Longevity of Diabetic Patients in Recent Years

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SUMMARY

A virtually complete follow-up of diabetic patients treated at the Joslin Clinic since 1930 shows a downward trend in the mortality and corresponding improvement in the survivorship record. The mortality rates of diabetics, however, remain higher than those in the general population; the excess is relatively greatest at ages twenty-five to thirty-four and least in older patients.

The death rates among diabetic females tend to be lower than among diabetic males, but the difference is less than in the general population.

The survivorship rate among cases seen within a year of onset of the disease is better than in the aggregate experience.

The pattern of causes of death among diabetics has changed radically. There has been a marked increase in the proportion of deaths caused by vascular disease, with small vessel disease playing a more and more important role. Reductions have been recorded for diabetic coma, diabetic gangrene and infections.

Analysis of causes of death by age at onset and duration of diabetes show the effect of these factors on mortality and, in particular, the outstanding importance of diabetic nephropathy in juvenile diabetics with long duration of disease.

Mortality from all types of vascular disorders is higher in diabetics than in the general population. In this experience the mortality for renal vascular disorders was seventeen times as high as in the general population.

The facts that we are privileged to report on this subject are the results of a long and fruitful collaboration of the Joslin Clinic and the Metropolitan Life Insurance Company. Primary credit for this work is due to the late Elliott P. Joslin who had the firm conviction that the results of treatment could only be known if one ascertained what happened to patients over the long term. Accordingly, he inaugurated a periodic follow-up of all patients, and nothing short of virtually complete follow-up satisfied him. It required prodigious labor and devotion, but he persisted in it to the end of his life. As a result the experience of the Joslin group provides a body of data, almost unique in clinical medicine, from which it is possible to trace the progress of the treatment of diabetes since the beginning of the century.

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METHODS

This paper is necessarily limited to some of the major findings of our mortality studies based upon the records of these patients. The information available makes it possible to analyze the records by standard actuarial and statistical methods and to make reliable internal comparisons of the mortality rates and of the causes of death. Suitable comparisons along the same lines can be made of the diabetic experience with data for the general population.

The basic measure we have used in the analysis of the data is the mortality rate—the number of deaths related to this diabetic population, expressed as rates per thousand on an annual basis. This underlies another major set of computations—the survivorship rate over various periods of time. In these sets of computations, deaths occurring within a week of first visit or hospitalization have been excluded.

A major factor influencing the results is the change in the character of the group of patients treated at the Joslin Clinic. With the passage of time, an increasing proportion of the patients, at the time of initial visit to the Clinic, have had the disease for many years and have already developed serious complications. Obviously this would tend to offset or reduce the effect of improvement in management of the disease on the mortality experience.

The primary data presented cover the experience on patients first observed at the Clinic in 1930 or later. They are based upon 17,654 cases which represents a 50 per cent sample; half of them were traced to the beginning of 1960 and the remainder to the beginning of 1961. The follow-up of these cases was virtually complete, 98.8 per cent being traced to the closing date.

TABLE 1

Death rates per 1,000 among diabetic patients. Comparison between cases first seen in 1930-39, 1940-49 and 1950-58, within a decade after first visit. By age and sex (experience of the Joslin Clinic, Boston, Massachusetts)

Attained age (years)	Males			Females		
	1930-39	1940-49	1950-58	1930-39	1940-49	1950-58
5-14	7.7†	1.3*	0.9*	6.7†	5.2†	0.8*
15-24	12.5	6.5†	5.4†	11.2	5.7†	0.8*
25-34	12.0	10.9	10.3†	14.8	10.1	15.3
35-44	20.0	16.4	16.1	10.8	11.0	10.4†
45-54	28.5	23.1	21.5	28.5	19.9	18.2
55-64	57.3	49.6	44.9	51.8	42.3	35.7
65-74	100.3	85.1	84.8	89.4	78.3	85.8

*Based on less than five deaths.
†Based on five to nineteen deaths.
NOTE: Excludes deaths within one week of first observation or hospital discharge.

