

Mortality Study of Policies on Insured Lives With Diabetes Mellitus Known at Time of Issue

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Background. This is an Impairment Study Capture System (ISCS) study of contemporary diabetes mellitus mortality among insured lives. Because the diagnosis and treatment of diabetes has changed during the last 15 years, many applicants may be expected to exhibit more favorable outcomes than in the past. The study covers policy-years durational experience extending to only 10 years.

Methods. We analyzed the total mortality experience of 41,972 insurance policies. The policies were issued at standard or substandard premium rates between 1989 and 2002 policy anniversaries. The number of policies terminated by death (actual deaths) is compared with expected deaths using the 2001 Valuation Basic Table (2001 VBT). Main outcome measures are expressed as mortality ratios (MR %) and excess death rates/1000 (EDR/M). Poisson confidence intervals are used to test the statistical significance of mortality ratios at the 95% confidence limit.

Results. The total experience is based on 103,104 policy-years exposure: males 57,888 policy-years (56%) and females 45,216 policy-years (44%). There were 495 policy-deaths 284 male and 211 female. Substandard risks represented the majority of the total exposure, 76,658 policy-years in both sexes combined (male 56%, female 44%). The mean duration of substandard exposure was 2.3 years. Total mortality for all insured age-groups and risk categories combined was 187%. The mortality ratios for policies rated standard had confidence intervals that were consistent with 100% of the 2001 VBT. The mortality ratios for policies rated substandard had confidence intervals that were above 100% of the 2001 VBT. Mortality ratios varied with the type of treatment. They were lowest in those treated with diet alone and highest in individuals treated with diet plus insulin.

Conclusion. A clinical diagnosis of diabetes continues to demonstrate evidence of increased, but improving, mortality in insured individuals. The underwriting risk appraisal process effectively categorizes the risk, especially for the substandard classes where the ratings assigned to policies were consistent with the mortality results. The lack of significant differences in the mortality ratios between males and females as well as between nonsmokers and smokers indicate that the early duration variations by gender and smoking status in the 2001 VBT account for these differences in early duration diabetes mortality. Subsequent follow-up studies containing longer durations may show these differences emerging. Results must be interpreted with caution because of the small data set, limited number of ISCS participating companies, and durational experience extending to only 10 policy years.

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INTRODUCTION

Diabetes mellitus is a chronic and complex multisystem metabolic/endocrine disease characterized by inappropriate hyperglycemia and impaired metabolism of sugar and other energy yielding foods. It is genetically determined and linked to defects in insulin secretion, insulin utilization, or both. Diabetes-related mortality is frequently associated with multisystem pathologies affecting the cardiovascular, cerebrovascular and peripheral vascular systems, and renal and central nervous systems.

The importance of this disease to the insurance industry and others interested in diabetes follow-up studies is emphasized by the recent increase in the incidence of type II diabetes mellitus linked to obesity and lack of physical activity.¹⁻³ Now the sixth leading cause of death in America, diabetes is responsible for over 200,000 deaths each year.⁴

Recognizing that diabetes age-adjusted death rates in the general population have increased by about 30% in the past 12 years⁵ and that diabetes is routinely encountered by life underwriters in insurance applications, the Mortality and Morbidity Liaison Committee (MMLC) deemed it highly important to examine current diabetes-related mortality trends, patterns and outcomes in the insured population.

Diabetes mellitus classification and risk factors⁶ as well as the new and more stringent 1997 World Health Organization (WHO) clinical and laboratory definitions and diagnostic criteria for diabetes have been cited elsewhere.⁷ Detailed reviews are also available from the *Journal of Insurance Medicine*^{8,9} and other publications.¹⁰⁻¹²

METHODS

Analysis was performed on the total mortality experience of 41,972 insured lives submitted by 17 participating Impairment Study Capture System (ISCS) insurance companies that were issued at standard or substandard premium rates between 1989 and 2002 policy anniversaries and followed for up to the first

Table 1. Policy-Years Exposure in Both Sexes Combined

	Exposure Policy-years (E)	Percent Exposure (%)
Diabetes Only	38,472	37
Standard rating	11,849	31
Substandard rating	26,623	69
Diabetes With Another Impairment	64,632	63
Standard rating	14,597	23
Substandard rating	50,005	77
Diabetes Alone or With Another Impairment	103,104	100
Standard rating	26,446	26
Substandard rating	76,658	74
Nonsmoker	64,291	63
Smoker	13,744	13
Unknown smoker status	25,069	24

10 annual policy durations. (See Appendix A for ISCS contributing companies). Data demographics on insured lives include age- and sex-specific, number of policies issued, exposure in policy years, observed deaths, average size claim amount, average policy amount, and issue age grouping. Data demographic information may be reviewed in Appendix B.

