TRANSACTIONS OF SOCIETY OF ACTUARIES
1963 VOL. 15 PT. 1 NO. 43

CORONARY DISEASE AS AN UNDERWRITING PROBLEM

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THERE was a time when coronary disease presented no problem in insurance underwriting except that of diagnosis. The diagnosis presents its own difficulties, but once it was established or strongly suspected, the underwriter had only to decline. In recent years, however, insurance companies have been cautiously accepting applicants with a history of coronary disease, and the difficulties of selection and rating have been added to those of diagnosis.

As a result of this new interest, several mortality studies have been made in an attempt to find answers to the pertinent questions. The one most nearly comparable to the present study is that by Waldron and Constable (*Association of Life Insurance Medical Directors of America*, XXXIV, 69, 1950).

SCOPE OF THE PRESENT STUDY

The material for this study was taken from the Prudential's file of Home Office employees, containing about 33,000 electrocardiograms on approximately 12,000 individuals. All cases with the requisite history and findings were studied, regardless of what other impairments they had. Entrants were admitted through age 69. At the Prudential, women usually retire between the ages of 60 and 65 and men at 65, with a few individuals working to age 68. Thus, the study consists chiefly of people who were on active duty at onset, although a few retirees who came in voluntarily or were recalled by us for examination and found to qualify were included. The observation period ran from 1933 to June 30, 1961. No entrants were admitted after December 31, 1960. Those who had coronary occlusions were not admitted to that group until sixty days after onset, to exclude the deaths during the acute episode; durations were measured from the date of onset (more definite than the date of recovery) and the first year's expected mortality was reduced in the proportion 60/365 to compensate for the sixty-day exclusion period.

It is of interest to note here what proportion died within sixty days after experiencing their first occlusion. The count was restricted to males with onset prior to age 65 and females with onset prior to age 60, the ages at which they begin to retire. This was necessary because when a retired employee is reported dead of coronary disease, we have no way of knowing, in many cases, whether or not there had been a previous occlusion after retirement. While an employee is on the active staff, we are, of course, promptly notified of any illness that necessitates absence from duty. There were 370 males experiencing their first occlusion prior to age 65, of whom 126 (34 per cent) died within sixty days. There were 30 females with onset of first occlusion prior to age 60, of whom 16 (53 per cent) died within sixty days.

The expected deaths were computed on the 1946–1949 Basic Table, Select and Ultimate. A select table does not, of course, accurately reflect the mortality on a group of impaired lives. Nor does any ultimate table reflect the mortality on a group in which every individual is impaired. An ultimate group is "ultimate," not because every individual in it has deteriorated a little, but because some of them have deteriorated a great deal; others have not deteriorated at all. The choice of table depends largely on the purpose of the investigation, and the purpose here is to produce mortality ratios that can be used as a guide in underwriting coronary risks. Substandard premiums are computed in various ways, but they always bear some relation to the mortality used for the standard premiums. The most useful form for the results of a mortality study intended for selection and rating purposes would, therefore, be mortality ratios that are based on a table approximating the mortality of the standard risks, that is, a select table. This is, in effect, what is done in intercompany mortality investigations, when a basic table is constructed from the standard risks for measuring mortality on the impairments under study.

Since the 1946–1949 Basic Table overstates the mortality for the latter part of the observation period, a better idea of the extra mortality that must be covered would be obtained by measuring the coronaries against a normal control group taken from the same file, in the same age range, and for the same observation period. To qualify for the Normal Control group, individuals must have had no significant medical history and have been found normal on a physical examination comparable in all respects to that required of insurance applicants, with a normal chest X-ray and electrocardiogram. They were entered as of the date of that examination. The mortality on the Normal Control group was 78 per cent of the Basic Table for males and 28 per cent for females (Table 1).

The mortality ratios shown in all subsequent tables are based on 78 per cent of the expected deaths by the Basic Table to make the Normal Control group the measure of standard. The male factor was used in converting the female ratios because, in underwriting, any adjustment made for females is usually some modification of the ratings for males.

The percentages under Coronary Deaths in Table 1 and any subsequent tables where they are shown are the ratio of coronary deaths to deaths from all causes.

The various manifestations of coronary disease were studied in three broad groups:

1. *Coronary occlusion.*—These were all well-documented coronary occlusions. In most of them (81 per cent) the electrocardiogram showed the diagnostic signs: abnormal Q waves with abnormal T waves and the characteristic evolutionary changes. When the electrocardiogram was compatible but not diagnostic, the diagnosis had to be supported by laboratory findings and a characteristic clinical course to qualify for this group. No case was admitted in which the electrocardiogram remained normal during an acute episode thought clinically to be coronary occlusion. It is believed that all cases included in this group were definite coronary occlusions.

TABLE 1

NORMAL CONTROL GROUP
Ages 40–69 at Entry
Observation Period September 1, 1933, to June 30, 1960
1946–1949 Basic Table, Select and Ultimate

Sex	Number of Cases	Actual Deaths	Expected Deaths	Mortality Ratios	Coronary Deaths
Males	1,805	145	187.1	78%	52 (36%)
Females	902	29	102.8	28	7 (24)

2. *Angina pectoris.*—These were cases in which substernal distress, either pain or oppression, came on repeatedly with exertion and was relieved promptly by rest or nitroglycerin. It was not required that characteristic radiation be present. Nor was it required that the electrocardiogram be abnormal, since it is well known that the electrocardiogram may be normal in angina pectoris, as it was in 45 per cent of these cases when they entered the group. A few cases with questionable symptoms were included because the electrocardiogram after exercise showed characteristic evidence of coronary insufficiency, namely, flat depression of the S-T segments exceeding one-half millimeter. Despite all precautions, it is possible that some of the cases in this group are not true angina pectoris.

3. *Suspected coronary disease.*—These were cases in which the presence of coronary disease was suspected but not proved. None had had a clinical episode documented as coronary occlusion. Most had symptoms suggestive of angina pectoris, but the symptoms were not consistently produced by exertion, or were not relieved within a few minutes by rest or nitro-

glycerin, or came on at rest as well as after exercise. No cases were included in which the symptoms were believed to be of neurogenic origin. Most of the cases included (83 per cent) had abnormal T waves; for an individual to be admitted to this group with a normal electrocardiogram, the symptoms had to be very suggestive indeed. On the other hand, no one was admitted for T wave abnormalities without suspicious chest pain, these cases having been dealt with elsewhere (Kiessling, Schaaf, and Lyle, *Association of Life Insurance Medical Directors of America*, XLV, 70, 1961). In addition, there were certain electrocardiographic abnormalities that themselves qualified as presumptive evidence of arteriosclerotic heart disease: complete bundle branch block with no history of coronary occlusion or congenital heart disease; auricular fibrillation with no evidence of rheumatic heart disease or hyperthyroidism; intraventricular block; sinus arrhythmia at the older ages with marked and abrupt changes in rate not phasic with respiration. There were 23 males and 8 females who had no symptoms and qualified on the electrocardiogram alone. This is, obviously, the least homogeneous group of the three.

A case considered suspicious at first, then taking on the characteristics of angina pectoris, and later having a coronary occlusion was studied in all three groups.

The over-all mortality in the three coronary groups is shown in Table 2. The term "coronary deaths," in this and subsequent tables, is used broadly. People who die of coronary disease do not necessarily die of a coronary occlusion, although many if not most of them do. Some die suddenly, without occlusion, of acute heart block, cardiac arrest, ventricular tachycardia or fibrillation, emboli complicating auricular fibrillation or flutter, or a few less frequent phenomena. Others die after a short illness due to acute congestive heart failure with pulmonary edema, or after a longer illness due to progressive myocardial decompensation. It is often impossible for the attending physician to determine the nature of the terminal event. For this reason the cause of death on death certificates is frequently given as "coronary artery disease," "arteriosclerotic heart disease," "heart attack," or some other general term; and many of the deaths reported as "coronary occlusion" may not actually have been due to a fresh coronary closure, but to one of the other causes. In this paper the term "coronary death" is used where coronary disease appeared to be the primary cause of death, regardless of whether or not the terminal event was said to be an actual occlusion, and even though there may have been other contributing causes. Where the death appeared due primarily to some other cause, it was not considered a coronary death, even though coronary disease was stated to be a contributing factor.

Deaths attributed to other forms of cardiovascular disease—such as hypertensive heart disease, cerebral vascular disease, rupture of an aortic aneurysm—were included in the deaths from unrelated causes.

As might be expected, many individuals had one or more ratable impairments (cardiovascular or noncardiovascular) associated with their coronary disease. The three groups outlined above were studied first with all their associated impairments to gain the advantage of numbers as

TABLE 2

THREE GROUPS OF CORONARY DISEASE

	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths	Still Living with	
					Angina Pectoris	Coronary Occlusion
	Males					
Coronary occlusion	266	126	744%	101 (80%)	....	....
Angina pectoris	157	69	476	47 (68)	....	14
Suspected coronary disease	173	60	274	37 (62)	7	7
	Females					
Coronary occlusion	16	3	356%	2 (67%)	....	....
Angina pectoris	62	17	195	7 (41)	....	2
Suspected coronary disease	57	22	321	12 (55)	3	0

large as possible for the purpose of bringing out the features of underwriting significance. They were then studied again with all cases having ratable associated impairments excluded to determine the mortality experienced on the coronary disease alone.

CORONARY OCCLUSION

The Coronary Occlusion group is the logical one with which to begin, because there are doubtless fewer errors of diagnosis in it than in either of the other groups, and because, since the disease is presumably further advanced in this group, it might be expected to show the significant features more clearly.