RESULTS

a. Mortality rates

Table 1 shows the death rates according to attained age for the experience within the decade following first visit for new patients of successive calendar year periods 1930-39, 1940-49, and 1950-58. These figures show not only the level of the death rates by age, but also the change that has occurred in the interval. They reveal significant improvement in the mortality record of diabetic patients. For example, at ages forty-five to fifty-four, which is fairly typical of the experience among adults, the death rate among men first seen in 1950-58 was 21.5 in the decade following first visit as against 28.5 in patients of the 1930's. In virtually all age groups and in both sexes, the death rates of patients of recent years have been below the corresponding figures for those of 1930-39 and in most cases the difference is substantial.

Despite the decline in mortality among the diabetics, their death rates at every age and in both sexes are still much higher than in the general population. Comparisons were made on the basis of the most suitable available mortality tables and, consequently, they should be considered as only approximate. The rates for the diabetics are seen to be consistently the higher, as shown in table 2. It may be noted, furthermore, that the rates for the females tend to be lower than those for males, although not consistently so. The sex differential in the rates, however, is less than in the general population. Thus, the ratios of the death rates for diabetics to those for the general population are appreciably higher for females than for males. This ratio reaches a peak between ages twenty-five and thirty-four in both sexes and declines thereafter with age.

In view of the interest in the acceptability of diabetics for life insurance, an additional comparison has been made in table 3 of the recent experience in which the mortality of the diabetics has been compared with that of standard insured risks. The age grouping is somewhat different from that in the preceding table. For reference purposes the corresponding ratios of mortality of diabetics to that for the general population are also shown. Since the mortality among standard insurance risks is lower than the general population, the mortality ratios based upon them are distinctly less favorable than those based upon general population mortality. The mortality ratios for female diabetics to that for female standard risks are consistently higher than the corresponding ratios for males. In both sexes the ratios are extremely high at ages under forty but decline progressively with advance in age, but even at ages over fifty the mortality of the diabetic males was about three times as high as among standard insured male risks and, for diabetic females, about four times

TABLE 2

Mortality of diabetic patients of the Joslin Clinic first seen in 1950-58 and traced to Jan. 1, 1961 (compared with general population mortality,* by age and sex)

Attained age (years)	Death rates per 1,000				Ratio diabetics to general population Death rate	
	Diabetics		General population			
	Males	Females	Males	Females	Males	Females
5-14	0.9†	0.8†	0.5	0.3	1.8	2.7
15-24	5.4‡	0.8†	1.2	0.6	4.5	1.3
25-34	10.3‡	15.3	1.4	1.1	7.4	13.9
35-44	16.1	10.4‡	3.7	2.3	4.4	4.5
45-54	21.5	18.2	10.3	5.8	2.1	3.1
55-64	44.9	35.7	24.7	14.6	1.8	2.4
65-74	84.8	85.5	53.0	35.7	1.6	2.4

*White persons in New England, 1949-51.
†Based on less than five deaths.
‡Based on five to nineteen deaths.

TABLE 3

Mortality of diabetic patients of the Joslin Clinic examined since 1950 (compared with persons accepted for standard insurance and with persons in the general population)

Attained age (years)	Ratio of death rate* of diabetics to that of:			
	Standard insured risks	General population	Standard insured risks	General population
	Males		Females	
20-29	8.1	6.9	9.3	8.8
30-39	9.7	6.7	16.0	9.5
40-49	4.7	3.1	5.8	3.8
50-59	2.8	1.8	4.2	2.9
60-74	3.0	1.7	4.0	2.4

*Bases of comparison: Insured persons—1946-49 Select Basic Table, with suitable adjustment for female mortality. General population—mortality among white persons in New England, 1949-51.

as high as among insured females.

b. Survivorship ratios

Survivorship ratios have been computed by age groups at examination on the basis of the observed mortality rates at successive anniversaries from admission for patients first observed at the Joslin Clinic in 1930-39, 1940-49, and 1950-58. These data relate to total persons. In table 4 are shown the proportion surviving at the tenth anniversary for each of these calendar year groups and at the twentieth anniversary for the two earlier categories. Among juveniles in the most recent group there were only two deaths during the period of observation in a rather substantial experience, yielding a survivorship rate of 99.6 per cent at the tenth anniversary. Naturally, the proportion surviving diminishes with increase in age. Nevertheless, the ten-year survivorship rate was as high as 90 per cent for those fifteen to twenty-nine years old and even exceeds 70 per cent for those forty-five to fifty-nine years. The ten-year survivorship rates are appreciably higher for patients of the 1940's and of the 1950's than for those of the 1930's.