Observed deaths are based on the number of policies terminated by a death claim. Consequently, each policy death provides information about the outcome of a different underwriting event. However, an individual with multiple policies could lead to multiple observed deaths in a study. An analysis of the diabetes mellitus death claims indicate a maximum of 9 death claims out of a total of 495 death claims (1.8%) could have been counted more than once.

Review of the data indicated that all cases had a diabetes code. In the first section of Table 1, By Rating and Smoking Status, standard and substandard policies are presented. In the remaining sections of Table 1, only substandard policies are presented.

In Tables 2 and 3, only substandard policies are presented. The substandard cases without codes for other medical or nonmedical im-

Table 2. Comparative Mortality by Sex, Rating & Smoker Status, Issue Age, Policy-Year Durations and Duration from Diagnosis (1989 to 2002 Policy Anniversaries)

MALE						FEMALE						Combined MALE & FEMALE			
Exposure Policy-yrs <i>E</i>	Observed Deaths <i>d</i>	Expected Deaths ⁱ <i>d'</i>	Mortality Ratio (%) MR	95% CI _{MR} (%) ⁱⁱ	Excess Deaths/M EDR/M	Risk Categories & Groups	Exposure Policy-yrs <i>E</i>	Observed Deaths <i>d</i>	Expected Deaths ⁱ <i>d'</i>	Mortality Ratio (%) MR	95% CI _{MR} (%) ⁱⁱ	Excess Deaths/M EDR/M	<i>d</i>	<i>d'</i>	MR
						Single and Multiple Impairments Combined									
<u>By Rating & Smoker Status</u>															
All Ages, Duration & Treatments Combined															
7845	42	31	134	96 to 181	1	Standard; Non-Smoker	6184	29	21	141	94 to 203	1	71	52	136
1584	11	9	127	63 to 227	1	Standard; Smoker	809	8	3	229	98 to 451	6	19	12	157
5863	18	15	118	70 to 186	0	Standard; Unknown	4161	8	8	96	41 to 189	0	26	24	110
15,292	71	55	128	100 to 163	1	Total Standard; All S, NS, U Combined	11,154	45	32	139*	101 to 186	1	116	88	132
27,568	134	74	181*	150 to 212	2	Substandard; Non-Smoker	22,694	112	57	196*	160 to 232	2	246	131	187
6748	43	25	175*	127 to 236	3	Substandard; Smoker	4603	30	13	230*	155 to 328	4	73	38	194
8280	36	19	194*	136 to 268	2	Substandard; Unknown	6765	24	15	166*	106 to 247	1	60	33	181
42,596	213	117	181*	157 to 205	2	Total Substandard; All S, NS, U Combined	34,062	166	85	196*	166 to 226	2	379	202	187
57,888	284	173	164*	145 to 183	2	Total: All Ratings; All S, NS, U Combined	45,216	211	117	180*	156 to 204	2	495	290	171
<u>By Policy-Issue Age</u>															
Substandard, All Durations Combined															
Smoker, Non-Smoker, Unknown Combined															
11,196	14	7	211*	116 to 354	1	0–39	7824	7	3	269*	108 to 554	1	21	9	228
12,262	27	15	177*	117 to 257	1	40–49	7352	13	7	184	98 to 315	1	40	22	179
10,510	52	27	192*	143 to 252	2	50–59	7842	24	17	142	91 to 211	1	76	44	173
6755	77	41	188*	148 to 235	5	60–69	8196	70	33	212*	165 to 268	5	147	74	199
1873	43	27	156*	113 to 210	8	70 up	2848	52	25	206*	154 to 273	9	95	53	180
42,596	213	117	181*	157 to 205	2	Total	34,062	166	85	196*	166 to 226	2	379	202	187
<u>By Policy-Year Durations</u>															
Substandard, All Issue Ages Combined															
Smoker, Non-Smoker, Unknown Combined															
24,228	74	43	174*	137 to 218	1	1–2	19,999	70	36	195*	152 to 246	2	144	79	183
13,573	89	46	192*	152 to 236	3	3–5	10,541	61	31	197*	151 to 253	3	150	77	194
4795	50	28	176*	131 to 232	5	6–10	3522	35	18	196*	137 to 273	5	85	46	184
42,596	213	117	181*	157 to 205	2	Total	34,062	166	85	196*	166 to 226	2	379	202	187
<u>By Duration from Diagnosis</u>															
Substandard, All Diagnostic Ages Combined															
All issue Ages Combined															
5377	10	8	129	62 to 237	0	1–2	4110	12	6	192	99 to 335	1	22	14	158
13,398	37	27	138	97 to 190	1	3–5	10,048	33	20	168*	116 to 236	1	70	46	151
12,947	93	42	220*	178 to 268	4	6–10	10,022	47	29	163*	119 to 218	2	140	71	197
3124	26	15	174*	114 to 255	4	11–15	2606	23	10	225*	143 to 338	5	49	25	194
7750	47	26	184*	135 to 245	3	16–25	7276	51	20	261*	194 to 343	4	98	46	215
42,596	213	117	182*	157 to 205	2	Total	34,062	166	85	196*	166 to 226	2	379	202	187