The females in the Coronary Occlusion group are too few to study separately and their mortality is too far below that of the males to study them together. The only point of interest in regard to them is their number, which appears to be fantastically small in comparison with the number of males, raising the question whether ours is a representative group.

It has been observed in clinical practice that females with coronary occlusion are seen less often than males until the advanced ages, and experimental work has demonstrated rather convincingly that women are protected against coronary disease by the female hormones. After the menopause, apparently, it takes ten or fifteen years for the women to catch up with the men, by which time Prudential women are retiring and would not generally be included in this study.

In view of this, it seemed advisable to check our male-female distribution against that of some other experience, and the United States vital statistics for 1959 were used for this purpose. These consist of deaths from coronary disease, by sex and age at death, among a population that is

From TABLE 2

CORONARY OCCLUSION

Sex	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
Males..........	266	126	744%	101 (80%)
Females........	16	3	356	2 (67)

about equally divided between males and females until old age, when females predominate as a result of their greater longevity. All deaths from coronary disease among our Home Office employees (including those who did not qualify for this study, either because the death occurred within sixty days after the first occlusion or because the first occlusion occurred after retirement) were tabulated by age at death and adjusted to a staff equally divided as to sex to correspond with the United States population distribution. The resulting comparison (Table 3) shows the staff ratios sufficiently close to those for the white population of the country as a whole to suggest that our 16 females to 266 males is about what one would expect. It might be added, in passing, that the delayed development of coronary disease in females may go far to account for their greater longevity.

Females were more numerous in the Angina Pectoris and Suspected Coronary Disease groups than in the Coronary Occlusion group, but their mortality fluctuated so much that no useful purpose would be served by presenting it in detail. It is to be understood, therefore, that all of the subsequent tables shown refer to males.

Numerous questions arise in underwriting these risks: Can an applicant who has had more than one coronary occlusion be considered for insurance? Do young coronaries do better or worse than older ones? What mortality is to be expected when there is a history of coronary occlusion 2 years, 5 years, 10 years ago? What should the waiting period be? Can a credit be given if the electrocardiogram shows T wave abnormalities only, without abnormal Q waves? Is the case better than average if the electrocardiogram has returned to normal? Is the presence of angina pectoris after coronary occlusion a contraindication for insurance? Does an elevated blood pressure after the occlusion increase the risk? If the blood pressure is normal after the occlusion, can hypertension before the occlusion be ignored? What should be our attitude toward associated impairments? In general, is it possible to select the best of the group and bring the mortality within practical limits?

TABLE 3

RATIO OF MALE TO FEMALE DEATHS FROM CORONARY DISEASE

Adjusted to Staff Equally Divided as to Sex

Home Office Staff Compared with 1959 U.S. Vital Statistics (White)

Age at Death	Prudential Home Office Staff			1959 U.S. Vital Statistics		
	Male Deaths	Female Deaths (Adj.)	Ratios Male: Female	Male Deaths	Female Deaths	Ratios Male: Female
30–39	7	0	....	3,561	575	86:14
40–49	35	9	80:20	18,371	3,003	86:14
50–59	91	18	83:17	45,410	10,808	81:19
60–69	117	43.5	73:27	76,865	33,610	70:30
70–79	62	39	61:39	82,386	58,834	58:42
80–89	21	15	58:42	43,912	48,441	48:52
90–99	3	6	33:67	6,598	10,476	39:61

The amount of material available was small, but the results in some categories were so well-defined that something could be learned about the features that are significant for underwriting purposes.

Repeated Coronary Occlusions

Among those who survive their first coronary occlusion, recurrence is common and the majority will die sooner or later of their coronary disease. Table 4 shows the mortality on those in our group who have survived one, two, or three acute coronary occlusions by at least sixty days. It will be noted that seven people in our group survived a third occlusion, only two of whom are still alive. No one, as yet, has survived a fourth.

Electrocardiographic Changes

At the time of the initial occlusion, 49 electrocardigrams showed T wave changes only, and 217 showed both QRS and T changes. The mortality ratios on these two groups showed only a small difference, of doubtful significance.

Out of the 266 cases studied, there were 68 in which the T waves subsequently returned to normal. These 68 showed a mortality of 427 per cent. In 24 of them the occlusion produced T wave changes only, with a mortality of 579 per cent. The remaining 44, in which the occlusion produced both Q wave and T wave changes, had a mortality of 372 per cent. Since it is illogical to think that the mortality should be higher on cases that had T wave changes only than on those that had both Q wave and T wave

TABLE 4

SUCCESSIVE CORONARY OCCLUSIONS

Each Survived at Least Sixty Days

(All Associated Impairments Included)

Sequence of Occlusions	Number of Cases	Actual Deaths	Mortality Ratios
First occlusion	266	126	744%
Second occlusion	41	24	1,176
Third occlusion	7	5	3,651

changes, the validity of all three of these mortality ratios is doubtful. It it also pertinent to observe that the mortality was measured from the date on which normal T waves were first recorded, which was several weeks, several months, or several years after the occlusion occurred, so that a part of the early period when mortality is highest was excluded. It might be added that in many cases the T waves sooner or later became abnormal again.

Age at Onset

There is some question whether young coronaries should be treated more or less severely than older ones in underwriting coronary occlusion. One might expect them to do worse because they have developed a degenerative disease at an unnaturally early age. Many clinicians have the impression that they are more likely to succumb to the initial attack, presumably because they have not had time to develop the collateral circulation that usually comes with advancing age, but that those who survive the initial attack do better clinically and live longer than older patients. Waldron and Constable, studying disability claims at The Mutual Life Insurance Company of New York, in the paper previously cited, found that survivors among the young coronaries have a longer expected lifetime but a higher mortality ratio than the older ones. An unpublished study of the Prudential's disability claims about the same time also showed the highest mortality ratios at the younger ages. This was not true in the present study, although the young coronaries did live longer on the average (Table 5), but this experience is small and, so far as number of cases is concerned, the weight of evidence is against the present study.

TABLE 5

CORONARY OCCLUSION BY AGE AT ONSET

(All Associated Impairments Included)

Age at Onset	Number of Cases	Actual Deaths	Mortality Ratios	Average Survival in Years*
Under 50........	75	22	592%	7.9
50–59...........	122	63	787	6.6
60–69...........	69	41	783	5.0
Totals.......	266	126	744%	6.5

* Life-years in this exposure divided by number of cases.

Duration

Other studies have shown that the mortality after coronary occlusion decreases with time elapsed since the acute attack, and this impression is borne out in the present study (Table 6). It is noted that the percentage of deaths from coronary disease, also, diminished with time elapsed.

Past History of Coronary Occlusion

A duration table of the conventional type, like that shown in Table 6, does not give a realistic view of the mortality to be experienced on newly selected risks with a history of coronary occlusion 2 years, 5 years, 10 years old, for two reasons:

First, the expected mortality for newly selected risks who have a history of coronary occlusion t years ago at age x begins with select duration one at the current age, that is, $[x+t]$; by this time the expected mortality in the duration table is that for the age at onset plus the t years elapsed since the acute attack, $[x]+t$. The former is substantially less than the latter. This would produce a higher mortality ratio on newly selected risks than that shown in the duration table, for the same number of deaths and exposures.

Second, the underwriter may, at his discretion, exclude any risks that have developed additional impairment during the t years elapsed since the acute episode, in the hope of reducing the mortality rate that will have to be covered, whereas these cases remain in the duration table, there being no decrements except by death or the close of observation. This lowers the mortality rate on the newly selected group if his selection is successful, which would, all other things being the same, lower the mortality ratio.

TABLE 6

CORONARY OCCLUSION
BY TIME ELAPSED SINCE ACUTE ATTACK
(All Associated Impairments Included)

Duration	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
1st yr.	266	10	1,337%	9 (90%)
2nd yr.	249	20	1,712	19 (95)
3rd yr.	216	17	1,294	16 (94)
4th yr.	187	11	831	8 (73)
5th yr.	164	12	917	10 (83)
1st–2nd yrs.	266	30	1,565	28 (93)
3rd–5th yrs.	216	40	1,014	34 (85)
1st–5th yrs.	266	70	1,195	62 (89)
6th–10th yrs.	138	35	704	27 (77)
11th yr. on	54	21	344	12 (57)
Totals	....	126	744%	101 (80%)

What the net effect on the mortality ratio of these two factors, working in opposite directions, will be depends on several variables and cannot be estimated from the duration table. Table 7 shows the mortality ratios on newly selected risks with a history of coronary occlusion at various intervals after the initial attack. Since this is a preliminary test to elucidate a principle and we are interested, for the moment, in comparative results and not mortality levels, the entire group was used, with all the associated impairments originally present included, to gain the advantage of as large numbers as possible. The underwriting process after each interval was simplified by limiting the exclusions to a single impairment developed since the initial attack, namely, a second coronary occlusion, which has been shown in Table 4 to result in a high mortality. All other cases living at the end of each interval studied were considered acceptable and were entered at their then current age and at select duration one, as they would be in actual underwriting. After acceptance there were, of course, no further decrements except by death and the close of observation.

