Chapter 5

Complications of Diabetes

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Summary

Diabetes is a major source of morbidity in Vermont. Diabetes is associated with nearly three-quarters of all inpatient non-traumatic amputations, one-third of hospitalizations for renal failure and one-fifth for cardiovascular disease. The proportion of discharges for these conditions associated with diabetes has increased significantly since 1983. People with diabetes are about 5.8 times more likely to be hospitalized for acute and chronic kidney diseases and approximately four times more likely to be hospitalized with septicemia and CVD than non-diabetics. In addition they are more likely to be hospitalized for liver disease, Chronic Obstructive Pulmonary Disease, Pneumonia and Influenza, and other conditions.

Approximately 30 percent of Vermonters with diabetes report they have poor vision. They are significantly more likely to report they have been told they have high blood pressure and high cholesterol than those who do not have diabetes. Among Vermonters ages18 through 64, those with diabetes are significantly less likely to report that they are currently employed (67% employed) than those who do not have diabetes (90% employed).

Chapter Contents

Complications of Diabetes

Diabetes is a major source of morbidity in the U.S. In 1997, according to the Centers for Disease Control and Prevention, 10.3 million people reported they had diabetes[1], and it is estimated that 5.4 million people have undiagnosed diabetes[2]. People with diabetes are at risk for the development of specific acute metabolic complications, such as diabetic Ketoacidosis, hyperglycemic hyperosmolar non-ketotic coma, and hypoglycemia and a variety of chronic complications specific to diabetes, including circulatory, renal, ophthalmic, neurological, and skin disorders[3]. People with diabetes also appear to be at increased risk for general medical conditions other than acute glycemic and chronic complications of diabetes[4].

Data sources and limitations

The information in this report is derived from two primary sources: 1) the reports of hospitalization and out-patient ambulatory surgery provided by hospitals in Vermont, New Hampshire, New York, and Massachusetts; and, 2) the self reported experience of people with diabetes responding to the Vermont Behavioral Risk Factor Surveillance Survey (BRFSS).

All data are presented for Vermont residents only.

The estimates of prevalence of diabetes are from the BRFSS. Estimates of relative risk for inpatient hospital care related to common complications are based on data from the BRFSS and from population estimates[5]. Since there is considerable variability in the prevalence estimate, a low and a high *age-adjusted*, relative risk was calculated.

Coding on both inpatient and outpatient records is subject to the usual concerns of accuracy and forms design. In addition, the number of possible diagnoses entered on the inpatient form was limited to five prior to 1990 and is now ten. The potential for omission of diabetes related diagnoses before 1990 is discussed in the Chapter 4—Hospitalizations. The outpatient form has space for only three diagnoses.

When comparisons to national or other groups in this document, they are made to the specific sources cited. As a result they vary somewhat in the specificity of the condition being described. This may lead to some perception of inconsistency, as when one figure displays *kidney disease* and another *nephritis* or *nephrotic syndrome.* A table of the relationship between the various schemes cited in this report is contained in Appendix 5-A.

Inpatient hospital care

People with diabetes are at high risk of eye disorders, cardiovascular disease (CVD), non-traumatic amputation, and chronic renal failure as a result of the disease. The hospitalization data files were used to determine the number of hospitalizations for each of these disorders and whether or not diabetes was present on the report (i.e. either the complication or diabetes appears in any of the ten diagnoses). As can be seen in Table 1, diabetes is associated with nearly three-quarters (72%) of all inpatient non-traumatic amputations and about one third of hospitalizations for renal failure (38%) and eye disorders (32%). Diabetes is also associated with more than one-fifth (22%) of cardiovascular disease, which is a less specific diagnosis than the other three, and is far more common in the population as a whole.

Table 1
Hospitalizations for Complications of Diabetes 1992-1996

Complication	*Total Discharges*	*Diabetes Related Discharges*		*Relative Risk**	
	Number	*Number*	*Percent*	*Low*	*High*
Amputation (Non-traumatic)	926	669	72%	56.1	63.4
Chronic Renal Failure	2,362	890	38%	21.3	23.9
Eye Disorders	7,256	2,339	32%	17.6	19.8
CVD	116,648	25,801	22%	5.1	5.8

*Age adjusted relative risk of hospitalization due to diabetes

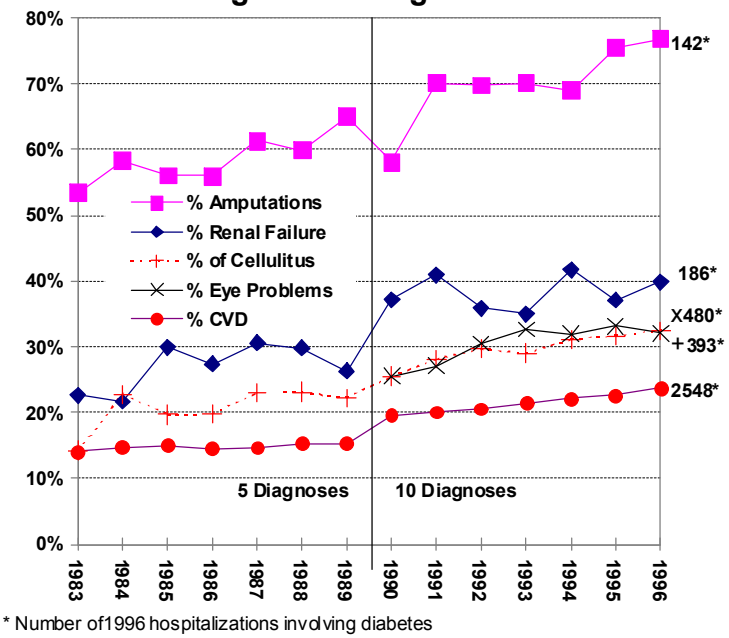
Calculation of the relative risk of people with diabetes being hospitalized for one of these disorders shows a similar pattern, but provides a more stark contrast with people who do not have the disease. People with diabetes are 56 to 63 times more likely to be hospitalized for non-traumatic amputations and 21 to 24 times more likely to be hospitalized for chronic renal failure than people who do not have diabetes. They have about 18 to 20 times the risk for hospital care because of eye problems. Without these huge numbers, the finding that people with diabetes have five to six times the risk for hospital care related to CVD would be considered staggering.