TABLE 4

Percentage of diabetics surviving ten and twenty years from first visit (experience of Joslin Clinic on patients examined 1930-58, traced to 1961)

Age at examination	Per cent surviving 10 Yrs. Years of examination 1950-58	1940-49	1930-39	20 Yrs. 1940-49	1930-39
Under 15	99.6*	95.6	91.1	84.2	79.8
15-29	90.1	91.9	87.7	73.2	70.3
30-44	84.0	86.3	81.6	61.5	61.6
45-59	71.2	67.6	63.1	29.2	29.0
60-74	40.7	40.8	34.1	7.7	5.6
75+	15.5	13.3	13.8	—	—

*Only two deaths.

The longer term comparisons for the twenty-year survivorship show a rate as high as nearly 85 per cent for juvenile patients of the 1940's and also a generally better record according to age for patients of the 1940's as compared with those first observed a decade earlier.

Duration of diabetes has an appreciable effect on longevity of patients but this effect is very difficult to measure. Some indication, however, is given by a comparison of the survivorship of patients in whom the onset was judged to be within a year of initial observation with that of all cases. Table 5 shows such comparisons as of the tenth year after observation for cases first seen in the successive calendar year periods 1930-39, 1940-49, and 1950-58, and as of the twentieth year for the two earlier groups. It is clear that cases seen within a year of onset fared much better than the general run of cases. Our data show, moreover, steady and substantial improvement in all age groups in the survivorship rates of first-year cases when the patients of the later periods are compared with those of earlier periods.

C. Causes of death

Related to these trends in the mortality among diabetics from all causes are significant changes in the specific causes of death. Table 6 gives the experience in successive periods since 1922 when insulin first came into use. The data of the table relate to all deaths reported over this forty-year span up to April 28, 1962. Diabetic coma which, even in the early years after insulin was responsible for one death out of every seven, now is the primary cause in only 1 per cent of the deaths. In contrast, the proportion of vascular deaths has risen from under one half the total to a little over three fourths. Within this major category, cardiac deaths have risen from under one fourth of the total to slightly more than one half. The proportions both for cerebral vascular and renal vascular disease have also risen. The increase in the latter reflects the more frequent designation of this condition as the concept of diabetic nephropathy has become established. In contrast the proportion of deaths from gangrene has dropped to less than 2 per cent of the total.

Diabetics have benefited from the control of infections by chemotherapy and antibiotic therapy. Consequently, there has been a sharp reduction in the percentage of deaths from such causes. On the other hand, the longer duration of life of diabetics has increased their chances of acquiring malignancies. Deaths from this cause have steadily mounted to more than one out of every ten.

In addition to these over-all changes in the mortality by cause are significant differences in the pattern of causes of death by age and duration of the disease. Details of this, based on 5,721 deaths between 1956 and 1962 are given in table 7. It is found that, regardless of age at onset or duration of disease, vascular diseases account for the great majority of deaths among diabetics except in patients under forty who have had the disease less than ten years. Moreover, as the table shows, the type of vascular disorder and the organ system primarily involved vary greatly by age at onset and duration of the disease. Disease of the small vessels is the dominant type at the younger ages at onset with long duration of the disease. The total for renal vascular disease is given because complete information

TABLE 5

Percentage of all diabetic patients and of those first seen within one year of onset surviving ten and twenty years (experience of Joslin Clinic—specified groups examined in 1930-58, traced to 1961)