Since Table 6 cannot yet be directly compared with Table 7, there is shown in Table 8 the mortality ratio on newly selected risks with a history

TABLE 7

PAST HISTORY OF CORONARY OCCLUSION
(All Associated Impairments Included)
No Acceptances after a Second Occlusion

Age of History	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
0 yrs. old	266	126	744%	101 (80%)
1 yr. old	240	113	763	90 (80)
2 yrs. old	203	89	708	68 (76)
3 yrs. old	168	69	627	49 (71)
4 yrs. old	149	60	628	42 (70)
5 yrs. old	117	46	573	30 (65)
10 yrs. old	47	17	486	10 (59)

TABLE 8

CORONARY OCCLUSION
COMPARISON OF DURATION AND AGE OF HISTORY

Truncated Duration	Actual Deaths	Mortality Ratios	Age of History	Actual Deaths	Mortality Ratios
1st yr. on	126	744%	0 yrs. old	126	744%
2nd yr. on	116	716	1 yr. old	113	763
3rd yr. on	96	639	2 yrs. old	89	708
4th yr. on	79	576	3 yrs. old	69	627
5th yr. on	68	549	4 yrs. old	60	628
6th yr. on	56	505	5 yrs. old	46	573
11th yr. on	21	344	10 yrs. old	17	486

of coronary occlusion one year old from Table 7, alongside the mortality ratio for the corresponding period (from the second year on) from Table 6, and so on for older histories and longer durations. It must be remembered that this is partial selection—only one newly developed impairment having been excluded from a group with other associated impairments (both originally present and newly acquired). The effect of full selection will be explored later on. The point we wish to make here is that, in spite of the fact that there were fewer deaths to be covered, the mortality ratios increased as a result of the decrease in expected deaths.

Waiting Period

Closely allied with the foregoing discussion is the question: How long should the waiting period be? An impairment having a high early mortality that decreases with passing time, as it does in this one, is frequently underwritten with a waiting period, which has a dual purpose: to bring the over-all mortality within acceptable limits, and to lower the mortality in the first few years after acceptance when expenses are heavy and the lapse rate is high.

The results shown in Table 7 apply, just as they are, to the over-all mortality that would be experienced after various waiting periods equal in length to the age of the history, with the only disqualifying underwriting feature a second occlusion occurring during the waiting period. It will

TABLE 9

CORONARY OCCLUSION
MORTALITY DURING FIRST FIVE YEARS AFTER ACCEPTANCE
FOLLOWING WAITING PERIODS OF VARIOUS LENGTHS

(All Associated Impairments Included)
No Acceptances after a Second Occlusion

Duration after Acceptance	No Waiting Period		One Year		Two Years		Three Years	
	Actual Deaths	Mortality Ratios	Actual Deaths	Mortality Ratios	Actual Deaths	Mortality Ratios	Actual Deaths	Mortality Ratios
1st–2nd yrs..	30	1,565%	35	1,910%	25	1,566%	20	1,404%
3rd–5th yrs..	40	1,014	32	944	28	972	20	783
1st–5th yrs..	70	1,195%	67	1,283%	53	1,183%	40	1,005%

be observed that a one-year waiting period produced a higher mortality ratio than no waiting period would have done, but this is due largely to the disproportionately small number of deaths in the last ten months of the year immediately following the acute episode (see Table 6), which is probably an accidental fluctuation. Aside from this, when the mortality ratios for successive periods are compared, it can be seen that the waiting period does decrease the over-all mortality, but perhaps on a somewhat more modest scale than might have been anticipated from inspection of the duration table.

The mortality for the first five years after acceptance following waiting periods of one, two, and three years is shown in Table 9, with the first five years of the duration table (no waiting period) for comparison. Following waiting periods of two years and three years, the number of deaths during the first 5 years after acceptance was substantially reduced, but there was not a reduction of the same magnitude in the mortality ratios.

Since the mortality ratios are the primary consideration if the substandard premiums are based on a multiple of the standard mortality rates, it is clear that a waiting period does not necessarily accomplish its intended purpose. A great deal depends on how rapidly the mortality decreases and how soon the curve flattens out and at what level. A waiting period should be imposed only if tests show that it would accomplish enough to justify postponing consideration for insurance.

Associated Impairments

After a coronary occlusion has occurred, the proportion of deaths due to coronary disease is so high (80 per cent of the deaths among males,

TABLE 10

CORONARY OCCLUSION
WITH AND WITHOUT OTHER IMPAIRMENTS

Associated Impairments	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
None	136	51	504%	45 (88%)
Hypertension only, slight-moderate	52	28	955	21 (75)
Hypertention only, marked-very marked	21	16	1,778	11 (69)
Diabetes mellitus only	10	6	1,158	4 (67)
Multiple or miscellaneous impairments*	47	25	1,008	20 (80)
Totals	266	126	744%	101 (80%)

* There were 86 associated impairments among 47 individuals. Heading the list were 27 hypertensives and 14 diabetics (in addition to those shown in the table), each of whom had more than one associated impairment.

with other cardiovascular deaths making up 10 per cent and noncardiovascular deaths 10 per cent of the total) that the question arises whether the associated impairments contribute their usual quota of deaths or whether they are overshadowed by the coronary disease. Table 10 shows that the mortality on the combined impairments is very high—probably higher than the mortality on the separate impairments—and that the proportion of total deaths due to noncoronary causes is greater when there are associated impairments than when coronary occlusion is present alone.

Postocclusion Angina Pectoris

Among the 136 cases of coronary occlusion with no associated impairments (Table 10) there were 86 without angina pectoris who had a mortality of 577 per cent (33 deaths) and 50 with angina pectoris who had a mortality of 410 per cent (18 deaths). It came as a surprise that the presence of angina pectoris after a coronary occlusion apparently adds nothing to the risk. It is noteworthy that Waldron and Constable's group showed the same finding. One might have expected those with postocclusion angina to be more likely to have a recurrence than those without it, since the presence of angina pectoris may mean that another artery is insufficient and is a candidate for another occlusion. A review of the cases shows the difference in the rate of recurrence to be insignificant—38 per cent of those without angina having a subsequent occlusion and 40 per cent of those with angina.

But there are other modifying considerations. An important one is the amount of physical activity the individual undertakes: he may have no angina because he avoids exerting himself to the degree that produces angina and, if activity is markedly restricted, the absence of angina could mean that some of those without angina are the worst of the lot. The history obtained depends on temperament, too, some people having a tendency to minimize their symptoms and others a tendency to make much of them. The presence or absence of postocclusion angina pectoris may be an indication of the condition of the coronary arteries that are still patent, but in practice it is not easy to evaluate.

Hypertension and Coronary Occlusion

As seen in Table 10, the mortality was much higher when the postocclusion blood pressure was elevated than when it was normal. The question then arises: If the blood pressure is normal after coronary occlusion, can a history of hyptertension before the occlusion be ignored?

It has been observed clinically that individuals with hypertension frequently have a lower blood pressure after coronary occlusion than before. In some of them it is lower but still elevated; in others it is normal. Whether it is normal or still elevated, it may remain at the lower level indefinitely or may rise again after a while. A review of our own cases was consistent with the clinical impression and showed, also, that blood pressures that had been normal before the occlusion were much more likely to be normal after the occlusion than blood pressures that had been elevated, and a little less likely to rise later on. Of those whose blood pressures were normal before occlusion, 95 per cent were normal after occlusion and 13 per cent of these rose later on. Of those whose blood pressures were elevated before the occlusion, only 29 per cent were normal after the occlusion and 22 per cent of these rose again. To qualify as a normal postocclusion blood pressure for this count, the blood pressure must have remained normal for approximately a year, during which the individuals were ambulatory.

A test was made on the 136 males from Table 10 whose blood pressure was normal after the occlusion and who had no associated impairments (Table 11). While the numbers are small, those whose blood pressure was elevated before the occlusion had a substantially higher mortality than those whose blood pressure was normal. There were three cases with the preocclusion blood pressure unknown which probably belong in the normal group. They have survived the initial occlusion for 24, 26, and 33 years;[1] have maintained a normal blood pressure throughout the postocclusion period; and were still living at the end of observation. If they were transferred from the unknowns to the normals, the mortality ratios would be 312 per cent for the normal, 804 per cent for the unknown.

TABLE 11

CORONARY OCCLUSION WITH POSTOCCLUSION BLOOD PRESSURE NORMAL AND PREOCCLUSION BLOOD PRESSURE AS STATED

(No Associated Impairments)

Preocclusion Blood Pressure	Number of Cases	Actual Deaths	Mortality Ratios	Number Becoming Elevated Later
Normal	75	21	394%	7 (9%)
Elevated	20	8	1,244	5 (25)
Unknown	41	22	532	6 (15)
Totals	136	51	504%	18 (13%)

The results indicate that when the postocclusion blood pressure is normal, the preocclusion blood pressure could be disregarded and the mortality would fall within acceptable limits, but that greater equity would be achieved by excluding the preocclusion hypertensives.

Selection of Risks

Finally, there is the question whether it is possible to select the best of the group and bring the mortality within practical limits. For this investigation a hypothetical set of underwriting rules, based upon the results of the present study that seemed sufficiently well defined, was formulated:

1. *Angina pectoris.*—Ignore postocclusion angina pectoris, unless it is increasing in frequency or severity.

[1] The observation period was 28 years, 1933–61. This case had a history of coronary occlusion in 1928, and our first electrocardiogram, made in 1934, showed clear evidence of an old infarction. Since mortality was being measured from the date of occlusion, it was entered as of 1928.

2. *Multiple occlusions.*—Exclude cases with a history of more than one occlusion.

3. *Associated impairments.*—Exclude all associated cardiovascular impairments and diabetes mellitus.

4. *Preocclusion hypertension.*—Disregard preocclusion hypertension.