Trend in hospitalization for complications of diabetes

It would appear that the proportion of hospitalizations for complications of diabetes is not only high for the period 1992 to 1996, but that the proportion of discharges for these conditions associated with diabetes has increased since 1983 (Figure 1). Non-traumatic amputations, renal failure, CVD and cellulitus have all seen a significant (all $p<0.0001$) trend upward, indicating an increasing percentage of hospitalization for each cause is related to diabetes. The trend in percentage of hospitalization for eye problems related to diabetes also has a significant ($p<0.02$) upward trend for the period 1990 to 1996.

Figure 1

Percent of Vermont Hospital Discharges Involving Diabetes



* Number of1996 hospitalizations involving diabetes

In 1990, data collection went from report of just five to a total of ten possible diagnostic codes on the hospitalization records. The added diagnostic codes allow recording of comorbid conditions in greater detail. It is important then, to look at the trends with that transition in mind. CVD hospitalizations related to diabetes present additional problems in interpretation. The trend was fairly flat up through 1989, had a sharp rise in 1990 and a steeper increase since. Because CVD encompasses so many diseases, numerous codes would be needed to identify the specific complication(s) that are increasing.

Outpatient hospital care

Examination of data from the ambulatory surgery data files reveals a pattern similar to that seen for inpatient hospitalization. As can be seen in Table 2, about 23 percent of outpatient non-traumatic amputations were diabetes related. About 25 percent of outpatient hospitalizations for chronic renal failure were diabetes related.

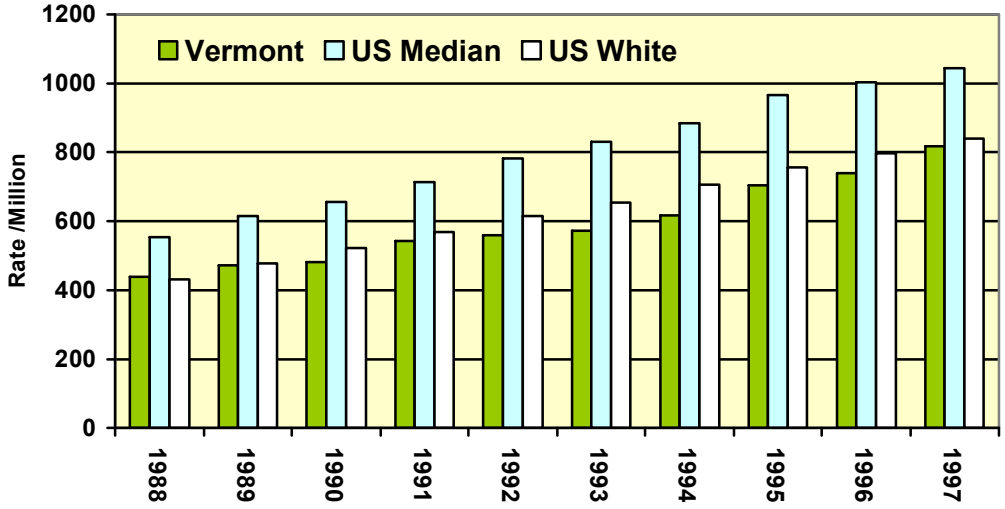
Table 2
Hospital Outpatient Surgery 1992-1996

Complication	Total Encounters	Diabetes Related Encounters	
	Number	*Number*	*Percent*
Amputation (Non-traumatic)	95	22	23%
Chronic Renal Failure	283	70	25%
CVD	6,419	643	10%
Eye Disorders	19,676	1,277	6%

End stage renal disease

Figure 2

Point Prevalence Rates per Million Population of Reported ESRD Therapy



A recent national report[6] indicates that one-third of the 1997 U.S. prevalence of end-stage renal disease (ESRD) had diabetes as the primary diagnosis (Appendix 5-B). This is up from 22 percent in 1988. The prevalence of ESRD has increased by 86 percent in Vermont over the last decade (Appendix 5-C), from 439 per 1 million population, adjusted for age, race and sex to over 816 (Figure 2). Prevalence in Vermont is about the same as the US rate for the white population, but lower than the US rate overall.

In the three northern New England states of Maine, Vermont and New Hampshire, the hospitalization ratio for all dialysis patients declined by eight percent between 1995 and 1997. (Appendix 5-D).

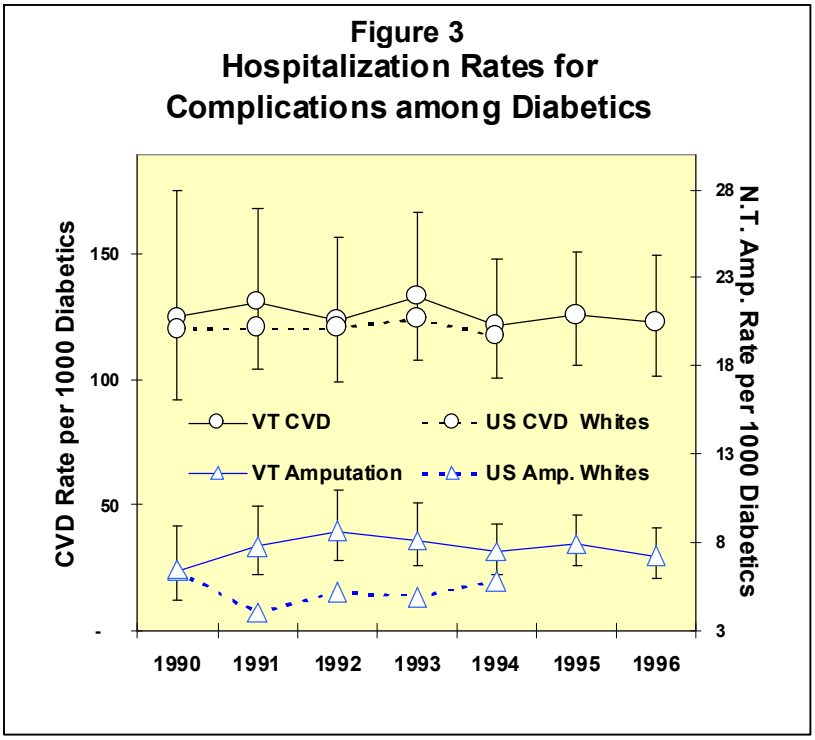
Retinopathy

Between 1992-96 in Vermont, 73 percent of inpatient and 34 percent of the outpatient hospitalizations for retinopathy was related to diabetic retinopathy. Diabetic retinopathy is the leading cause of new cases of blindness among adults in the U.S.[7]

