited data at our disposal. You will notice that in this rather complicated coding for which I am responsible there are four digits, and practically the fourth digit indicated by a letter has not been introduced into the classification at all in the majority of instances, just because we have not got enough data to break it down. But, of course, in the question of peptic ulcer—and this applies to tuberculosis also—the fourth letter is really most important because it indicates the duration. An underwriter dealing with a case of peptic ulcer who had symptoms within six months would obviously take a much more serious view of it than a man who had been quiescent for six years and, yet, owing to the paucity of information it does not come out at all in this. Under the heading 203 or 210 or whatever it may be, I included people who had had active symptoms of duodenal ulcer—well, not within three months (it probably would not have been taken) but within the year at any rate, and with them people who had been quiescent for perhaps four, five, six years. I could not agree more with that point, but there it is ; we have not got the figures to do it. In the case of the hypertension and atheroma group, the fourth digit represents family history. Well, everybody agrees that family history is most important in cardio-vascular diseases, and if we could break these blood pressure cases up we might have some valuable information, combining the question of blood pressure with height and weight and family history. It would produce a most interesting study.

Reference was made to the high mortality of pulmonary tuberculosis. Yes, I think it is a warning that we should not underrate the importance of pulmonary tuberculosis. When I first started work with an insurance company, tuberculosis was regarded as practically an uninsurable condition. Of course, during the last twenty years, treatment has improved so much that I think there is almost a tendency to treat it too lightheartedly ; but I think perhaps those figures, even with all the corrections which are obviously necessary and which perhaps my friend, Mr. Clarke, will deal with, do, nevertheless, leave you with the fact that there is an appreciable mortality from tuberculosis, and I think that it does indicate that one has still got to be very careful in one's selection of risks. It is rather an anomaly. Somebody referred to the high mortality in the artificial pneumothorax cases. It is perhaps even more ironical that there is a high mortality under the group that we have classified as " mild ". That is an answer to somebody who said how did we arrive at the conclusion that a case was mild or moderate ; well, we simply have to judge by the information that we are given. We judge a case of tuberculosis " mild " if the chest physician says it is mild and that there are no tubercular bacilli found in the sputum and usually no symptoms, but obviously some of these cases clearly were not mild, were they ?

I turn to the question of high mortality among cases of nephrectomy. Unfortunately, this is rather a miscellaneous group, and we do not always know what the nephrectomy was for. As the group appears we have not consciously or deliberately put in cases of malignant disease, but there might be some included. We hope we have excluded malignant disease and also tuberculosis, because they come in separate groups, but nevertheless it is a miscellaneous group. Some may be traumatic, carrying very little risk ; others, renal calculus, and so on. But I would comment, incidentally, that some companies take people with only one kidney as

first class. Our results, on the other hand, rather suggest that if a person has lost a kidney, one cannot be sure that he is not an impaired life.

Another question related to the increased mortality among cases of glycosuria with a B.S.T.T. done, not shown to be diabetes. Well, there again, the answer is the same. We have to rely on information that we are given, but I am afraid B.S.T.T.'s are not always reliable. The particular figure that we have may be reliable as it was done on one particular day, but we cannot be absolutely certain that the applicant might not develop diabetes in a year's time, and I think that, with all these cases of so-called " lag curves " that we get, we have to be a bit cautious about accepting them as unqualified first-class lives. It may be desirable to review them in a year's time.

I turn to the very difficult question about the estimation of the diastolic pressure. Of course, the way they are taught at the Edinburgh Medical School is correct. There is no question about that, and they are probably taught the same in London schools. This estimating at the point of disappearance of the sounds is not scientifically accurate, but most people who are not completely deaf can tell when a sound disappears ; to judge a different phase is so difficult to estimate. In fact, the Assurance Medical Society appointed a committee to go into it about thirty years ago and it recommended that it should be the change of sounds. But when we had it that way we quite commonly used to get blood pressures reported by some doctors of 150 systolic and 140 diastolic or something like that ; so one concluded really that although the disappearance of the sounds was not accurate one had got something a little bit near what it was. It is usually within 5 or 6 points. But the other way is undoubtedly the correct one.

A questioner referred to codes 668 and 678 which are the very big overweights, non-medical examination, saying that they ought to be examined. I should think the answer is that there were probably no data at all at these codes. The coding system follows a logical pattern with the result that it includes some codes which do not come down at all.