The tests in Tables 12–15 were made to determine by comparison with Tables 6–9 what would be accomplished by applying these hypothetical

TABLE 12

CORONARY OCCLUSION
WITH PREOCCLUSION BLOOD PRESSURE IGNORED
BY TIME ELAPSED SINCE ACUTE ATTACK
(No Associated Impairments)

Duration	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
1st yr.	136	3	880%	3 (100%)
2nd yr.	124	7	1,299	7 (100)
3rd yr.	109	6	955	6 (100)
4th yr.	97	2	294	1 (50)
5th yr.	86	6	901	6 (100)
1st–2nd yrs.	136	10	1,136	10 (100)
3rd–5th yrs.	109	14	709	13 (93)
1st–5th yrs.	136	24	841	23 (96)
6th–10th yrs.	72	17	619	15 (88)
11th yr. on	34	10	222	7 (70)
Totals	....	51	504%	45 (88%)

TABLE 13

PAST HISTORY OF CORONARY OCCLUSION
WITH PREOCCLUSION BLOOD PRESSURE IGNORED
(No Associated Impairments)
No Acceptances after a Second Occlusion
or after Development of an Associated Impairment

Age of History	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
0 yrs. old	136	51	504%	45 (88%)
1 yr. old	126	48	521	42 (88)
2 yrs. old	105	36	458	30 (83)
3 yrs. old	84	27	390	21 (78)
4 yrs. old	75	25	406	20 (80)
5 yrs. old	60	18	329	13 (72)
10 yrs. old	30	7	263	5 (71)

underwriting rules. No account was taken of the questionable or inconclusive results of this study—namely, the type of electrocardiographic changes, the return of T waves to normal, and the age at onset. Preocclusion hypertension was disregarded, under rule 4, because in practice it would seldom be known, although excluding it would lower the mortality. In making the comparison it should be noted that second and subsequent

TABLE 14

CORONARY OCCLUSION
COMPARISON OF DURATION AND AGE OF HISTORY

From Table 12				From Table 13			
Truncated Duration	Actual Deaths	Mortality Rates	Mortality Ratios	Age of History	Actual Deaths	Mortality Rates	Mortality Ratios
1st yr. on.....	51	375	504%	0 yrs. old.....	51	375	504%
2nd yr. on....	48	387	491	1 yr. old......	48	381	521
3rd yr. on.....	41	376	444	2 yrs. old.....	36	343	458
4th yr. on.....	35	361	407	3 yrs. old.....	27	321	390
5th yr. on.....	33	384	416	4 yrs. old.....	25	333	406
6th yr. on.....	27	375	372	5 yrs. old.....	18	300	329
11th yr. on.....	10	294	222	10 yrs. old.....	7	233	263

TABLE 15

CORONARY OCCLUSION
MORTALITY DURING FIRST FIVE YEARS AFTER ACCEPTANCE
FOLLOWING WAITING PERIODS OF VARIOUS LENGTHS
(No Associated Impairments)
No Acceptances after a Second Occlusion
or after Development of an Associated Impairment

Duration after Acceptance	No Waiting Period		One Year		Two Years		Three Years	
	Actual Deaths	Mortality Ratios	Actual Deaths	Mortality Ratios	Actual Deaths	Mortality Ratios	Actual Deaths	Mortality Ratios
1st–2nd yrs....	10	1,136%	13	1,478%	6	766%	6	878%
3rd–5th yrs....	14	709	13	745	13	876	9	679
1st–5th yrs....	24	841%	26	990%	19	838%	15	747%
Mortality rates	....	176	....	206	....	181	....	179

occlusions have already been excluded from Table 7. Only the 136 cases with no associated impairments, from Table 10, qualified for these tests, the remainder being excluded under rule 3.

The results for past history, in Table 13, apply also to waiting periods of the same length as the history.

As a crude measure of what was accomplished by full selection, the mortality rates are shown together with the mortality ratios in Table 14. Under the foregoing rules, the underwriter was successful in reducing the mortality rates, but with no appreciable change in the mortality ratios. The improvement in mortality rates did, however, prevent the increase in the morality ratios that would otherwise have occurred as a result of the loss in expected mortality due to the setback to duration one.

Table 15 shows no advantage in the first five years as a whole for waiting periods of less than three years, but it is noted from the duration table that the mortality on this impairment remains high for the first three years. The important point is, it cannot be assumed that a waiting period will perform its intended function automatically.

Inasmuch as this impairment is well suited to a multiple table rating plus a flat temporary extra premium, the data from Table 13 have been recast in that form (Table 16). The actual deaths (from Table 13) and the expected deaths (78 per cent of the expected deaths on the 1946–1949 Basic Table, used but not shown in Table 13) were first converted to deaths per thousand entrants (the entrants being the number of cases with histories of various ages from Table 13). To eliminate accidental fluctuations, the actual and expected deaths per thousand entrants, thus calculated, were graduated and interpolated for the sixth to the ninth years by the graphic method, and are shown in Columns (1) and (2). The remainder of the calculation is indicated in the column headings. The mortality ratio for a history 5 years old, 337 per cent, was arbitrarily chosen as the level above which the high mortality of the early years would be converted to extra deaths per thousand. The figures shown in Column (5) are the total extra deaths per thousand entrants with histories up to 5 years old in excess of the deaths represented by a multiple table ratio of 337 per cent.

The extra deaths shown in Column (5) came from groups of entrants that numbered 1,000 at the time of acceptance but were depleted year by year thereafter in two ways: by death and by the close of observation. In Columns (6) to (8) are shown the numbers remaining in the experience at the beginning of each year after acceptance to cover the mortality on the extra deaths. The amount of the decrement due to death and the amount due to the close of observation are also shown. Among insured lives there would be no withdrawals due to the close of observation but there would be terminations due to lapses, requiring, perhaps, some further adjustment.

TABLE 16

CONVERSION OF HIGH EARLY MORTALITY TO EXTRA DEATHS PER 1,000 ENTRANTS, AFTER GRADUATION

Age of History	Graduated Deaths per 1,000		Mortality Ratios (3) = (1) ÷ (2)	Expected Deaths per 1,000 ×3.37 (4) = (2) ×3.37	Actual Deaths per 1,000 in Excess of 337% (5) = (1) − (4)
	Actual (1)	Expected (2)			
1 yr. old	381	73.1	521%	246	135
2 yrs. old	352	76.5	460	258	94
3 yrs. old	331	80.3	412	271	60
4 yrs. old	314	84.4	372	284	30
5 yrs. old	300	89.1	337	300	0
6 yrs. old	286	89.0	321	....	....
7 yrs. old	273	89.0	307	....	....
8 yrs. old	260	89.0	292	....	....
9 yrs. old	247	89.0	278	....	....
10 yrs. old	233	89.0	262	....	....

NUMBER SURVIVING AND CONTINUING PER 1,000 ENTRANTS AT BEGINNING OF SUCCESSIVE YEARS AFTER ACCEPTANCE WITH HISTORIES ONE, TWO, AND THREE YEARS OLD

Years after Acceptance	Age of History		
	One Year Old No. of Cases (6)	Two Years Old No. of Cases (7)	Three Years Old No. of Cases (8)
1st yr.	1,000	1,000	1,000
2nd yr.	886	894	887
3rd yr.	781	789	780
4th yr.	684	685	679
5th yr.	593	581	....
6th yr.	508	....	....
Decrements due to			
Death	206	152	107
End of observation	286	267	214

ANGINA PECTORIS

In the Angina Pectoris group from Table 2, the women again attract attention because of their numbers, but here because they are more numerous in comparison with the men than they were in the Coronary Occlusion group. This is consistent with the clinical impression that coronary disease is more likely to manifest itself as angina pectoris than as coronary occlusion in women, whereas it is the other way around in men. The presumption is that the disease is not so far advanced in the women, since they are less susceptible to coronary disease in this age range than are men.

From TABLE 2

ANGINA PECTORIS

Sex	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths	Still Living after Coronary Occlusion
Males......	157	69	476%	47 (68%)	14
Females....	62	17	195	7 (41)	2

TABLE 17

ANGINA PECTORIS
BY AGE AT ONSET
(All Associated Impairments Included)

Age at Onset	Number of Cases	Actual Deaths	Mortality Ratios	Average Survival in Years*	Living after Coronary Occlusion
Under 50....	51	17	828%	8.4	8
50–59.......	64	28	432	8.2	2
60–69.......	42	24	401	6.4	4
Totals..	157	69	476%	7.8	14

* Life-years in this exposure divided by number of cases.

It is of interest to note that of the 157 males with angina pectoris, 59 have had one or more coronary occlusions, and that 24 (41 per cent) of them died during the acute stage of the first occlusion—not counting six other deaths without prior occlusion in which the cause was given less specifically as "coronary disease," etc.

Age at Onset

In Table 17 the highest incidence among males is seen to be in the 50–59 age group, as it was also in the Coronary Occlusion group, although the number of cases at 60–69 is understated because men usually retire at 65. The mortality ratios decreased with advancing age at onset, contrary to the findings in our Coronary Occlusion group, but consistent with those in other studies of coronary occlusion, suggesting again that our Coronary Occlusion group may not be dependable in this respect. Among females the mortality showed no trend by age.

Electrocardiographic Changes

Males in the Angina Pectoris group whose electrocardiograms were abnormal had a higher mortality than did those whose electrocardiograms were normal at onset—519 per cent and 379 per cent, respectively. The corresponding mortality ratios for females were 268 per cent and 109 per cent. Both males and females with abnormal electrocardiograms had a higher proportion of coronary occlusions during the observation period than those with normal electrocardiograms.

Duration

The mortality by duration (confined to males) decreases with time elapsed since onset, as it did in the Coronary Occlusion group (Table 18).