i. Basis of expected deaths: 2001 VBT Expected Tables.

ii. 95% Confidence Limits (CL) as a ratio of *d* (MR) based on the Poisson Distribution.

An asterisk “*” indicates the statistically significant result that the mortality is greater than the basis of expected deaths.

Table 3. Comparative Substandard Mortality by Sex, Single & Multiple Medical Impairments, Degree of Rating, Diagnostic Age (1989 to 2002 Policy Anniversaries)

MALE						Risk Categories & Groups By Degree of Rating	FEMALE						Combined MALE & FEMALE		
Exposure Policy-yrs <i>E</i>	Observed Deaths <i>d</i>	Expected Deaths ⁱ <i>d'</i>	Mortality Ratio (%) MR	95% CI _{MR} (%) ⁱⁱ	Excess Deaths/M EDR/M		Exposure Policy-yrs <i>E</i>	Observed Deaths <i>d</i>	Expected Deaths ⁱ <i>d'</i>	Mortality Ratio (%) MR	95% CI _{MR} (%) ⁱⁱ	Excess Deaths/M EDR/M	<i>d</i>	<i>d'</i>	MR
<u>Single & Multiple Impairments</u>															
6476	41	26	156*	112 to 212	2	125-175%	4847	33	17	189*	130 to 265	3	74	44	169
9839	60	29	206*	157 to 265	3	180-250%	7534	42	23	185*	133 to 250	3	102	52	196
8805	28	14	195*	130 to 282	2	Over 250%	7495	34	11	313*	217 to 437	3	62	25	246
17,476	84	48	177*	141 to 219	2	Other	14,186	57	34	170*	129 to 220	2	141	81	174
42,596	213	117	182*	157 to 205	2	Total	34,062	166	85	196*	166 to 226	2	379	202	187
Single Impairment															
3253	20	13	158	97 to 244	2	125-175%	2029	12	6	193	98 to 337	3	32	19	170
3308	15	8	188*	105 to 310	2	180-250%	2096	8	5	167	72 to 329	2	23	13	180
2956	4	3	133	36 to 340	0	Over 250%	2334	8	2	421*	181 to 829	3	12	5	246
6185	21	11	187*	116 to 286	2	Other	4463	9	7	127	58 to 241	0	30	18	164
15,702	60	35	172*	131 to 221	2	Total	10,922	37	20	185*	130 to 255	2	97	55	177
Multiple Impairments															
3223	21	14	154	95 to 235	2	125-175%	2818	21	11	187*	116 to 286	3	42	25	169
6530	45	21	212*	155 to 284	4	180-250%	5438	34	18	190*	132 to 266	3	79	39	202
5850	24	11	212*	136 to 315	2	Over 250%	5161	26	9	290*	189 to 425	3	50	20	246
11,291	63	36	174*	134 to 223	2	Other	9723	48	26	181*	133 to 240	2	111	63	177
26,894	153	82	186*	157 to 209	3	Total	23,140	129	65	200*	165 to 235	3	282	147	192
<u>By Diagnostic Age</u>															
Substandard, All Issue Ages, Durations Combined; Smoker, Non-Smoker, Unknown Combined															
Single & Multiple Impairments Combined (Diabetes Diagnostic Duration to 25 Years)															
16,425	30	13	226*	152 to 323	1	0-39	11,582	17	6	279*	162 to 447	1	47	19	243
12,688	44	23	188*	137 to 252	2	40-49	8132	19	14	137	82 to 214	1	63	37	169
8763	66	37	180*	139 to 229	3	50-59	7990	52	26	203*	152 to 266	3	118	62	189
4104	58	33	175*	133 to 226	6	60-69	5290	60	28	216*	165 to 278	6	118	61	194
612	15	11	143	80 to 236	7	70-79	1051	18	11	166	98 to 262	7	33	21	154
4	0	1	—	—	-20	80 up	17	0	0	—	—	-24	0	1	0
42,596	213	117	182*	157 to 205	2	Total	34,062	166	85	196*	166 to 226	2	379	202	187

i. Basis of expected deaths: 2001 VBT Expected Tables.

ii. 95% Confidence Limits (CL) as a ratio of *d* (MR) based on the Poisson Distribution.