The question about how we select the actual blood pressure figure, whether it is the average or whether it is the lowest or whether it comes from a single reading, is very difficult to answer. Believe me, it is extremely difficult to be absolutely consistent in grading these things. I think that the figures which we give are of some interest to underwriters because we have to take the information as we get it. But, of course, a scientific physician would probably tear this to pieces because the information that we get cannot be accepted as really reliable from a strictly medical point of view. Any physician who just took a person's blood pressure once and said : " You have got high blood pressure ", and treated it without taking it again, would be denounced as a disgrace to the profession, of course. Unfortunately, in our work we have often got to do that. It would be very desirable to have a number of readings taken and have electro-cardiograms and X-rays and urine analysis and all the rest of it, but often one is lucky if one can get the proposer along to the doctor once. If you ask him to come along half-a-dozen times, you are just going to lose the business. So, bad as it is from a scientific point of view, I am afraid very often these blood pressures are just the one figure. Where we are able to get several readings, we do take what can be approximately said to be an average ; but sometimes, if the figures are extraordinary and seem unreliable, we try to get another reading taken possibly by a different observer and, in a case like that, of course, we should not take an average; we should probably disregard the blood pressure which seemed improbable.

Reference was made to the mortality of diabetics. That we obtained so much more unfavourable figures than Steeds is difficult to account for. Several people, not only here but at other meetings, have suggested that Steeds's cases were more carefully selected than ours. That is partly so, but I think our cases have also been selected. To some extent I think the only complication which we may have introduced with diabetes is obesity. We have included some obese cases—they appear as a separate classification—but we would not include diabetes known to have other complications such as hypertension or albuminuria. Our cases are, so far as we know, uncomplicated diabetics except that they may be overweight.

This question of introducing a sub-coding according to insulin dose would be extremely valuable, I agree, but we just have not got enough information to do it.

Finally, there are some strictly medical questions. I have already indicated, Sir, what a very unsatisfactory answer I can give you as to how we diagnose emphysema. It does, of course, depend very much on the fact that we just have to accept the report of the examining doctor, eliminating cases where it is fairly obvious that the report was quite unreliable. I think my medical colleagues will agree with me that some radiologists, for example, report emphysema in nine cases out of ten. It probably does not mean anything at all, but I can only say that we just have to accept it. Similarly, when an examining doctor reports that the man has got emphysema, we have just got to accept it. That is the information we have to go on and we can only hope that it is reliable.

How do we select malignant tumours ? We do not take many cases but there are a few included in the investigation. Without having the actual full data with me, I should say they are mostly malignant disease of the breast and a few of the bowel, and we usually do not touch them within five years. Most of them are after they have gone ten years, or more, reputedly free from recurrence.

Reference was made to cystitis and pyelitis showing a light mortality, contrary to the experience of physicians. I have pointed out somewhere in the text that that is a little misleading because, of course, all cases included in the cystitis and pyelitis groups are cases with a *history* of cystitis and pyelitis. They would all of them be medically examined and free from albumen and pus and so on at the time of examination. It does not include any cases who had active cystitis or pyelitis at the time of examination.

I am afraid, Sir, I have not replied to the discussion at all completely, but I have gone into it so far as I can.

Mr. A. E. Bromfield, replying to the discussion on the mortality reports, said :—Before referring directly to tonight's discussion and the reports, I should like, as a member of the Committee, to make one or two general points. This is probably just as well because the discussion was more or less confined to members of the Committee and I cannot very well argue with them.

The purpose of the Committee is to make statistical investigations and forecasts based on emerging mortality. This could cover scientific research, but even if the difficulties mentioned by Mr. Redington were not present the Committee would still take the view that its overriding duty was to give actuaries the kind of information that they need in their day-to-day work. Wherever the balance of opinion on this point may have rested in the early days of the Committee, I welcome this opportunity of confirming that, at least since the War, the Committee have always kept the

practical approach very much to the forefront of the discussions. Apart from the recent decision to investigate causes of death, which some might consider as an interesting but slightly theoretical exercise, I believe that every investigation undertaken by the Committee during recent years has had a clear, practical application, and certainly the seven reports before us tonight are nothing if not practical.

As Mr. Ratcliff has said, it is only right and proper that the members of Committee should hold an open meeting now and then in their constituencies to give voters the chance to endorse or exhort or criticize or suggest, or any combination of these that they wish. The only thing we are really rather afraid of is indifference, and I may be forgiven for adding that we believe it is a great mistake to imagine that the increased financial weight of the investment side means that undue liberties can be taken regarding mortality.