TABLE 18

ANGINA PECTORIS
BY DURATION
(All Associated Impairments Included)

Duration	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
1st–5th yrs........	157	29	749%	22 (76%)
6th–10th yrs.......	95	18	419	15 (83)
11th year on......	49	22	346	10 (46)
Totals........	....	69	476%	47 (68%)

Past History

The mortality for a history of angina pectoris, measured from the onset of typical anginal symptoms, is shown in Table 19. It was assumed that there would be no acceptances in this group after the first coronary occlusion, as such cases would thereafter be underwritten as coronary occlusion, not as angina pectoris.

Associated Impairments

The associated impairments among males in the Angina Pectoris group are essentially what they were in the Coronary Occlusion group, and the relative mortality among the various impairments about the same but at a lower level (Table 20).

TABLE 19

HISTORY OF ANGINA PECTORIS

(All Associated Impairments Included)
No Acceptances after Coronary Occlusion

Length of History	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
0 yrs. old	157	69	476%	47 (68%)
1 yr. old	143	61	487	40 (66)
2 yrs. old	126	51	474	33 (65)
3 yrs. old	103	40	422	24 (60)
4 yrs. old	90	34	415	19 (56)
5 yrs. old	81	32	445	18 (56)
10 yrs. old	39	17	556	7 (41)

TABLE 20

ANGINA PECTORIS
WITH AND WITHOUT OTHER IMPAIRMENTS

Associated Impairments	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
None	62	20	313%	16 (80%)
Hypertension only, slight-moderate	37	11	346	7 (64)
Hypertension only, marked-very marked	24	18	1,140	13 (72)
Diabetes mellitus only	6	5	704	2 (40)
Multiple or miscellaneous impairments*	28	15	565	9 (60)
Totals	157	69	476%	47 (68%)

* There were 55 associated impairments among 28 individuals. There were 20 hypertensives (which again led the list) and 7 diabetics, in addition to those shown in the table. It is noteworthy that hypertension was more prevalent among the females with angina pectoris than among the males—49 out of 62 females having hypertension, and 81 out of 157 males.

Selection of Risks

It remains to determine the trend of mortality by duration in our 62 males who had angina pectoris without other impairments (Table 21) and to find the mortality experienced among them with histories of various lengths, with full selection (Table 22).

TABLE 21

ANGINA PECTORIS
BY DURATION
(No Associated Impairments)

Duration	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
1st–5th yrs.	62	5	328%	5 (100%)
6th–10th yrs.	46	5	254	4 (80)
11th yr. on	24	10	344	7 (70)
Totals	....	20	313%	16 (80%)

TABLE 22

HISTORY OF ANGINA PECTORIS
(No Associated Impairments)
No Acceptances after Coronary Occlusion
or after Development of an Associated Impairment

Length of History	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
0 yrs. old	62	20	313%	16 (80%)
1 yr. old	55	17	313	13 (77)
2 yrs. old	47	14	295	10 (71)
3 yrs. old	42	14	355	10 (71)
4 yrs. old	35	12	377	8 (67)
5 yrs. old	32	12	419	8 (67)
10 yrs. old	15	7	512	4 (57)

SUSPECTED CORONARY DISEASE

The Suspected Coronary Disease group, from Table 2, is the least homogeneous of the three. At one extreme there are a few cases in this group which began with an acute episode that was diagnosed coronary occlusion

From TABLE 2

SUSPECTED CORONARY DISEASE

Sex	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths	Still Living With	
					Angina Pectoris	Coronary Occlusion
Male	173	60	274%	37 (62%)	7	7
Female	57	22	321	12 (55)	3	0

clinically, and may have been, but which did not meet our criteria for the Coronary Occlusion group because the electrocardiogram remained normal. At the other extreme there are cases which, in retrospect, appear not to have been coronary disease at all. Of the three groups under study, it is the most difficult to underwrite, requiring a wider range of ratings and more judgment on the part of the underwriter as to how strong the suspicion of coronary disease is.

Age at Onset

The highest incidence was again in the 50–59 age group, but there was no well-defined trend in mortality by age in either sex.

Electrocardiographic Changes

The changes found in the electrocardiograms could be studied only in broad groups (Table 23). The 55 miscellaneous findings included 43 complete bundle branch blocks, 28 on the right side and 15 on the left. A possible explanation of the comparatively low mortality on this group lies in the fact that 17 of the 23 cases that qualified on the electrocardiogram alone, without symptoms, are here.

TABLE 23

SUSPECTED CORONARY DISEASE
ACCORDING TO ELECTROCARDIOGRAPHIC FINDINGS
(All Associated Impairments Included)

Electrocardiogram	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
Normal	30	14	259%	7 (50%)
T wave abnormalities only	70	20	376	13 (65)
Auricular fibrillation	18	7	665	7 (100)
Miscellaneous	55	19	188	10 (53)
Totals	173	60	274%	37 (62%)

Duration

As shown in Table 24, the mortality on males decreases with time elapsed since onset, as it does in the other two groups.

Past History

The mortality on suspected coronary disease, present for various lengths of time, is shown in Table 25, coronary occlusion and angina pec-

TABLE 24

SUSPECTED CORONARY DISEASE
BY DURATION
(All Associated Impairments Included)

Duration	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
1st–5th yrs.......	173	24	541%	16 (67%)
6th–10th yrs......	119	18	356	11 (61)
11th yr. on.......	62	18	146	10 (56)
Totals.......	....	60	274%	37 (62%)

TABLE 25

HISTORY OF SUSPECTED CORONARY DISEASE
(All Associated Impairments Included)
No Acceptances after Coronary Occlusion or Angina Pectoris

Length of History	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
0 yrs. old.......	173	60	274%	37 (62%)
1 yr. old........	165	57	290	35 (61)
2 yrs. old.......	158	52	286	31 (60)
3 yrs. old.......	142	44	278	25 (57)
4 yrs. old.......	119	37	267	20 (54)
5 yrs. old.......	109	31	255	17 (55)
10 yrs. old.......	55	14	253	9 (64)

toris developing in the interim being excluded, since they would then be underwritten in the other two groups.

Associated Impairments

The associated impairments, shown in Table 26, are much the same as in the other two groups. The men show about the same relative mortality among the various impairments, and lower throughout than the Angina Pectoris group which, in turn, was lower than the Coronary Occlusion group.

Selection of Risks

The mortality on the 71 males with no associated impairments is shown by duration in Table 27, and with histories of various lengths, with full selection, in Table 28.

TABLE 26

SUSPECTED CORONARY DISEASE
WITH AND WITHOUT OTHER IMPAIRMENTS

Associated Impairments	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
None	71	20	194%	11 (55%)
Hypertension only, slight-moderate	39	11	227	4 (36)
Hypertension only, marked-very marked	19	12	868	10 (83)
Diabetes mellitus only	3	3	517	0 (0)
Multiple or miscellaneous impairments*	41	14	299	12 (86)
Totals	173	60	274%	37 (62%)

* There were 68 associated impairments among 41 individuals. There were 25 hypertensives and 4 diabetics in addition to those shown in the table. There were 18 with auricular fibrillation, not rheumatic in origin. Females with hypertension outnumbered males in about the same proportion as in the Angina Pectoris group.

TABLE 27

SUSPECTED CORONARY DISEASE
BY DURATION

(No Associated Impairments)

Duration	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
1st-5th yrs.	71	8	471%	4 (50%)
6th-10th yrs.	50	3	129	1 (33)
11th yr. on	30	9	142	6 (67)
Totals	....	20	194%	11 (55%)

TABLE 28

HISTORY OF SUSPECTED CORONARY DISEASE

(No Associated Impairments)
No Acceptances after Coronary Occlusion or Angina Pectoris
or after Development of an Associated Impairment

Length of History	Number of Cases	Actual Deaths	Mortality Ratios	Coronary Deaths
0 yrs. old	71	20	194%	11 (55%)
1 yr. old	69	20	212	11 (55)
2 yrs. old	63	17	192	9 (53)
3 yrs. old	55	14	185	7 (50)
4 yrs. old	47	12	183	7 (58)
5 yrs. old	44	11	188	7 (64)
10 yrs. old	26	8	296	5 (63)

THE ROLE OF THE ELECTROCARDIOGRAM IN THE SELECTION AND RATING OF CORONARY DISEASE

The electrocardiogram played a somewhat different role in the formation of each of the three groups studied, and requires different treatment in underwriting them.

In the Coronary Occlusion group, it was used primarily for diagnosis. In the majority of our cases it was diagnostic and in the remainder it supported or confirmed the diagnosis. One expects the electrocardiogram to be abnormal after a coronary occlusion and must be prepared to accept electrocardiographic abnormalities as part of the impairment. Our experience did not show convincing evidence that a return to normal would justify an underwriting credit.

In the formation of the Angina Pectoris group, the electrocardiogram played a distinctly minor role. A few cases, in which the symptoms were not characteristic, were qualified for entry by electrocardiographic signs of coronary insufficiency after an exercise test. Except for this, the electrocardiogram was never diagnostic, was often normal, and at best provided supportive evidence. Nearly all the cases were qualified on symptoms alone, a normal electrocardiogram being no deterrent. The experience did indicate, however, that those with electrocardiographic abnormalities had both a higher mortality and a greater incidence of subsequent coronary occlusion than those with normal electrocardiograms, so that in this group a differential in rating based on electrocardiographic findings seems to be justified.

In the Suspected Coronary Disease group, the electrocardiogram occupied a middle ground. When atypical chest pain was the question, the electrocardiogram was usually the deciding factor, qualifying the case if abnormal and disqualifying it if normal unless the symptoms were exceptionally suspicious. In this group the electrocardiogram was never specific for coronary disease, but in a number of cases it furnished evidence of a conduction defect, an arrhythmia, or some other condition so strongly presumptive of arteriosclerotic heart disease as to qualify these cases, whether or not symptoms were present. Our experience suggests that ratings should vary according to the electrocardiographic findings, but that much depends also on how suspicious the symptoms are. From an underwriting standpoint, this group is the least definite and the most complicated and troublesome of the three.