An asterisk “*” indicates statistically significant result that the mortality is greater than the basis of expected deaths.

A dash “—” indicates no result due to no policies terminated by death.

pairments are called single impairment. The substandard cases with codes for other medical or nonmedical impairments are called multiple impairment. The headings of each section of these tables clearly indicate whether single or multiple impairment cases are combined or presented separately.

It is important to remember that several of the parameters used in this study are actually calculated values. Based on the range of years indicated by the time stamp on the code for the diabetes impairment, the number of years diagnosis occurred before application was assigned a value of 1 within the first year, 2 within the second year, 4 within the years 3–5, 8 within the years 6–10, 15 if it occurred more than 10 years prior and if the time in the past was indefinite. Diabetes diagnosis age was coded as the issue age minus the number of years diagnosis occurred before application. Duration from diagnosis is the issue age minus diabetes diagnosis age plus duration.

Basis of Expected Deaths

Expected deaths are based on the 2001 Valuation Basic Tables (2001 VBT) created by the Society of Actuaries (SOA) Individual Life Insurance Valuation Mortality Research Task Force (Task Force) and published in its November 2001 report. As that report relates, the Task Force took the experience tables that were fit to the underlying experience data and created a smoothed valuation table split by gender and smoking status. The 1990–1995 experience tables include experience from individually underwritten life insurance policies for the period 1990–1995 that was formulated into composite tables (nonsmoker, smoker and unknown smoker combined) that varied by gender.

The Task Force added data at older issue ages that was provided by Bragg Associates and data for males in ultimate durations from the Veterans Administration's National Service Life Insurance program to create the 2001 VBT's male and female composite tables. Based on existing studies, the Task Force de-

veloped factors to separate the composite tables into the 2001 VBT male and female tables for nonsmokers and smokers. The 2001 VBT includes issue ages from 0 to 99 with select durations 1 to 25 and ultimate factors.

Based on the gender and smoking status of the insured, the 2001 VBT mortality rates are used to calculate expected deaths. If the insured is a nonsmoker, the nonsmoker version of the 2001 VBT is used. If the insured is a smoker, the smoker version of the 2001 VBT is used. If the smoking status of the insured is unknown, the composite version of the 2001 VBT is used. Caution needs to be used in interpreting results of the unknown smoker. If the proportion of the unknown smokers is in fact heavily weighted with smokers, the expected deaths based on the composite table will understate the number of deaths.

Expected deaths based on 100% of the 2001 VBT are used as the basis for comparison for statistical significance evaluation. The reader should be aware that the actual deaths vary by underwriting classification and over time. Mortality experience of the preferred class will be less than 100% of the 2001 VBT. The SOA's 2000–2001 Individual Life Experience Report, the overall experience of preferred and residual standard classes was 89% of the 2001 VBT for policy anniversaries beginning in 1996 and ending in 2001. The mortality experience of substandard classes will be greater than 100% of the 2001 VBT. Additionally, overall mortality experience will tend, and has historically tended, to improve over time.

Statistical Significance Evaluation^{10,13,15}

Poisson confidence intervals are calculated around mortality ratios (MR) based on the number of observed policy deaths relative to VBT expected deaths. The null hypothesis is that the actual deaths are the same as expected deaths based on 100% of the 2001 VBT. To achieve a statistically significant difference from 100% of the 2001 VBT for a given mortality ratio, the confidence interval must exclude 100%. A statistically significant result can be modified by using a different

mortality basis for that business other than 100% of the 2001 VBT. The 95% confidence interval for the mortality ratios was calculated using the Byar approximation of the Poisson confidence intervals.

RESULTS

Exposure

Policy-years exposure by rating category, smoking status and single and multiple impairments for both sexes combined are presented in Table 1.

It is noteworthy that 74% of the total exposure of 103,104 policy-years was represented by substandard risks (76,658 policy-years). Smoker and unknown smoking status combined represented 37% of the total exposure. Mean duration of total policy exposure is 2.46 years, and mean duration of substandard risk exposure is 2.30 years.

Mortality by Rating and Smoker Status

See Table 2. All ages, durations, treatments and single and multiple impairments are combined.

No significant difference in relative mortality between nonsmokers and smokers was noted. The lack of significant differences in the mortality ratios between males and females, as well as between nonsmokers and smokers, indicate that the early duration variations by gender and smoking status in the 2001 VBT account for these differences in early duration diabetes mortality. Subsequent follow-up studies containing longer durations may show these differences emerging.