For many years now, we have had the advantage that the medical profession has been very much on our side and a very useful ally. Cures have been found for one disease after another, but because the doctors, although supermen, are only human, it would be too much to expect that all those they cure carry on with an undiminished expectation of life. In so far as their expectation is curtailed, we have the double effect of more quickly declining assurance mortality and more slowly declining annuity mortality. The shape of our mortality curves might well have been quite different if it had not been for the help of our medical friends.

Having paid this tribute to the doctors, I should like to draw your attention to one or two of their more recent subjects for research which are less likely to bring comfort to actuaries. I recently had an unnerving discussion with an American business consultant, who is attached at the moment to some research organization in America which is concentrating on cryobiology and gerentology. Having had time to look up a dictionary, I can loosely translate these two phrases as the deep-freezing of people and the lengthening of the life-span. The idea of cryobiology is that anyone who is suffering from an incurable disease can elect to be deep-frozen and put away until a cure is found. He is then de-frosted, cured and carries on where he left off. It is difficult to take this idea seriously, I know, but the fact is that vast sums are being spent on research in America just now on these very lines. The guiding objective, I was told by this man (and I may say that he seemed a very sensible fellow) was that if they are going to send a missile to a planet, they have got to put two frozen people on board and then de-frost them when they arrive, otherwise they would be dead before they got there.

Now, all this sounds silly, but it is true, and I am assured that the medical problems have been largely solved and that startling developments in this field are very much closer than any of us might believe. Studies of the legal and social and financial effects of this are actually in progress and at least one American assurance company is taking this matter very seriously in so far as it is even paying money towards it. If, in conjunction with this, research on delaying the normal aging process were to begin achieving results—and I am told that it is doing this—we actuaries might have to begin paying as much or even more attention to mortality as our forefathers did. There may be little we can do at the moment, but the doctors have sounded a warning bell, and I think it would be foolish to ignore it entirely. Certainly, the man to whom I was talking took the matter extremely seriously and, although one might feel that a lot of it springs from the American way of life, the medical results have, I believe, been reported

on by a well-known biologist in this country. Although he does not relish the prospect for himself, he agrees that medically the facts are there.

Turning to the reports before us tonight, you will, I hope, have noticed that the Committee make no claim to superior knowledge. When the figures show certain features, we try to suggest possible explanations and inferences, but each actuary will have his own ideas, and in the end of the day it is up to him to draw his own conclusions: a comment which Mr. Doull put much more elegantly. As regards the main assurance and annuity investigations, everything was really going along rather nicely according to plan, until this distressing drop in annuitants' mortality after 1956. It was not a development which could have been clearly foreseen and, as has been said, we are not yet sure if it denotes the emergence of a new class of life or if it is just a further extension of annuitants' diabolical self-selection, using the extra scope provided by the 1956 Act. Time and further investigation will probably throw some light.

The noticeable improvement in pensioners' mortality, and particularly the marked reduction as regards " amounts " as compared with " lives ", is obviously a matter of considerable importance: to some of us possibly more than to others. The " works " experience is significant, but it still leaves undecided the question whether the difference in mortality is due to class of life or occupation or amount of pension, or all three. If it depends on amount of pension, and the day promised by the politicians comes when everybody will retire in comfort, we may find that our pension premiums are less than adequate.

One comment on the medical/non-medical report. The reassuring possibility referred to on the top of page 240, that the experiences may merge after the early durations, is based on data collected when limits on non-medical amounts and on ages at entry were on the whole conservative. It is not necessarily a suggestion that these limits can safely be extended, a development which seems to be gaining some acceptance just now.

As regards the discussion tonight, there really does not seem to be anything for me to comment on. The C.M.I. reports are obviously the " B " pictures this evening, supporting the main feature, and whilst the Committee won't mind about this, I expect they will interpret from the comparative silence that it is approbation, and if they do it will serve you right.

Mr. A. D. Shedden wrote :—I would like to welcome the report by Dr. Preston and Mr. Clarke as a further step towards the attainment of objective information on impairments in this country. It is encouraging to see that with the growth it exposed it is now possible to have a finer subdivision of results, and one would hope that this trend will continue as the experience matures.