DISCUSSION OF PRECEDING PAPER

EDWARD A. LEW:

I want to congratulate Miss Lyle on a fine piece of research in a very important area of medical investigation where more accurate data are urgently needed. The importance of the subject is underscored by the fact that there are about five million persons in the United States suffering from heart disease, the majority of them from coronary disease. The most significant factors affecting prognosis in this disease are still not well understood. I hope that others will be prompted by Miss Lyle's shining example to undertake similar research projects.

Miss Lyle has traced the mortality of some seven hundred Prudential home-office employees over a period of nearly thirty years, separately for those (*a*) with well-documented coronary occlusion, (*b*) with angina pectoris, and (*c*) with suspected coronary disease. She has compared the results with those for a suitably chosen control group and analyzed them by age at onset, duration, past history, associated impairments, effect of a waiting period, and in other ways. I attach great weight to Miss Lyle's findings and judgment because she had available detailed clinical and laboratory data, has a thorough understanding of the medical aspects of the problem, and has handled the material with rare actuarial acumen. I am particularly impressed with her findings as to the over-all level of mortality in each of the categories she studied, the markedly adverse effect on mortality of associated hypertension, other cardiovascular-renal impairments, and diabetes, and the relatively minor effect of lengthening the waiting period in the case of recent histories of coronary occlusion.

We could not match Miss Lyle's study point by point, but we were able to assemble data from two sources and thus obtain information which may supplement hers. Our information relates to the experience among (1) male Metropolitan employees (predominantly from the home office but including also a small proportion of outside nonagency employees reporting through the home office) to whom either disability or hospital benefits were allowed on account of a heart attack under the company's Group Health Insurance program, and (2) male Metropolitan ordinary policyholders with total and permanent disability benefits who had recovered from disability due to a heart attack.

Metropolitan Home-Office Employees Insured under Group Health Insurance Program Who Submitted Claims for a Heart Attack

This experience covers predominantly male Metropolitan home-office employees through age 65, the normal retirement age, who were hospitalized or disabled by a heart ailment between 1953 and 1962 and who survived at least 60 days after the episode. They were traced to July 1, 1963.

The medical information on our claim papers was limited in scope. It was often a mere statement of the diagnosis, without any details, by the attending physician. Clinical and laboratory data, including electrocardiograms, were not available to confirm the diagnosis. In a great many cases we knew only that the claimant had had a heart attack. Since there was good reason to assume that these were usually coronary attacks, we included all cardiac cases other than those where the diagnosis indicated an etiology not consistent with coronary disease, as, for example, rheumatic and hypertensive heart disease. We did segregate for separate analysis those cases in which the diagnosis was stated to be coronary occlusion or myocardial infarction. The residual group consisted of cases with diagnoses such as arteriosclerotic heart disease, coronary insufficiency, angina pectoris, or coronary occlusion qualified as "probable" or "possible." Furthermore, we segregated those groups for which information about medical history prior to attack could be obtained either from disability claim papers or from records in the Medical Division at the home office. In addition, we studied separately the experience for males on the clerical and on the building maintenance staff of our home office (i.e., excluding certain outside male nonagency employees reporting through the home office) for whom we had records of periodic examinations, including electrocardiograms, or other supplementary medical information. The male home-office employees constitute a more homogeneous group for whom we have comprehensive information. The results for these men, who account for the great majority of the total, did not differ markedly from the total experience. No separate comment will be made on them, but the pertinent data are given in the tables.

This Metropolitan experience is of relatively short average duration—only 4.13 years for the entire cohort consisting of 215 cases. We have compared the mortality in this experience with both the select and the ultimate sections of the 1955–1960 Intercompany Male Table and with the ultimate section of the 1946–1949 Basic Mortality Table. In the latter case we made computations both with and without the 78 per cent adjustment to expected deaths which Miss Lyle used in her analysis. The

1955–1960 Intercompany Male Table is fairly contemporaneous with the experience on our cardiac cases. Computations of mortality ratios on that table are, therefore, more meaningful than those on the earlier intercompany table. The mortality ratios on the select 1955–1960 Intercompany Male Table provide a measure of the relative mortality of our cardiac cases compared with lives newly insured under standard ordinary policies, while those on the ultimate 1955–1960 Intercompany Male Table indicate the relative mortality of our cardiac cases compared with lives to whom standard ordinary policies were issued some years ago.

Incidentally, our "immediate" mortality, comprising the deaths within 60 days after onset, was 36 per cent, based upon 121 deaths. This ratio is quite close to the 34 per cent reported by Miss Lyle for the Prudential's experience.

Of the entire 215 cases in our experience, 36 died by July 1, 1963. The observed mortality was three times the expected on the 1955–1960 Intercompany Male Table and 2.75 times the expected on the 1946–1949 Basic Mortality Table (unadjusted). The ratios for ages under 50 at onset were significantly higher than those for older men—4.75 and 2.75 times the expected, respectively, on the 1955–1960 Intercompany Male Table. The mortality *rate*, however, was higher among the older men than among the younger. All but two of the deaths were attributed to heart disease (see Table 1).

Of the 97 cases in this experience in which there was a specific diagnosis of coronary occlusion or myocardial infarction, 23 had died up to the end of the follow-up period, 22 of the deaths being ascribed to heart disease. The mortality ratio for the experience on these 97 cases was significantly higher than that for the entire experience—four times the expected on the 1955–1960 Intercompany Male Table, compared with only three times the expected for the entire experience. This difference, however, is accounted for largely by the cases with onset under age 50, among whom the mortality experienced was about ten times the expected on the 1955–1960 Intercompany Male Table. Among men 50–65 years of age the mortality ratio was about three times the expected on that table.

Among the 118 cases where there was no mention of occlusion at onset, the mortality ratio was lower than those with occlusion. This reflects the very favorable experience among 37 cases under age 50 at onset, none of whom had died up to the end of the follow-up period. The mortality ratio among men aged 50 and over at onset was moderately lower than that for the corresponding group with occlusion. The ratios were 2.6 and 2.9 times the expected, respectively, by the 1955–1960 Intercompany Male Table (see Table 2).

Cases with definite coronary occlusion which we could identify as being first attacks were tabulated separately (Table 3). There were 85 such cases, with 18 deaths. The mortality ratio in this group was 4.33 times the expected by the 1955–1960 Intercompany Male Table, or slightly higher than the ratio for all cases with definite coronary occlusion. This difference is accounted for primarily by a slightly poorer experience on

TABLE 1

MALE METROPOLITAN HOME-OFFICE EMPLOYEES WHO SUBMITTED CLAIMS FOR A HEART ATTACK*

(Disabilities of 1952–63 Traced to July 1, 1963)

AGE AT ONSET	TOTAL CASES	ACTUAL DEATHS	RATIO ACTUAL TO EXPECTED DEATHS				CARDIAC DEATHS
			1955–60 Male		1946–49 Basic		
			Select	Ultimate	Ultimate	Adjusted†	
	All Employees‡						
All ages...	215	36	580%	310%	270%	347%	35
Under 50..	69	9	746	482	431	553	9
50–65.....	146	27	540	277	241	308	26
	Home-Office Clerical and Building Personnel Only						
All ages...	176	32	599%	321%	280%	359%	31
Under 50..	54	8	872	570	510	653	8
50–65.....	122	24	543	280	244	312	23

* Includes cases with unknown etiology but excludes those with known noncoronary etiology.

† Using 78 per cent of the 1946–1949 Basic Ultimate expected deaths.

‡ Includes small number of outside nonagency employees reporting through home office.

cases with first attack at ages 50–65. Again the mortality ratio among cases with onset at ages under 50 was substantially higher than that for cases with onset at older ages.

We also analyzed the experience on cases with a first coronary occlusion, according to time elapsed since attack. The experience is rather scanty when subdivided but suggests a downward trend in the mortality ratios with increase in the time elapsed since attack.

In line with Miss Lyle's analysis of the effect on mortality of lengthening the "waiting period" following attack, we computed mortality ratios for periods excluding the experience in the first year, then excluding the experience within two years after attack, in both instances eliminating cases with recurrences within those periods. The mortality ratio with the first year excluded was 3.75 times the expected by the 1955–1960 Intercompany Male Table. With the first two years excluded, the mortality ratio fell to 2.75 times the expected, but this figure is based on only 6 deaths (see Table 4).

TABLE 2

MALE METROPOLITAN HOME-OFFICE EMPLOYEES WHO SUBMITTED CLAIMS FOR A HEART ATTACK*

(Cases with and without Definite Diagnosis of Coronary Occlusion; Disabilities of 1953–62 Traced to July 1, 1963)

Diagnosis and Age at Onset	Total Cases	Actual Deaths	Ratio Actual to Expected Deaths				Cardiac Deaths
			1955–60 Male		1946–49 Basic		
			Select	Ultimate	Ultimate	Adjusted†	
	All Employees‡						
With occlusion:							
All ages	97	23	744%	405%	353%	453%	22
Under 50	32	9	1,538	979	880	1,128	9
50–65	65	14	559	294	255	327	13
	Home-Office Clerical and Building Personnel Only						
All ages	86	22	769%	420%	366%	469%	21
Under 50	27	8	1,507	966	867	1,111	8
50–65	59	14	601	317	275	353	13
	All Employees‡						
Without occlusion:							
All ages	118	13	417%	219%	191%	245%	12
Under 50	37	......	......	......	......	......	......
50–65	81	13	521	261	227	291	12
	Home-Office Clerical and Building Personnel Only						
All ages	90	10	404%	212%	185%	237%	9
Under 50	27	......	......	......	......	......	......
50–65	63	10	478	241	210	269	9

* Includes cases with unknown etiology but excludes those with known noncoronary etiology.