The mortality ratios for standard policies are 128% for males, 139% for females and 132% for males and females combined. For males, the results are not significantly above 100% of the 2001 VBT. For females and both genders combined, the results are significantly above 100% of the 2001 VBT. These results are consistent with diabetics rated standard that are in the classification of residual standard.

The mortality ratios for policies rated sub-

standard had confidence intervals that are above 100% of the 2001 VBT. The diabetic risks that underwriters categorized as substandard showed mortality consistent with substandard risks.

Substandard Mortality by Policy Issue Age

See Table 2. Analysis includes only substandard policy issues with all durational intervals, single and multiple impairments and all smoker status (smoker, nonsmoker and unknown) combined.

Issue ages include the following age groups: 0–39, 40–49, 50–59, 60–69 and ≥ 70 .

When split by policy-issue age, almost all of the substandard policies show mortality that is significantly above 100% of the 2001 VBT.

There is a trend towards higher mortality in younger age bands and lower risk in the oldest group, but this does not achieve statistical significance. This may be because the longest credible policy duration studied was 10.

Substandard Mortality by Policy-Year Durational Intervals

See Table 2. Analysis includes substandard lives: all diagnostic and issue ages combined; smoker, nonsmoker, unknown and single and multiple impairments combined.

Policy-year durational intervals include: 1–2, 3–5 and 6–10.

There is no statistically significant trend in this study among the policy-year durational intervals in the early policy durations.

Substandard Mortality by Duration from Diagnosis

See Table 2. This is a substandard group with all diagnostic and issue ages combined; smoker, nonsmoker, unknown and single and multiple impairments combined.

Durational intervals are: 1–2, 3–5, 6–10, 11–15 and 16–25 years.

For duration intervals 1–2 and 3–6, the mortality ratios are not significantly different

from 100% of the 2001 VBT. For all of the higher duration intervals, the mortality ratios are significantly higher than 100% of the 2001 VBT.

Mortality by Degree of Rating

See Table 3. Analysis includes all ages, durations and treatments combined; smoker, nonsmoker and unknown combined.

For substandard policies by degree of rating, the upper limit of the confidence intervals increased as the level of risk increased with higher ratings.

For single and multiple impairments combined, all the breakdowns had mortality ratios significantly higher than the 100% of the 2001 VBT.

Substandard Mortality by Age at Diagnosis

See Table 3. Analysis includes substandard lives: all issue ages and durations combined; smoker, nonsmoker and unknown combined; single and multiple impairments and all durations to 16–25 years combined.

For males by diagnostic age, the results are significantly higher than 100% of the 2001 VBT except for diagnostic ages ≥ 80 . For females by diagnostic age, the results are significantly higher than 100% of the 2001 VBT except for diagnostic ages 40–49 and diagnostic ages ≥ 80 . For males and females combined, all results are significant. The increased significance for males and females combined is due to combined experience making the confidence interval narrower.

Substandard Mortality by Type of Treatment

See Table 4. Analysis includes substandard lives: all ages and durations combined; smoker, nonsmoker and unknown combined.

For treatment type with both sexes combined, increasing mortality was associated with more aggressive types of treatment:

- Cases treated by diet alone produced the most favorable mortality ratio of 160%.
- Diet plus oral agent treated cases exhibited a higher mortality ratio of 195%.
- Diet plus insulin treated individuals had the highest mortality ratio of 224%.

DISCUSSION

Total Mortality

In Table 2 the overall mortality ratio (187%) for the combined study group is increased but is less than that noted in previously reported insured lives studies. The precise reasons for the improvement are unclear from this data but may include:

- Improved comprehensive, multidisciplinary case management
- Improvements in diabetes preventive care measures
- More aggressive glycemic control as measured by hemoglobin A1c
- Positive life style improvements and secondary preventive measures
- Use of newer and better medications (statins, ACE inhibitors, etc.) for the prevention and management of complications
- Web-based (evidence-based) information and availability of clinical practice guidelines
- Shorter average duration of follow-up than in earlier insured lives studies
- Probably most importantly, revision of the disease definition leading to the insuring of applicants with less severe diabetes mellitus than in the past

In general, many categories did not show a significant difference between factors (their confidence intervals overlapped). This may very well be due to the relatively small size of this study and the short duration of follow-up, both of which may tend to mitigate mortality rates. Nevertheless, several interesting *patterns* of mortality can be observed that might achieve statistical significance given longer durations and increased exposure.