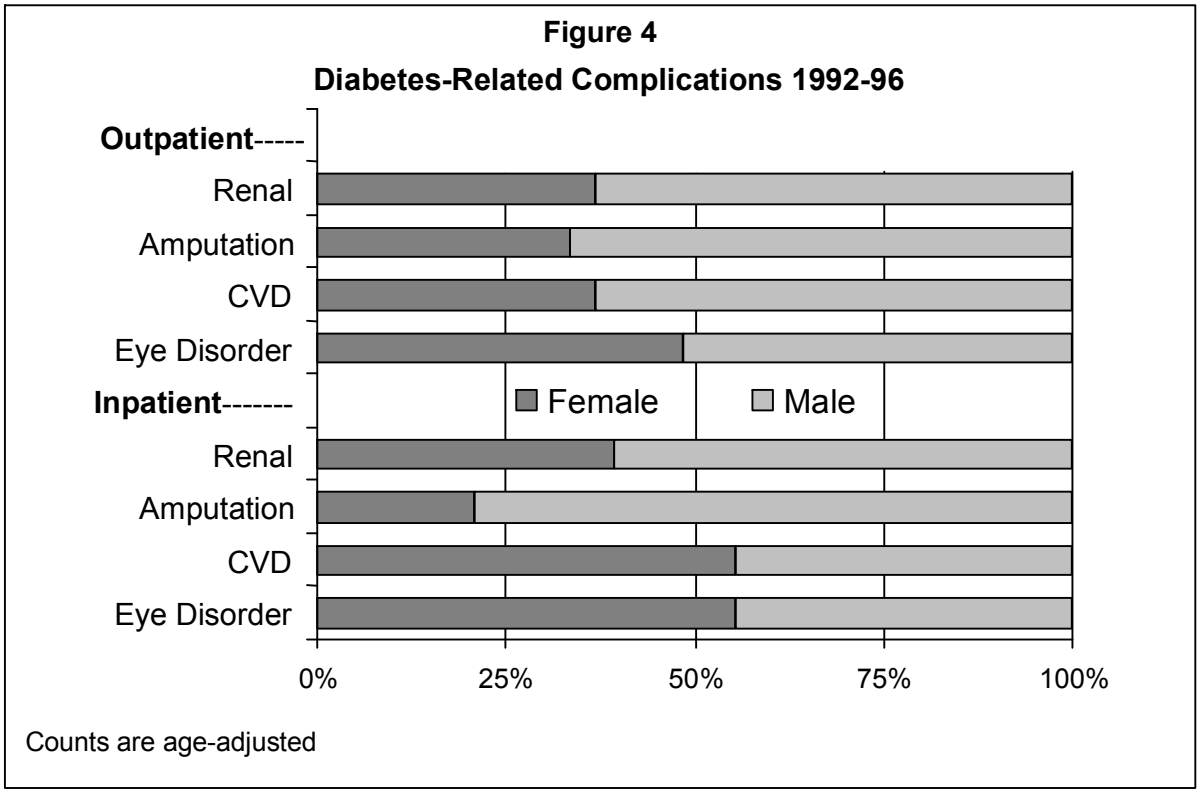
Cardiovascular disease and non-traumatic amputations

It is possible to compare the Vermont hospitalization rates among people with diabetes-related complications, CVD and non-traumatic amputation, with equivalent U.S. rates. The BRFSS data was used to estimate the number of people with diabetes in Vermont for each year 1990 to 1997 within a 95% confidence interval. The CVD hospitalization rate is the ratio of the number of hospitalizations with CVD as the primary diagnosis and any mention of diabetes divided by the number of people with diabetes. Vermont rates are not significantly different than the US white rates for the period.

Figure 3
Hospitalization Rates for Complications among Diabetics



Gender



There are no apparent gender differences between men and women for eye disorders or for CVD treated in the hospital outpatient setting (Figure 4). There is considerable gender bias for all other conditions with men making up the majority of discharges for renal disease and lower extremity amputations and for CVD treated in the hospital.

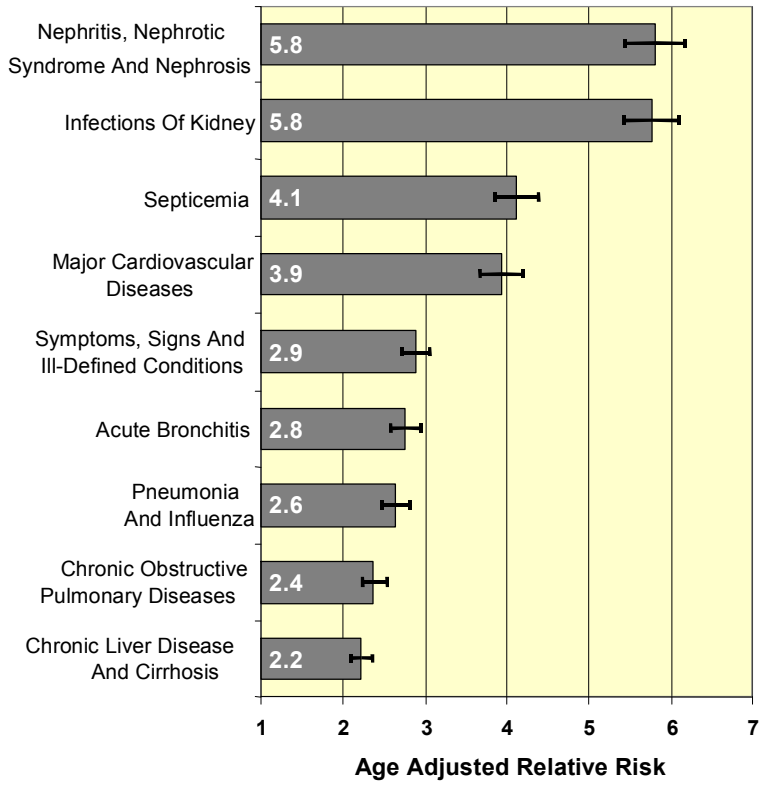
Reasons for the differences are not obvious but may be due to gender itself, to differences in behavior (higher rates of smoking), differences in treatment (less likely to receive foot exams), or the consequence of living long enough to develop complications.