† Using 78 per cent of the 1946–1949 Basic Ultimate expected deaths.

‡ Includes small number of outside nonagency employees reporting through home office.

TABLE 3

MALE METROPOLITAN HOME-OFFICE EMPLOYEES WHO SUBMITTED CLAIMS FOR A HEART ATTACK*

(Cases with Definite Diagnosis of Coronary Occlusion Identified as a First Attack; Disabilities of 1953–62 Traced to July 1, 1963)

Age at Onset	Total Cases	Actual Deaths	Ratio Actual to Expected Deaths: 1955–60 Male, Select	Ratio Actual to Expected Deaths: 1955–60 Male, Ultimate	Ratio Actual to Expected Deaths: 1946–49 Basic, Ultimate	Ratio Actual to Expected Deaths: 1946–49 Basic, Adjusted†	Cardiac Deaths
	All Employees‡						
All ages....	85	18	821%	431%	375%	481%	18
Under 50...	30	8	1,457	921	828	1,061	8
50–65......	55	10	600	303	261	335	10
	Home-Office Clerical and Building Personnel Only						
All ages....	74	17	856%	454%	396%	508%	17
Under 50...	25	7	1,414	899	808	1,036	7
50–65......	49	10	670	337	292	374	10

* Includes cases with unknown etiology but excludes those with known noncoronary etiology.
† Using 78 per cent of the 1946–1949 Basic Ultimate expected deaths.
‡ Includes small number of outside nonagency employees reporting through home office.

TABLE 4

MALE METROPOLITAN HOME-OFFICE EMPLOYEES WHO SUBMITTED CLAIMS FOR A HEART ATTACK*

(Cases with a First Occlusion [1] by Duration since Attack and [2] Experience Exclusive of the First and Second Years without Recurrence; Disabilities of 1953–62 Traced to July 1, 1963)

Duration since Attack	Total Cases†	Actual Deaths	Ratio Actual to Expected Deaths: 1955–60 Male, Select	Ratio Actual to Expected Deaths: 1955–60 Male, Ultimate	Ratio Actual to Expected Deaths: 1946–49 Basic, Ultimate	Ratio Actual to Expected Deaths: 1946–49 Basic, Adjusted‡	Cardiac Deaths
First year..............	85	5	1,873%	560%	485%	621%	5
Second year............	79	4	1,047	472	410	525	4
Third and fourth years..	62	5	810	465	407	521	5
Fifth and later.........	33	4	421	269	237	303	4
Experience excluding							
First year............	73	12	661%	381%	332%	427%	12
First two years.......	49	6	442	275	241	309	6

* Includes cases with unknown etiology but excludes those with known noncoronary etiology.
† Includes small number of outside nonagency employees reporting through home office.
‡ Using 78 per cent of the 1946–1949 Basic Ultimate expected deaths.

Metropolitan Ordinary Policyholders with Disability Benefits Who Recovered from Disability

The second experience covers 537 males insured under ordinary policies between 1925 and 1949 with total and permanent disability income or disability waiver benefits who had become disabled due to arteriosclerotic heart disease but who had recovered during that period. The term "recovery" as used here means simply that payment of disability benefits was terminated when the policyholder resumed work of some kind or showed ability to do so. The great majority of the cases were probably in relatively good health and able to resume normal or near-normal activity. Some, however, may have been pressed by need or desire to get back to remunerative employment and did so, even though this may not have been advisable from a medical viewpoint. The results of a follow-up of these cases through 1952 were reported by Robb and Marks in 1953.[1] This experience updated to 1962 anniversaries is presented here. Robb and Marks had subdivided this experience into cases with and without a record of coronary occlusion at admission to disability or during the disability period, based on information available to them. Each group was then further subdivided according to the reported presence or absence of hypertension, questionable cases being grouped with the latter. Of the original total, of 537 men included in the study, 324 had died up to August 1, 1963.

Survivorship tables for 20 years were constructed for the four groups, the experience beyond the twentieth year being too sparse. The most favorable survivorship record was on cases without occlusion and no known hypertension, and least favorable on cases with occlusion complicated by hypertension. Thus, at the fifth anniversary the survivorship rate in the group with occlusion complicated by hypertension was 73 per cent as compared with approximately 80 per cent in the other three groups. At the tenth anniversary the survivorship rate in the former group was only 45 per cent as compared with 71 per cent in those without occlusion or hypertension; for the other two groups the survivorship was about halfway between these extremes. At the twentieth anniversary the survivorship rate in the occlusion-hypertension group was only 8 per cent as compared with 30 per cent or more in the other groups (see Table 5).

The survivorship record was analyzed further by age groups (40–49 and 50 and over) and for two broad categories—men with and those without a record of occlusion (Table 5). In the group with coronary occlusion the

[1] For full details on these cases see G. P. Robb and H. H. Marks, "What Happens to Men Disabled by Heart Disease," *Transactions of the Association of Life Insurance Medical Directors of America*, XXXVII (1953), 171.

survivorship record for the younger men was somewhat poorer than for the men aged 50 and over. The survivorship ratio at the fifth anniversary was 76 per cent for the younger men as against 81 per cent for the older men; at the tenth anniversary the ratios were 49 per cent and 60 per cent, respectively; and at the twentieth anniversary, 26 per cent and 31 per cent, respectively. In the group without occlusion the small experience on the younger men was better than that for the older men. When comparison is made by age for men with and without occlusion, the record among the younger men was distinctly better on cases without coronary occlusion, whereas for men aged 50 and over at recovery, there was no significant difference as between those with and without occlusion (see Table 6).

TABLE 5

SURVIVORSHIP RATES (PER CENT) OF MALE METROPOLITAN ORDINARY POLICYHOLDERS RECOVERED FROM DISABILITIES DUE TO ARTERIOSCLEROTIC HEART DISEASE

(At Specified Anniversaries of Recovery; Disabilities of 1925–49 Traced to 1962 Anniversaries)

Anniversary	With Occlusion		Without Occlusion	
	Hypertension Absent or Unknown	Hypertension Present	Hypertension Absent or Unknown	Hypertension Present
1	96%	97%	99%	97%
2	92	92	91	94
3	88	81	91	91
4	84	73	87	82
5	80	73	81	79
10	57	45	71	61
15	40	25	58	43
20	32	8	36	30
No. of deaths to twentieth year	207	45	34	20
No. of cases	357	63	81	36

We computed ratios of actual to expected mortality for this experience, using as the standard of expected deaths an adaptation of the intercompany experience at durations 16 years and over during the period 1939 to 1950. (An ultimate table is clearly more appropriate as a basis of expected mortality for this experience because the lives involved had for the most part been insured some years when disability occurred.) Mortality ratios were calculated, however, only for the subdivisions with and without a record of coronary occlusion. The mortality ratio for the total experience, limited to durations through the twentieth year, was 290 per cent, based upon 306 deaths. Among men with no record of occlusion the corresponding ratio was 227 per cent, as compared with 308 per cent for

TABLE 6

SURVIVORSHIP RATES (PER CENT) OF MALE METROPOLITAN ORDINARY POLICYHOLDERS RECOVERED FROM DISABILITY DUE TO ARTERIOSCLEROTIC HEART DISEASE

(At Specified Anniversaries of Recovery and by Age Groups at Recovery; Disabilities of 1925–49 Traced to 1962 Anniversaries)

Anniversary	With Occlusion		Without Occlusion	
	Ages 40 to 49	Ages 50 and Over	Ages 40 to 49	Ages 50 and Over
1	96%	96%	98%	99%
2	94	91	91	93
3	88	87	88	93
4	83	83	86	85
5	76	81	81	79
10	49	60	73	64
15	39	42	63	46
20	26	31	49	24
No. of deaths to twentieth year	99	139	17	37
No. of cases	151	245	44	70

men with occlusion. Among men without occlusion the mortality ratio drops sharply after the fifth year and remains fairly steady thereafter at approximately double the expected mortality. Among men with occlusion the mortality ratio is nearly four times the expected through the tenth year but then drops sharply and in the small experience from the sixteenth year onward is about the same as among men without occlusion (see Table 7).

The mortality ratios are markedly higher for men under age 50 at recovery than for those 50 and over. The disparity is particularly marked for men with a record of occlusion. In the small experience on men under

TABLE 7

MORTALITY EXPERIENCE AMONG MALE METROPOLITAN ORDINARY POLICYHOLDERS RECOVERED FROM DISABILITY DUE TO ARTERIOSCLEROTIC HEART DISEASE

(Disabilities of 1925–49 Traced to 1962 Anniversaries; Expected Deaths Based on Special Table 1939–50)

Duration	Age at Recovery					
	All Ages (20 and Over)		40–49		50 and Over	
	Actual Deaths	Ratio Actual to Expected Deaths	Actual Deaths	Ratio Actual to Expected Deaths	Actual Deaths	Ratio Actual to Expected Deaths
	Total Arteriosclerotic Heart Disease					
1–20	306	290%	116	529%	176	213%
1–5	111	373	44	765	60	253
6–10	105	338	44	737	58	233
11–15	64	213	18	285	43	184
16–20	26	177	10	257	15	142
	Without Coronary Occlusion					
1–20	54	227%	17	287%	37	208%
1–5	22	335	8	624	14	266
6–10	12	183	3	211	9	176
11–15	13	191	4	223	9	180
16–20	7	180	2	141	5	203
	With Coronary Occlusion					
1–20	252	308%	99	618%	139	215%
1–5	89	384	36	805	46	250
6–10	93	379	41	902	49	248
11–15	51	220	14	310	34	185
16–20	19	176	8	323	10	123

40 with coronary occlusion, the mortality was thirteen times the expected, based on 14 deaths. In the even smaller experience among men without a record of occlusion, no deaths had occurred up to the end of the follow-up period.