At the discussion on the previous report by Mr. Clarke on this pilot investigation, differing opinions were expressed as to the desirability of an inter-company investigation into impairments, and several speakers were favourably inclined towards such an investigation. It is disappointing to find that at this meeting no one apart from Mr. Doull and Mr. Redington has mentioned this subject. Mr. Doull advocated a limited inter-company investigation into build and blood pressure, while Mr. Redington reported that there now seemed little demand for any inter-company investigation into impairments.

It would appear that the existence of the pilot investigation has had the effect of discouraging any further consideration of an inter-company investigation. In 1961, the C.M.I. Bureau reported that the discussions on Mr.

Clarke's 1961 report, in London and Edinburgh, showed that the consensus of actuarial opinion was that a substantial part of the benefit which might be expected to derive from a combined investigation would be achieved by an investigation based on the experience of the one office conducting the pilot investigation. In consequence it had been decided not to proceed with a combined investigation, although the possibility of conducting specialized investigations into particular problems was being explored.

It seems to me that we have become unduly pessimistic in our approach to the problems of an inter-company investigation. In the last seven or eight years many offices have doubled the number of new policies written in a year, and it is to be expected that growth in business will continue for several years. Accordingly, the exposed for any investigation will grow steadily each year. If the larger companies could agree on a common coding system it might be possible to consider an investigation involving a limited number of companies.

As far as build and blood pressure are concerned, no coding system need be necessary to record these items where a company has a computer and can programme to convert the absolute amounts of height, weight and blood pressure into any coding system which may be required. Here, in a most important category of impairment, we should have no great problems of consistency in coding, and the results as between companies should be consistent regardless of underwriting practice, provided there are no other impairments at the same time.

Mr. Clarke subsequently wrote :—Although Dr. Preston stated he would deal with only some of the matters raised in the discussion, and would leave the remainder for me to answer in a written contribution, he has, in fact, left me only a few questions to answer and these relate mainly to the controls.

First, then, I will attempt to reply to questions on the control experience used for calculating expected deaths. My critics and I are all agreed that a paired investigation is the ideal and I think we are also agreed that a paired investigation is impracticable. I think it is sometimes forgotten that nowadays most standard lives accepted under age 50 enter under a non-medical scheme. But since lives suffering from a major impairment are invariably examined, we need medically examined lives for the control. Among the comparatively small proportion of standard lives who are medically examined at younger ages, it would be no easy task to find a " twin " for every impaired case. Indeed, I suspect it would be virtually impossible to do so.

However, the main reason why we have not done a paired investigation is that the maintenance of a separate bureau for the first-class " twins " of the impaired lives would double the already heavy clerical labour. In fact it would more than double the labour, for the search for " twin " policies would in itself be a considerable extra burden to the recording staff concerned.

One of the criticisms made of the control table is that the same control is used for all impairment groups even though the mean durations vary from group to group. Thus if an impairment is of a kind which does not develop until middle life, there will be no data at young ages and the data at the youngest ages for which data exist will have a low mean duration in comparison with another group with a younger spread of entry ages. This is a valid criticism, but the only means of overcoming it would have been to construct a separate tailor-made control for every impairment, in which

due weight was given to the distribution of durations within each such impairment group. I need hardly add that the labour involved in such an operation would have been prohibitive. However, for those impairments which are subdivided by entry age, allowance was made for the different duration distributions as between different groups of entry ages by appropriate adjustments to the control table.

The complete answer to all these difficulties is to conduct a select investigation, in which case the control table would also be devised on a select basis. It is to be hoped that, with the help of a computer, a select investigation may one day become practicable.

Mr. Scobbie asked why we went back to the 1954-56 table as a starting point instead of using the 1957-58 rates. The answer to this is that the two experiences were so close as to be almost indistinguishable and it was more convenient to use the 1954-56 table, since the values of q_x in that table had been extended to age 75.

I now turn to the other control, viz that used for analysing deaths by cause. I agree with Mr. McBride that the use of 1964 data at all durations as a basis of comparison for an investigation extending over the period 1947-63 is far from ideal. But unfortunately we had no choice. In the previous report I used the cause of death distribution for certain groups within the investigation itself. This was clearly not very satisfactory and I feel that the control used in the present report is at least an improvement. But the fact that it embraces all durations, and hence has a considerably longer mean duration than the impaired experience, may mean that suicide and possibly accident are under-represented in the control. Consequently this may be the reason why so many impairment groups appear to show an excess of deaths from suicide and accident.