Table 4. Comparative Substandard Mortality by Sex, Treatment Type, Single & Multiple Impairments (1989 to 2002 Policy Anniversaries)

MALE						Risk Categories & Groups By Degree of Rating		FEMALE						Combined MALE & FEMALE		
Exposure Policy-yrs <i>E</i>	Observed Deaths <i>d</i>	Expected Deaths ⁱ <i>d'</i>	Mortality Ratio (%) MR	95% CI _{MR} (%) ⁱⁱ	Excess Deaths/M EDR/M	By Type of Treatment & Rating		Exposure Policy-yrs <i>E</i>	Observed Deaths <i>d</i>	Expected Deaths ⁱ <i>d'</i>	Mortality Ratio (%) MR	95% CI _{MR} (%) ⁱⁱ	Excess Deaths/M EDR/M	Combined MALE & FEMALE		
						All Ages & Durations Combined Smoker, Non-Smoker, Unknown Combined								<i>d</i>	<i>d'</i>	MR
SUBSTANDARD RATING																
<u>Single & Multiple Impairments Combined</u>																
9189	47	28	171*	126 to 227	2	Diet	7210	28	19	146	97 to 211	1	75	47	160	
20,427	118	66	179*	147 to 211	3	Oral	16,283	102	47	217*	175 to 259	3	220	113	195	
11,940	48	21	234*	173 to 310	2	Insulin	9678	34	16	211*	146 to 295	2	82	37	234	
1038	0	3	—	—	-3	Other/Unknown	891	2	2	87	13 to 299	0	2	6	35	
42,596	213	117	181*	157 to 205	2	Total (All)	34,062	166	85	196*	166 to 226	2	379	202	187	
<u>Single Impairment</u>																
2793	16	8	211*	121 to 343	3	Diet	1770	8	4	222	95 to 437	3	24	11	215	
6322	23	18	125	79 to 188	1	Oral	4108	18	10	173*	103 to 273	2	41	29	143	
6349	21	8	258*	160 to 394	2	Insulin	4808	11	6	194	97 to 347	1	32	14	232	
238	0	1	—	—	-3	Other/Unknown	236	0	0	—	—	-2	0	1	0	
15,702	60	35	172*	131 to 221	2	Total (All)	10,922	37	20	185*	130 to 255	2	97	55	177	
<u>Multiple Impairments</u>																
6396	31	20	155*	105 to 220	2	Diet	5440	20	16	128	78 to 198	1	51	36	143	
14,107	95	47	200*	162 to 245	3	Oral	12,175	84	37	230*	183 to 285	4	179	84	213	
5591	27	12	218*	144 to 317	3	Insulin	4870	23	10	220*	139 to 330	3	50	23	219	
800	0	3	—	—	-3	Other/Unknown	655	2	2	100	15 to 344	0	2	5	44	
26,894	153	82	186*	157 to 209	3	Total (All)	23,140	129	65	200*	165 to 235	3	282	147	192	

i. Basis of expected deaths: 2001 VBT Expected Tables.

ii. 95% Confidence Limits (CL) as a ratio of *d* (MR) based on the Poisson Distribution.

An asterisk “*” indicates statistically significant result that the mortality is greater than the basis of expected deaths.

A dash “—” indicates no result due to no policies terminated by death.

Substandard Mortality by Policy-Issue Age

Table 2 illustrates the trend in mortality seen with issue age. Although the values do not reach statistical significance, the pattern is similar to that seen with age of diagnosis. There is higher relative mortality in younger ages, a fairly constant risk in the middle age bands, and lower risk in the older cohort.

Substandard Mortality by Duration from Diagnosis

In Table 2 mortality was modestly increased in early durations. In the later durational years, relative risk increased with an upward trend. This pattern of increasing mortality with time is a well-recognized phenomenon and is likely related to the occurrence of diabetic complications, many of which become evident only after years of exposure.

Mortality by Degree of Rating

The results of this study indicate that diabetes remains a disease with significantly increased mortality risk in most cases. More importantly, the results further illustrate that the current insurance industry approach to evaluating mortality outcomes in this disease are accurate and adequately approximate the actual experience encountered by insurers. These results hold true for both the smoker and nonsmoker groups. The fact that the mortality ratios for smokers in this study may be lower than those seen in previous publications in the literature is likely due to the fact that the VBT table used for comparative mortality calculations adjusts for smoking status.

Substandard Mortality by Age at Diagnosis

As noted above, despite the lack of statistical significance in comparing age bands in this data, Table 3 shows the pattern of relative mortality with age in diabetes is one of greater risk in younger individuals. Insured lives rated substandard who were diagnosed with

diabetes before age 40 had a higher total mean mortality risk for all durations combined than later ages at diagnosis. There are several possible reasons for this pattern. Type I, insulin-dependent disease is more common in younger individuals. In addition, a younger age of onset provides a greater duration of exposure for serious complications to develop. Finally, expected death rates are lower in the lower age ranges thus increasing the relative mortality risk associated with any number of excess deaths.