Among men aged 40–49 with a record of coronary occlusion, the mortality in the first ten years after recovery was eight times the expected. Thereafter the mortality dropped to a level approximately three times the expected. Among men aged 50 or more at time of recovery the over-all mortality during the twenty years following recovery was somewhat over twice the expected. During the first ten years after recovery, the mortality was approximately two and a half times the expected but dropped thereafter.

About five-sixths of all the deaths in this experience were ascribed to heart disease and in the great majority death was specifically certified as due to coronary disease.

Comment

Despite the fact that the medical information available to us was much less detailed and probably less accurate than in the Prudential's study, the results from the two Metropolitan experiences are generally in accord with those reported by Miss Lyle and support her conclusions.

The principal disparity between the studies is in the relative mortality by age. In the two Metropolitan experiences the mortality ratios were much higher at ages under 50 than at ages 50 and over. The level of the Metropolitan mortality ratios at ages 50 and over was significantly lower than in the Prudential's experience. In my judgment much of the disparity in the mortality ratios by age reflects merely the different mortality standards used. The over-all levels of mortality (all ages combined) appear to be reasonably consistent.

Both Miss Lyle's experience and our own indicate that (1) applicants with a history of coronary disease who also have hypertension or certain other cardiovascular-renal impairments are uninsurable and (2) even as early as three months after recovery, carefully selected applicants with a history of coronary disease may be considered for insurance at a substantial extra premium. They must be free of other impairments and have definitely resumed regular work without encountering any difficulty.

These are two of the rules we have been following at the Metropolitan in underwriting applicants with a history of coronary disease.

COURTLAND C. SMITH:

I found Miss Lyle's paper both interesting and informative. Studies of this kind are based on small numbers, but skill in manipulating data can make the results tremendously useful to companies prepared to underwrite highly substandard risks.

An important observation made by the author is that a waiting period is not necessarily helpful, once the initial period of high fatality following occlusion is past. As a matter of fact, these data would indicate that an applicant for insurance who has survived at least 60 days after an attack, and who has no associated impairments, could be accepted after no waiting period with no worse results than after a one, two, or three-year waiting period.

In any event, the extra mortality would seem to be adequately covered by a rating of 300 to 400 per cent, plus an annual extra of $30 to $40 a thousand payable to the fifth anniversary of the attack. While the ratings and extras agree with current practice in my own and some other companies, the finding as to waiting period suggests that we are now overly conservative.

However, I think that we should keep in mind that the typical applicant for insurance may be considerably less candid than the home-office employees whose periodic examination records were used in this study. Furthermore, I believe we should give some weight to any informed clinical opinion that holds that a 6- or 12-month waiting period after recovery from disability is needed to enable the medical director to determine if a stable postcoronary adjustment has been made.

Underwriting coronary cases is still experimental, and current approaches are subject to modification as experience accumulates. I should like to thank Miss Lyle and the Prudential for providing us with a valuable increment to our knowledge in this area.

ROBERT E. BEARD:

I would first like to say how much I enjoyed reading Miss Lyle's paper and the valuable results presented. Two points occurred to me, and I hope they will not be regarded as criticisms; they are also implicit in Mr. Lew's remarks. While this paper is written from the point of view of an underwriting approach, it nevertheless is a contribution to medical statistical research. The classical method of looking at mortality as a percentage of standard provides only part of the picture and in some circumstances can be quite misleading. For example, if the extra mortality is constant for each age, it must, of course, be a substantially decreasing percentage of standard when regarded by age.

This problem recently arose in the United Kingdom in an investigation which is being made in regard to the mortality of diabetics in which a group of actuaries have been co-operating with the hospital authorities in Birmingham. A reasonably closed population of rather more than 6,000 cases have been traced over a period of fifteen years or so, and, with the co-operation of the General Registrar's office, the deaths among them are now being actively classified according to cause of death. It is hoped that this work will be completed some time next year.

The preliminary figures were first analyzed in the classical form of mortality percentages to various standards, and the first impressions showed a decreasing percentage with age. But, on more careful study, they showed that a significant part of the extra mortality was essentially constant in regard to age.

The point becomes of importance if mortality is being studied according to specific causes and an endeavor is being made to look at the structure of mortality as a physical process, since the structural models are quite different.

ALTON P. MORTON:

I think the possible special merit of Miss Lyle's study is that we had sufficient records in the Prudential about these cases so that we could use today's ideas and knowledge as to useful classifications of underwriting usefulness. We could thus measure the mortality results for classes which would show almost directly practical extra premium charges for current underwriting use.

I wanted to comment also on the limitations of any data that may be developed from a life insurance company's files on lives insured over a period of years. During the years that the data are accumulating, our knowledge of underwriting is changing. Medical methods, too, are undergoing continuous change in the areas both of diagnosis and of treatment, so that the mortality data yielded by our company records will never directly predict what we may expect in the future from underwriting standards being used today. There is a good deal of adaptation required before we can use any such data.

That is one reason—although I am not offering apologies for the Committee on Mortality (such apologies, I believe, are not needed)—why a good deal more in the way of mortality studies from insurance data has not been scheduled to reflect experience accumulated over the past thirty years or more.

(AUTHOR'S REVIEW OF DISCUSSION)

ANNIE MARY LYLE:

Mr. Lew has added greatly to the value of this paper by presenting the Metropolitan's experience for comparison with the Prudential's. This is an impairment on which it is difficult for one source to assemble more than a small group of cases. In the early stages of investigation, when the significant characteristics are being probed for, it is valuable to study many small groups independently. Each confirms and is confirmed by the others—or fails to confirm and be confirmed. Several small groups, studied separately, that confirm one another are more convincing than one somewhat larger but still modest group equal in size to their sum, although the mathematical theories of probable error may try to tell us otherwise. On the other hand, small groups studied separately might well show differences arousing doubts and uncertainties that would be lost if the several groups were combined in a joint venture to make a group of more respectable size.

Mr. Morton has brought out a point to be considered carefully in making any mortality investigation, namely, that old judgments may have become obsolete as a result of advances in clinical medicine and the development of our own skills. Over the thirty years that we have been using electrocardiograms at the Prudential, we have learned a great deal about them. Some of our interpretations in the past would not be our interpretations today. This applies not only to the recognition of diagnostic patterns but to some of the purely descriptive findings as well. No one pays much attention anymore to how deep Q waves in the standard leads are in comparison with the R waves to which they are coupled. These Q waves are now studied primarily in the unipolar extremity leads, rather than in the standard leads, and then not their depth alone but also their width and contour. There was a time when T waves were considered low only if they measured less than 1 millimeter. Now we consider them low if they appear low in comparison with the QRS complexes, so that a T wave exceeding 1 millimeter may be considered abnormally low if the R wave is tall, and a T wave that is isoelectric may be normal if the R wave is small. In each study that I make I find it necessary to review every electrocardiogram and appraise it in the light of what we know—or think we know—today. In any intercompany study of electrocardiographic findings that may be made in the future, I believe all electrocardiograms would have to be reviewed and classified anew according to the categories then believed to be most valid for statistical and underwriting purposes.

Mr. Beard has called to our attention a point to which I, for one, had never given much thought, although it involves nothing that we did not already know, namely, a difference in the requirements of statistical studies for underwriting purposes and for public health or clinical medicine.

To take a fresh look at ourselves, when we study an impairment statistically, we compare the deaths from all causes in the impaired group with the deaths that would be expected among a group of standard lives identical in number, age, and duration, thus obtaining what we call "mortality ratios." This is done in pursuit of our unique objective of expressing the risk in dollars and cents. In my experience, this method is not understood by medical men outside the insurance industry, nor does the information so obtained meet their requirements.

A public health official may wish to know the number of deaths from a given disease per 100,000 population, that is, the mortality rate. A clinician may wish to know how many deaths there are likely to be from a given disease among people who have the disease, that is, the fatality rate. In these instances, neither is particularly interested in the deaths from unrelated causes. On some diseases, such as cancer, they may wish to know the five- or ten-year survival rates.

TABLE 1

Duration	No. of Entrants	Actual Deaths	Deaths per 1,000 Entrants	Mortality Ratios
	From Table 12—Coronary Occlusion Only			
1st–5th years.....	136	24	176	841%
6th–10th years....	72	17	236	619
11th year on......	34	10	294	222
	From Table 6—All Associated Impairments Included			
1st–5th years.....	266	70	263	1,195%
6th–10th years....	138	35	254	704
11th year on......	54	21	389	344

Mr. Beard has pointed out that the insurance method introduces some distortion from a strictly medical viewpoint. He cites a study of diabetes made in the United Kingdom in which the mortality ratios decreased with age, while a significant part of the extra mortality was essentially constant by age.

This may be true of duration as well as age. As a result of insurance studies, we regard coronary occlusion as an impairment on which the risk decreases with time elapsed since the acute attack. But the calculations in Table 1 show that the deaths from all causes per 1,000 entrants with coronary occlusion only (from our Table 12) and per 1,000 entrants with all associated impairments included (from our Table 6) either remain constant or rise during successive periods after the attack, while the mortality ratios continue to fall.