Relative risk of hospitalization for complications of diabetes

As can be seen in Figure 5, in addition to the chronic complications of diabetes, people with diabetes have a higher relative risk for being hospitalized for many seemingly unrelated disorders. In this analysis, the "complication" is the first-mentioned diagnosis, and diabetes - if noted - would appear in any of the other nine diagnoses. People with diabetes are about 5.8 times more likely to be hospitalized for acute and chronic kidney diseases and approximately four times more likely to be hospitalized with septicemia and CVD than non-diabetics. In addition they are more likely to be hospitalized for liver disease (2.2 times higher than non-diabetics), COPD (2.4 x), Pneumonia and Influenza (2.6 x), and bronchitis (2.8 x).

Figure 5

Age Adjusted Relative Risk of Diabetics for Complications 1992-96



Note that these are a subset of the 72 major causes of death.

Attributable risk of hospitalization for specific diseases

In 1997, the American Diabetes Association published a report "*Economic consequences of Diabetes Mellitus in the U.S. in 1997*"[8]. The report relies on two approaches to calculate cost: 1) medical expenditures attributable to diabetes (i.e., the cost due to the excess prevalence of diabetes-related chronic complications and general medical conditions in people with diabetes); and 2) total medical expenditures incurred among people with diabetes. In the report diabetes includes both Type 1 and Type 2 diabetes. The first approach provides a method to determine the number of hospitalizations that may be attributable to diabetes. A few examples of general medical conditions that may or may not occur with greater frequency in people with diabetes are provided in Table 2.

Table 2
Examples of
General Medical Conditions

- liver disease
- septicemia
- respiratory failure
- gastritis
- malignant neoplasms
- affective disorders

Table 3
Hospitalizations Attributable to Diabetes
By Condition 1992-96*

Condition	*Age <45*	*Age <65*	*Age 65+*
Chronic Complications of Diabetes			
Cardiovascular disease	4.7	105.3	44.2
Peripheral vascular disease	0.9	9.5	4.2
Renal disease	0.8	4.5	4.2
Other chronic complications of diabetes	0.8	4.7	3.6
Neurological disease	0.4	5.4	9.5
Ophthalmic disease	0.1	0.8	0.2
General Medical Conditions			
All	41.0	177.1	129.8

*Increased rate of hospitalization per 100,000 population

Table 3 shows how many fewer hospitalizations would occur in each of these conditions, by age, if diabetes were eliminated. There would be 105 fewer hospitalizations per 100,000 population if diabetes were not present.

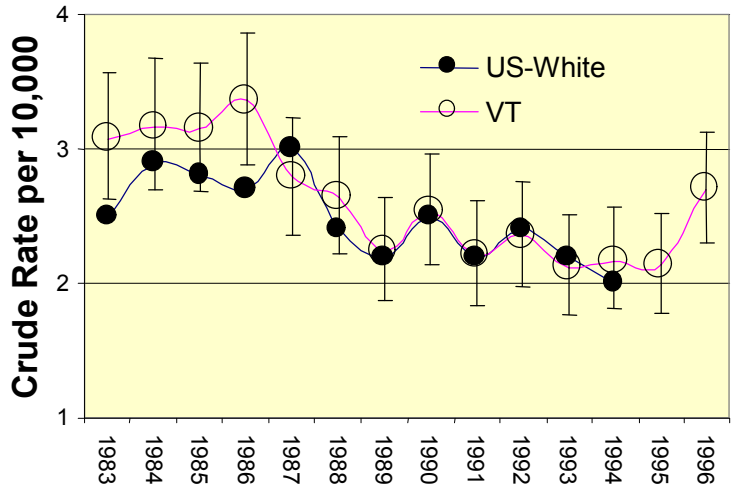
While rates of hospitalization attributable to diabetes for all chronic complications are high, the impact of diabetes on general medical conditions can be seen to be significant as well. There would be 177.1 fewer hospitalizations per 100,000 people under age 65 and nearly 130/100,000 fewer over age 65 without diabetes present.

Refer to Appendix 5-E, "Attributable Risk Fractions" for an explanation of the calculations used for this table. Also, Appendix 5-F illustrates a different approach to determining diabetes related hospitalizations and attributable risk developed by CDC.

Diabetic Ketoacidosis

Diabetic Ketoacidosis (DKA) is a severe complication that requires emergency treatment. There are between 122 and 159 hospitalizations each year for DKA. There is no significant difference in Vermont discharge rates for DKA (as primary diagnosis) compared with US rates among whites (Figure 6). Rates for both US whites and Vermont have declined since the mid-1980's, with an apparent increase in 1996, which may or may not be sustained.