	Surviving 10 yrs.						Surviving 20 yrs.			
	1950-58		1940-49		Examined in 1930-39		1940-49		1930-39	
	Duration from onset to examination									
Age at examination	All durations	Under one year	All durations	Under one year	All durations	Under one year	All durations	Under one year	All durations	Under one year
15-29	90.1	99.4	91.9	96.3	87.7	87.5	73.2	79.0	70.3	75.2
30-44	84.0	94.7	86.3	89.0	81.6	85.2	61.5	70.7	61.6	66.3
45-59	71.2	77.5	67.6	76.2	63.1	72.7	29.2	43.4	29.0	34.5
60-74	40.7	53.6	40.8	49.9	34.1	42.2	7.7	11.7	5.6	7.9

TABLE 6

Trends in causes of death among diabetic patients since 1922 (experience of the Joslin Clinic, Boston, Massachusetts)

	Per cent of total deaths in specified period					
Cause of death	1922-29	1930-36	1937-43	1944-49	1950-55	1956-62
Diabetic Coma	14.5	5.0	2.8	1.7	1.1	1.0
Total vascular	46.8	58.3	65.8	71.3	76.9	76.6
Cardiac	23.1	33.4	41.1	47.1	50.2	51.2
Coronary	8.3	14.4	22.7	26.9	33.7	28.1
Renal	4.7	4.6	4.6	5.8	9.1	9.1
Nephropathy*	—	—	—	—	5.0	5.7
Cerebral	8.1	10.1	11.8	12.8	13.3	12.6
Gangrene	8.6	7.6	5.3	2.9	2.0	1.8
Infections	16.2	12.3	10.4	5.9	5.2	5.4
Tuberculosis	5.5	3.4	2.2	1.7	0.7	0.3
Cancer	7.4	9.4	9.0	9.7	10.1	10.5
Number of deaths	1,457	2,696	3,638	4,140	5,572	5,731

*Classification first used with deaths in 1950 and later.

TABLE 7

Principal causes of death among diabetic patients by age at onset of diabetes and duration of disease (experience of Joslin Clinic, Boston, Massachusetts, 1956-62*)

	Per cent of total deaths in specified category															
Cause of death	Under age 20 at onset				Ages 20-39 at onset				Ages 40-59 at onset				Ages 60 and over at onset			
	Duration of diabetes (years)															
	Under 10	10-19	20-29	30+	Under 10	10-19	20-29	30+	Under 10	10-19	20-29	30+	Under 10	10-19	20-29	30+‡
All causes	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	—
Cardiovascular-renal	25	76	82	75	41	76	81	81	66	79	81	75	72	77	83	—
Large vessels	19	14	28	49	37	51	67	74	61	72	76	71	70	74	79	—
Cardiac	—	11	21	36	31	44	57	59	50	57	56	47	52	51	48	—
Cerebral	19	3	6	12	3	5	8	11	9	12	16	19	13	17	18	—
Other†	—	—	1	1	3	2	2	4	2	3	4	5	5	6	13	—
Small vessels	6	62	54	26	3	24	15	7	5	6	6	3	3	3	4	—
Nephropathy	6	53	46	23	3	16	8	5	2	3	2	§	1	1	1	—
Other renal	—	9	8	3	—	8	7	2	3	3	4	3	2	2	3	—
Diabetic coma	44	6	1	—	3	2	—	2	1	1	1	1	§	1	—	—
Cancer	13	—	1	7	13	7	7	7	19	11	8	11	16	9	5	—
Infections	13	11	5	9	25	7	4	6	4	4	5	5	5	7	6	—
Violence	—	1	5	4	9	§	3	3	2	2	2	3	2	3	6	—
Other and unknown	6	6	6	5	9	8	6	2	8	4	3	4	5	3	1	—
Number of deaths	16	114	174	81	32	245	306	195	464	1,421	847	205	820	694	106	1

*Includes all deaths reported up to April 28, 1962.
†Chiefly arteriosclerosis without additional details and diabetic gangrene.
‡One death only, due to renal disease.
§Less than 0.5.

is not routinely available to permit identification of all cases as true nephropathy, but the facts are given separately on those which can be so classified. More than half of the deaths among patients under twenty at onset who have had the disease ten to thirty years were due to renal vascular disease.