Conversely, the relative risk is lower in the oldest cohort and, in fact, may be only marginally greater than standard rates. However, the lower relative mortality does not mean that diabetes is trivial in this age group. While the relative risk is diminished, the absolute risk as evidenced by the excess death rates is higher. In addition, the overall burden of disease or the number of individuals affected in the population is greater in the older group, indicating a substantial overall mortality risk in both the general and insurance populations.

Substandard Mortality by Type of Treatment

In Table 4, the overall (and in most age bands) mortality ratios vary by the type of treatment from lowest with diet alone to highest with diet and insulin. There are several potential reasons for this pattern. In many ways the type of treatment is associated with other factors driving mortality risk. Diet controlled diabetes is more likely to be newer onset or milder disease. Insulin treatment, on the other hand, is associated with younger age of onset, insulin deficiency or poor control/compliance. That all insulin treated cells do not show the highest mortality ratios may be the result of some of the nuances of the insurance process. Since the lives here represent policies in force, the insureds studied represent the better risks associated with insulin treatment. The better risks, those accepted for insurance at lower rates, are more likely to accept the offered

policy and appear in the study. Others with poorer control are more likely to be declined or to not accept a high substandard offer.

COMPARISON WITH EARLIER STUDIES

The study design of the 1983 Single Medical Impairment Study (SMIS) provides data on single medical impairments by number of policies followed for 25 years.¹¹ It deals with the mortality experience between 1962–1977 anniversaries on nearly 2.4 million policies issued at standard or substandard premium rates. The Multiple Medical Impairment Study (MMIS) is a follow-up study of mortality in insured lives from the same years as the SMIS with one or more impairments in addition to diabetes.¹² This enables the determination of mortality consequences by the nature and severity of the additional impairments.

These studies do not readily allow direct comparison with the current ISCS data in most risk categories because of differing study designs, much longer periods of exposure, more liberal diabetes definitions, changes in the range of residual standard expectations by participating companies, and differences in treatment and clinical follow-up. In addition, consideration was not given to smoking status.

The Lincoln National Reinsurance Company 1995 study¹⁴ focused on policies issued from 1965 through 1984 that were followed to death, lapse or policy anniversary in 1991. The cases included all diabetics under treatment by diet alone, diet and oral agent, or diet plus insulin. Comparison with this study is difficult for several reasons: various subgroups were analyzed in the Lincoln study and these may not correspond to our groups, the time span of the Lincoln study was greater and duration of follow-up was longer, a factor that may have a major influence on complications and death rates, a different mortality expected basis was used, and finally, the era studied and the types of treatments available for the disease and its complications were distinctly different. That having been

said, the mortality risk for the entire study group combined in the current paper had improved relative to that in the Lincoln study. This trend continued a pattern noted by the Lincoln authors when they compared their 1995 results with those of their earlier studies.

CONCLUSIONS

- Long-term mortality rates in insured lives have improved in the modern era, but diabetes mellitus still remains a significant risk to life.
- Underwriting risk selection effectively uses current risk appraisal processes that include tools such as blood work and review of medical records to accurately assess the relative mortality risk in diabetic applicants.
- Even though standard-issue diabetics have mortality ratios in excess of 100, all the 95% confidence bands include 100. This means that standard-issue policies are within residual standard in the early policy durations studied. Substandard issue diabetics demonstrate an excess mortality consistent with the underwriting evaluation.
- In early policy durations, there is no statistically significant increasing trend in mortality among policy-year durational intervals. Subsequent follow-up studies containing longer durations may show these differences emerging due to increasing morbidity of diabetes over time.
- For the duration intervals from diagnosis 1–2 and 3–5 years, the mortality ratios are not significantly different from 100% of the 2001 VBT. For all other durations, the mortality ratios are significantly higher than 100% of the 2001 VBT.
- Policy-issue age groupings had a pattern of mortality risk consistent with that seen in earlier studies. Insureds diagnosed with diabetes prior to age 69 had mortality ratios significantly higher than 100% of the 2001 VBT. Those insureds age 70 and over are consistent with 100%

of the 2001 VBT when studied by gender, but were higher than 100% of the 2001 VBT when males and females were combined.

- For both genders combined, a pattern of increasing mortality by treatment type was associated with more aggressive treatment of the diabetes.