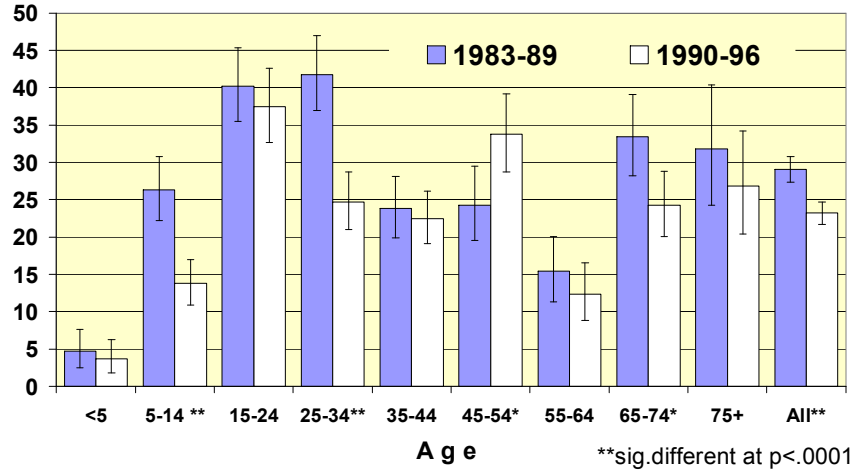
Figure 6
Hospital Discharge Rate for Diabetic Ketoacidosis as Primary Dx



Gamma function error bars

DKA accounted for 19.7 percent of the Vermont hospital discharges with diabetes listed as the primary diagnosis between 1992 and 1996. The majority occurred among those who were reported to be insulin users. DKA is more common in the younger population, and can be the first indication that a person has diabetes. Between the period 1983-89 and 1990-96, the discharge rate declined in all age groups except for a significant increase for the 45-54 year olds (p<.006). The decline was significant in rates of hospitalization among 5-14, and 65-74 year olds (p <.006), and 25-34 year olds (p <.0001).

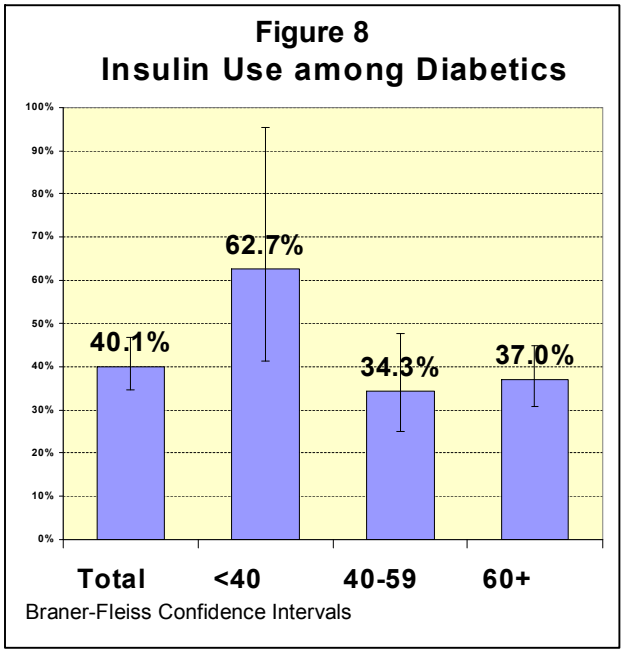
Figure 7
Hospital Discharges per 100,000 for Ketoacidosis in Vermont 1983-96



95% Gamma function error bars

**sig.different at p<.0001
* sig.different at p<.006

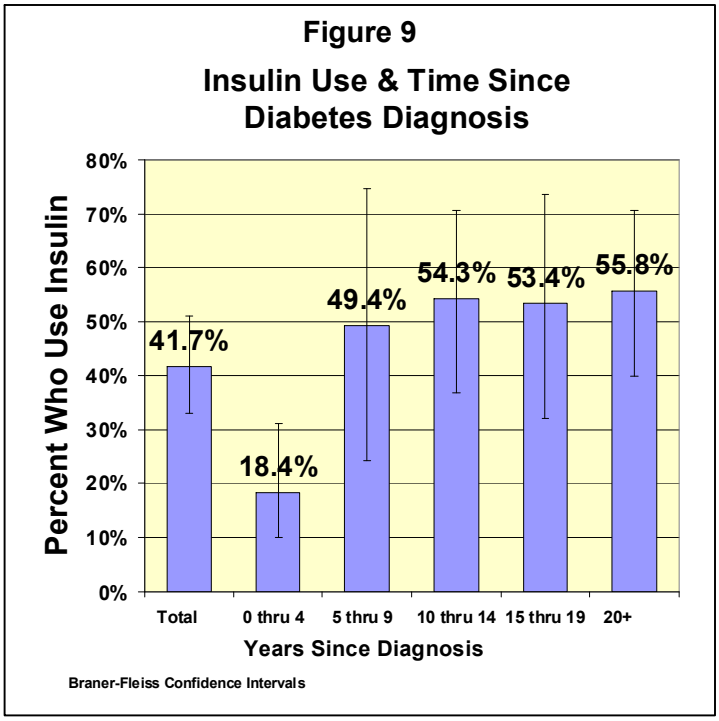
Need for insulin among people with diabetes



Approximately 40 percent of people with diabetes responding to the Behavioral Risk Factor Surveillance Survey (BRFSS) in 1996-97 indicated they use insulin (Figure 8). About 63 percent of the under 40 year-old age group report using insulin. Insulin use among those ages 40 to 59 is about 34 percent and among those age 60 and over it is about 37 percent.

While a series of diabetes-related questions were asked, none were asked to distinguish type 1 and type 2 diabetes.