Among adult-type diabetics, disease of the large vessels accounted for the majority of the deaths. Heart disease, and more particularly, coronary heart disease, accounted for the great majority of these fatalities. However, the proportion tends to decline with increase in duration of the disease and age at onset. Thus, among patients aged forty to fifty-nine at onset who had the disease twenty to twenty-nine years, 56 per cent of the deaths were from heart disease as compared with 47 per cent in those who had the disease thirty years or longer. This is offset by the rising frequency of deaths from cerebral vascular accidents with age and duration of diabetes. Cerebral vascular deaths have come to account for as much as one sixth of the total among patients forty years and over at onset with diabetes twenty years and longer. Some increase occurred also in the proportion ascribed to peripheral vascular disease or arteriosclerosis without further details. Relatively few deaths, however, even among older persons, were due to diabetic gangrene.

Comparison of the death rates from the major causes among diabetics with those in the general population (table 8) brings out even more clearly the excessive frequency of cardiovascular disease. Because the basic population data corresponding exactly to those for diabetics are not available, the comparisons shown in the table are only approximations. The disparity for cardiovascular disease is more marked for diabetic females than for the males. For all vascular diseases, the mortality of diabetic males is about two and one-half times that in the general population and in the females about three and one-half times. At ages fifteen to forty-four, the excess is truly great—about twelve times as high among diabetic males and among females nearly twenty times as high as in the general population. For cerebral vascular disease, the mortality among diabetics of each sex is about double that in the general population. Renal vascular deaths show by far the greatest relative excess among diabetics—about seventeen times that in the general population in both sexes. This reflects the great importance of small vessel lesions among diabetics, particularly among juvenile diabetics with long duration of the disease. For cancer there is a modest degree of excess mortality among diabetics—about one and one-half times that in the general population experience used.

TABLE 8

Relative mortality from specified causes among diabetic patients (Experience of Joslin Clinic on patients of 1950-58 traced to 1961, ages 15-74)

Cause of death	Ratio: Diabetic to general population death rate*	
	Males	Females
Total vascular disease	2.4	3.4
Ages 15-44	12.2	19.5
Ages 45-74	2.2	3.2
Heart disease	2.0	3.2
Cerebral vascular disease	1.8	2.0
Renal vascular	17.8	17.0
Cancer	1.5	1.6

*Basis of comparison: Vascular disease—mortality among white persons in New England, 1949-51; Cancer—mortality among white persons in United States, 1950.

SUMMARIO IN INTERLINGUA

Le Longevitate de Patientes con Diabete in Recente Annos

Un practicamente complete studio catamnestic del diabeticos tractate al Clinica Joslin depost 1930 monstra un tendentia declinante in le mortalitate e un correspondente melioration del cifras de superviventia. Tamen, le cifras de mortalitate pro diabeticos remane plus alte que illos pro le population general. Le excesso es relativemente le plus marcate in le gruppo de etates de inter vinti-cinque e trenta-quatro annos; illo es le minus marcate in patientes de etate avantiate.

Le cifras de mortalitate pro femininas diabetic tende a esser plus basse que illos pro masculos diabetic, sed le differentia es minus que in le population general.

Le superviventia inter patientes in custodia medical intra le prime anno post le declaration del morbo es melior que in le casuistica total.

Le causas de morte inter diabeticos ha cambiate radicalmente. Ha occurrite un marcate augmento in le proportion de mortes causate per morbo vascular, e in isto, vasos minor ha un rolo de plus in plus importante. Declinos es notate in le numero de mortes causate per coma diabetic, per gangrena diabetic, e per infectiones.

Le analyse del causas de morte secundo le etates al tempore del declaration del morbo e secundo le duration del diabete monstra le effecto de iste factores super le mortalitate e, particularmente, le eminente importantia de nephropathia diabetic in diabeticos juvenil con morbo de longe duration.

Le mortalitate ab omne generes de disordine vascular es plus alte in diabeticos que in le population general. In le hic-reportate casuistica, le mortalitate per disordines reno-vascular esseva dece-septe vices plus alte que in le population general.