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REFERENCES

1. Alberti G, Zimmet P, Shaw J, Bloomgarden Z, et al. Type 2, diabetes in the young: The evolving epidemic: The International Diabetes Federation Consensus Workshop. *Diabetes Care*. 2004;27:1798–1811.
2. A Report of the Congressionally-Established Diabetes Research Working Group. *Conquering Diabetes: A Strategic Plan for the 21st Century*. Bethesda, Md: National Institutes of Health; 1999. Publication No. 99-4398.
3. Ilanne-Parikka P, Eriksson J, Lindstrom J, et al. Prevalence of the metabolic syndrome and its components. Findings from a Finnish general population sample and the Diabetes Prevention Study cohort. *Diabetes Care*. 2004;27:2135–2140.
4. Center for Disease Control and Prevention. Diabetes: The Burden of Chronic Diseases and Their Risk Factors. National and State Perspectives 2004. Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion. Available at: <http://www.cdc.gov/nccdphp>.
5. Olefsky JM. Prospects for research in Diabetes Mellitus. *JAMA*. 2001;285:628–632.
6. Centers for Disease Control and Prevention. National Diabetes Fact Sheet: National estimates and general information on diabetes in the United States. Atlanta, Ga: US Department of Health and Human Services, CDC; November 1997. NIH Publication No. 98-3926.
7. Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. *Diabetes Care*. 1997;20:1183–1197.
8. Milano AF. Diabetes mellitus and life insurance. *J Insur Med*. 2001;33:50–103.
9. Regenauer A. Prognostic aspects of the metabolic syndrome. *J Insur Med*. 1998;30:180–190.
10. Lew AE, Gajewski AM. *Medical Risks: Trends in Mortality by Age and Time Elapsed*. Praeger Publishers, Greenwood Publishing Group, Inc; 1990.
11. Society of Actuaries and Association of Life Insurance Medical Directors of America. *Medical Impairment Study, Volume 1, 1983*. Published on March 1986:96–97.
12. SOA/AAIM/HOLUA-IHOU Mortality and Morbidity Liaison Committee and MIB Inc. *Multiple Medical Impairment Study*. CMAS Books of MIB Inc. 1998:110–111.
13. Singer RB. Confidence Limits Based on No. of Observed Deaths. In: Brackenridge RDC, Elder WJ, eds. *Medical Selection of Life Risks*. 4th ed. New York, NY: Stockton Press; 1998:Table 4.18.
14. Mast JL. Findings from LNRC's fourth major study on diabetics and mortality. *Reinsurance Reporter*. 1996;48:18–30.
15. Breslow NE, Day NE. *Statistical Methods in Cancer Research, Volume 2—The Design and Analysis of Cohort Studies*. New York, NY: Oxford University Press. International Agency for Research on Cancer; 1989.

Appendix A. ISCS Companies Contributing to Diabetes Mellitus Study

Allstate Financial
 Canada Life Assurance Company
 Great-West Life & Annuity Insurance Company
 Guardian Life Insurance Company
 Lincoln National Life Insurance Company
 Manulife Financial
 MONY Life Insurance Company
 Northwestern Mutual Life Insurance Company
 State Farm Insurance
 Sun Life Financial
 The Hartford
 Thrivent Financial for Lutherans
 Western and Southern Financial Group
 Woodmen of the World Life Insurance Society

Appendix B. Data Demographics on Insured Lives. The Total Number of Policies Issued Between 1989 and 2002 was 41,972 (23,268 Males and 18,704 Females). The Potential Exposure Period is Relatively Short at 13 Years. The Report Covers the First 10 Durations. Total Exposure in Policy-years was 103,104 with an Average Policy Exposure of 2.46 Years.

Gender	Avg. Issue Age Years	No. of Policies	Percent	Exposure Policy-Yrs	Observed Policy Deaths
Male	48.7	23,268	55	57,888	284
Female	51.4	18,704	45	45,216	211
Combined	49.9	41,972		103,104	495

Gender	Issue Age Grouping	Avg. Policy Amount (\$)	Policies Issued	Avg. Claim Amount (\$)
Male	<40 years	\$100,115	5468	\$67,821
	40-49	\$117,341	6560	\$84,298
	50-59	\$116,206	6146	\$56,757
	60-69	\$106,027	3952	\$36,660
	≥70	\$116,468	1142	\$137,922
	Total	\$111,028	23,268	\$68,461
Female	<40 years	\$67,827	3933	\$54,217
	40-49	\$57,049	4128	\$53,706
	50-59	\$49,602	4391	\$22,472
	60-69	\$35,207	4425	\$17,756
	≥70	\$39,366	1827	\$21,458
	Total	\$50,671	18,704	\$23,933

Number of Policies	
Standard risk	8657
Substandard risk	33,315
Total	41,972