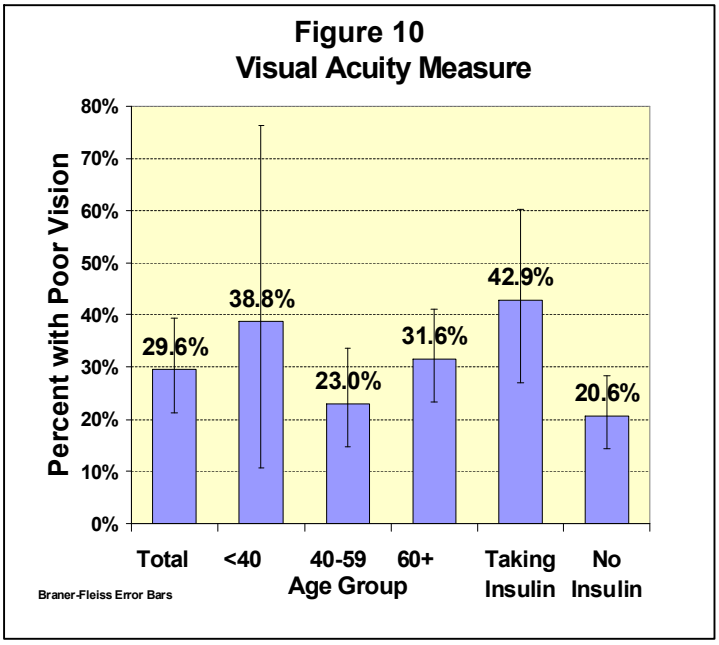
Insulin use increases the longer it has been since one has been diagnosed with diabetes (Figure 9). About 18 percent of people with diabetes use insulin in the first five years. This proportion increases to over 50 percent after about ten years.



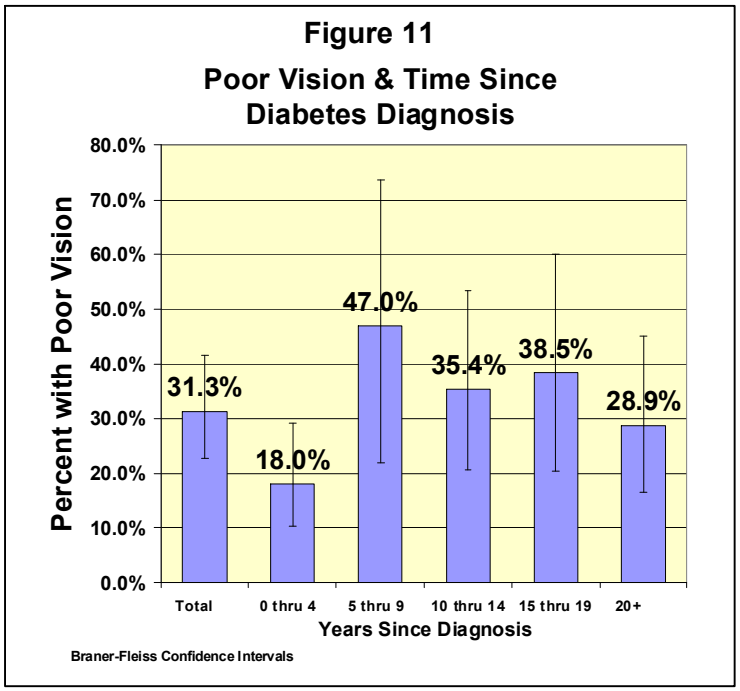
Both age and time since diagnosis appear to be important variables in insulin use and may be interrelated. A multivariate logistic regression model was tested to determine how insulin use is related to the age at diagnosis and the time since diagnosis. Insulin use is significantly more likely in those who report that diabetes was diagnosed prior to age 40 ($p<0.024$) and among those who have known of their disease for five or more years ($p<0.007$).

Visual impairment among people with diabetes

The 1996 and 1997 BRFSS asked people with diabetes three questions about how much of the time their vision is limited for far, close and intermediate vision situations. Using these three questions, an estimate of visual acuity can be made[9].



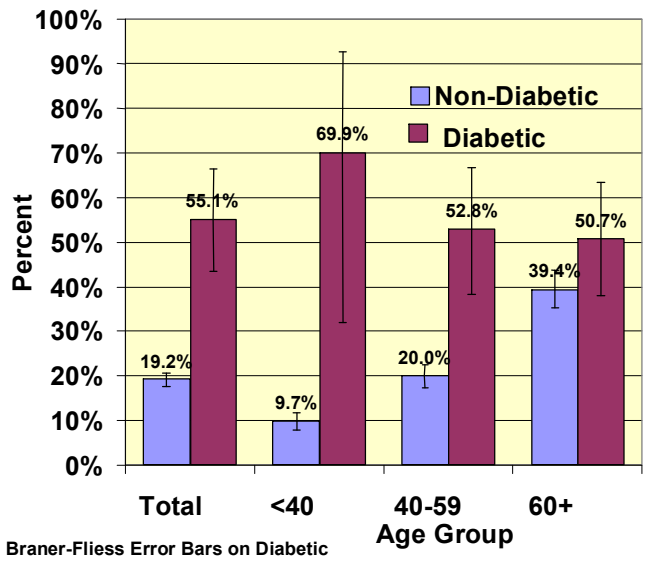
Using this method, about 30 percent of Vermonters with diabetes report they have poor vision (Figure 10)[10], with no significant differences by age. There are not enough people with diabetes in the survey to determine if those that now use insulin are more likely to have poor vision despite an average difference of more than twenty percentage points.



There was no significant difference in estimates of poor vision by time since diagnosis (Figure 11)[10]. However, when poor vision was used as the dependent variable in a multivariate logistic regression model, people who have known of their disease for five to twenty years, are significantly more likely to have poor vision than those who have known about their diabetes for less than five years. The age at diagnosis was not a significant predictor of poor vision, but did serve as a useful covariate in the model.

Hypertension and diabetes

Figure 12

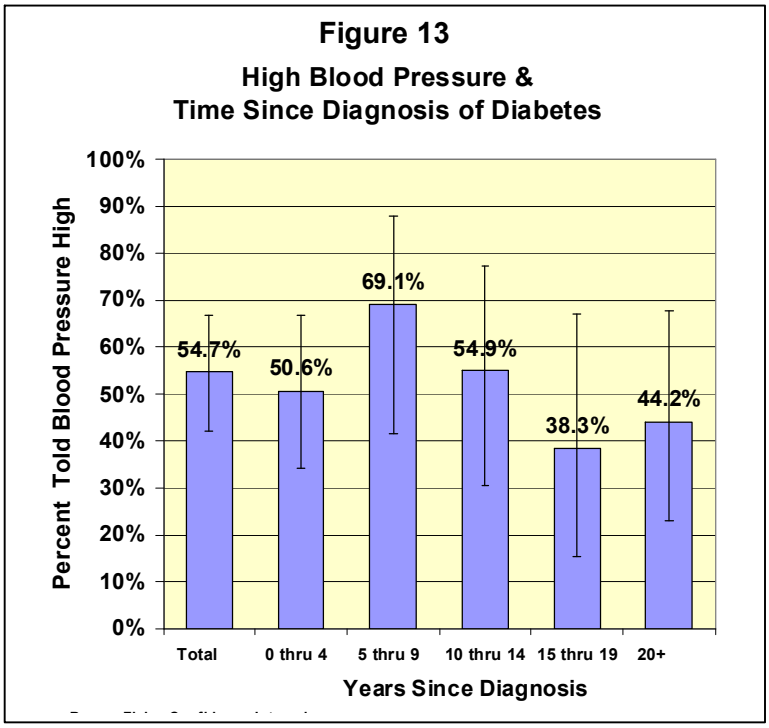


Over half of all people who have diabetes report they have been told they have high blood pressure according to the 1996-97 BRFSS (Figure 12)[10]. This is significantly higher than among people who do not have diabetes. Among people who do not have diabetes, the proportion with high blood pressure increases with age. Among people with diabetes, however, reports of high blood pressure are high across all age groups.

It appears that those who survive the longest with diabetes are least likely to report having been told that their blood pressure is high (Figure 13)[10]. However, small numbers make interpretation of this finding difficult.

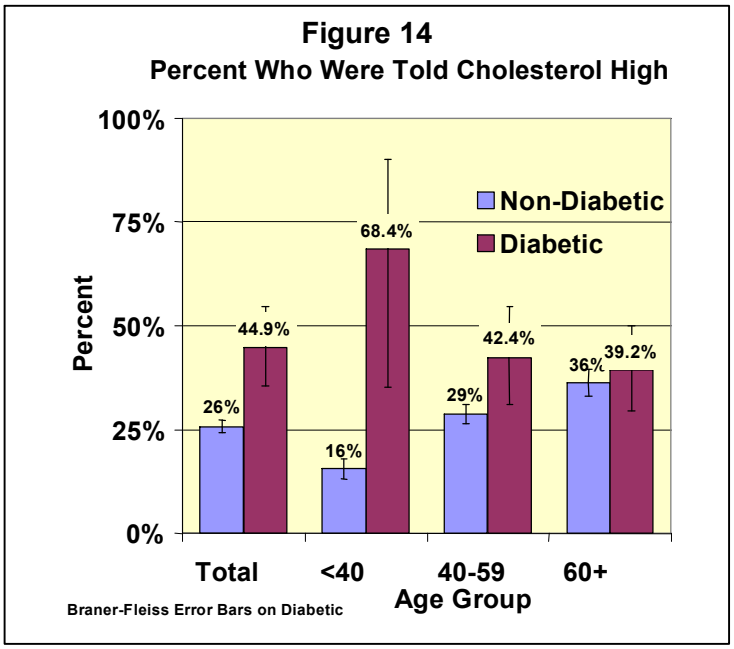
High blood pressure was used as the dependent variable in a multivariate logistic regression model. The age at which a person is first diagnosed and the amount of time since diagnosis did not predict high blood pressure. For people with diabetes the percentage remains about the same regardless of age in the multivariate model.

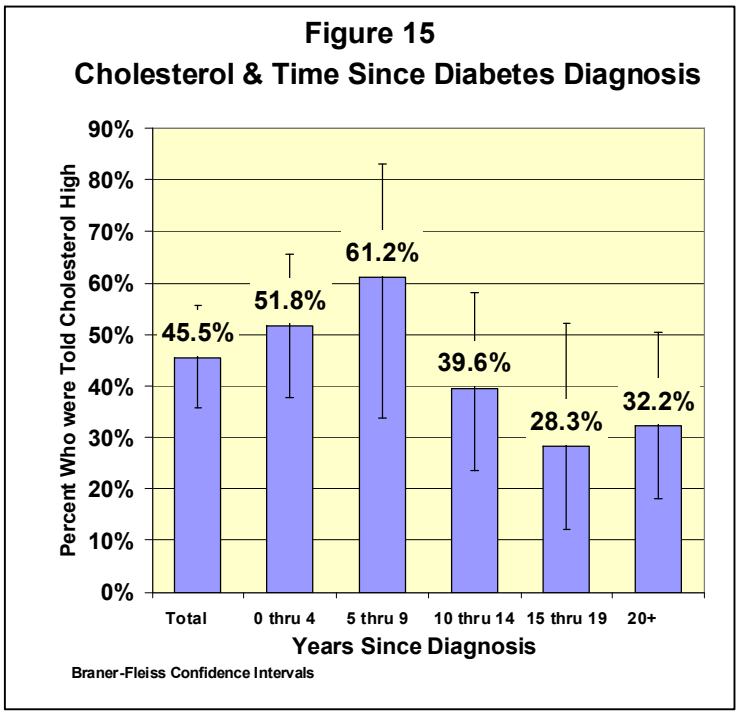
Figure 13



High Cholesterol and Diabetes

The BRFSS asks all respondents whether they were ever told that their cholesterol was high. People with diabetes are at a significantly higher risk for having been told that they have high cholesterol than those without diabetes (Figure 14)[10] do. The difference is greatest among young adults under the age of 40, (about 68%) of those with diabetes have been told that their cholesterol is high, compared to 16 percent of those who do not have diabetes. There is no significant difference between people with and without diabetes with respect to high cholesterol after age 59.



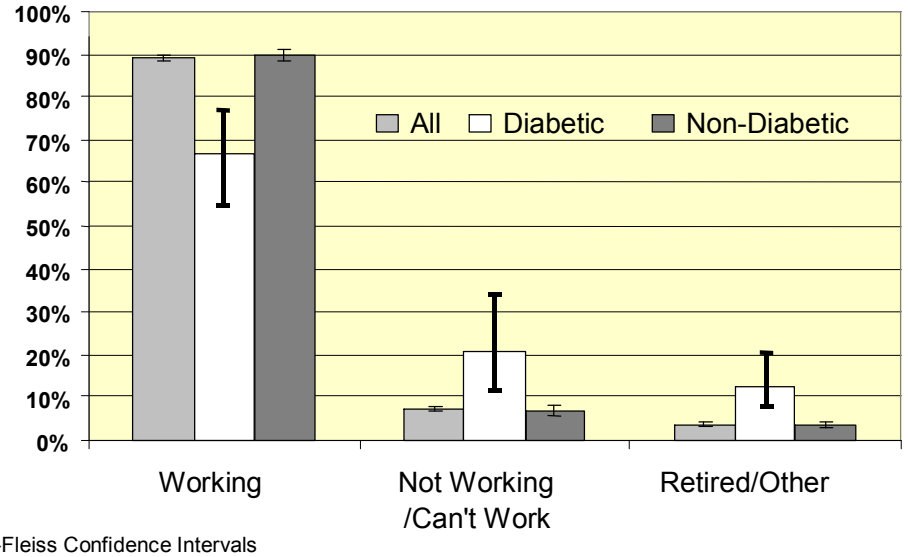


While it appears that the risk of being told that cholesterol levels are high decreases with time since diagnosis (Figure 15)[10], differences are not significant. Two years of BRFSS data is does not provide adequate numbers for a determination of differences in report of high cholesterol and of time since diagnosis of diabetes.

Disability

Using the 1993 to 1997 BRFSS question pertaining to employment among respondents ages18 through 64, one sees that Vermonters with diabetes are significantly less likely to report that they are currently employed than those who do not have diabetes (Figure 16). Approximately 67 percent of people with diabetes report being employed as compared to about 90 percent of people without diabetes. About 21 percent of people with diabetes in this age group report they are either unemployed or unable to work compared to about seven percent of others. People under the age of 65 with diabetes are also more likely to report that they have retired than others, about 13 percent as compared to about three percent.

Figure 16
Disability and Employment: Ages 18-64



Braner-Fleiss Confidence Intervals

Depression

The 1996-97 BRFSS asked all respondents a series of questions related to depression, including queries about periods of time for "which you felt sad, blue or depressed, or when you lost all interest or pleasure in things that you really cared about or enjoyed?"

Using the responses to the series, a depression variable was computed to indicate whether the respondent was depressed or not. Multivariable logistic regression was used to determine if having diabetes relates to depression. With age of the respondent included in the model, compared to people who do not have diabetes, having diabetes does not predict depression. However, among those with diabetes, taking insulin does predict depression ($p<0.009$). Controlling for age of the respondent, those with diabetes who use insulin are significantly more likely to be depressed than those who do not use insulin (95% CI odds ratio 1.37-8.37). The relationship is maintained even when controlling for smoking status, age of onset being before or after age 40, income being above or below $25,000, or time since diagnosis being more or less than ten years.

Appendix 5-A

Disease classification systems used by referenced sources

When comparisons to national or other groups in this document, they are made to the specific sources cited. As a result they vary somewhat in the specificity of the condition being described. This may lead to some perception of inconsistency, as when one figure displays *kidney disease* and another *nephritis* or *nephrotic syndrome.*

The table below shows how diseases are classified by the various sources that are cited in this and other chapters. Note that the table does include diseases that are and are not associated with diabetes. In their report *Diabetes Surveillance1997* the Centers for Disease Control compared risks of people with diabetes to the remainder of the population according to the *body system or major cause*. The American Diabetes Association has provided somewhat more specificity in their report *Economic Consequences of Diabetes Mellitus in the U.S. in 1997*, by making similar comparisons using *organ system* rather than body system. By far the most specific comparisons are made in previous chapters of this report and by others by comparing those have diabetes with those who do not, *by diagnosis*. The latter relies on the ICDA-9 classification system developed by the World Health Organization and the National Center for Health Statistics, primarily by referencing their 72 causes of death sub-system.

Disease classification systems used by referenced sources

By body system or major cause	*By organ system*	*By diagnosis*
Circulatory System	Cardiovascular disease Peripheral vascular disease	Non-traumatic amputation
Respiratory system		Chronic Obstructive Pulmonary Disease Acute bronchitis
Genitourinary system	Renal complications	Infections of the kidney Nephritis, nephrotic syndrome and nephrosis
Digestive system		Ulcers of the stomach and duodenum Nutritional deficiencies
Musculoskelatal system and connective tissue		
Neoplasms		
Skin and subcutaneous tissue		Cellulitus
Other endocrine, nutritional metabolic, immunity		Anemia's Chronic liver disease and cirrhosis
Injury and poisoning		
Infection and parasitic		Septicemia Pneumonia & Influenza
Mental disorders		
Nervous system, sensory	Neurologic symptoms Ophthalmic complications	Retinopathy
Pregnancy, childbirth puerperium		

Appendix 5-B
End Stage Renal Disease in the US: 1988-1997

The United States Renal Data System (USRDS) is a national data system which collects, analyzes, and distributes information about end-stage renal disease (ESRD) in the United States. The USRDS is funded directly by the National Institute of Diabetes Digestive and Kidney Diseases (NIDDK) in conjunction with the Health Care Financing Administration. The USRDS Coordinating Center is operated under a contract with the University of Michigan.

December 31 Point Prevalence Rates per Million Population of Reported ESRD Therapy by Year, Age, Race, Sex, and Primary Disease Causing ESRD Unadjusted[6]

AGE	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
0-4	15	15	15	15	16	17	18	20	23	22
5-9	29	32	35	36	35	37	37	39	39	43
10-14	55	56	59	60	62	64	69	74	77	76
15-19	111	120	122	124	126	129	136	141	144	144
20-24	207	216	227	238	252	263	275	287	294	290
25-29	332	357	382	401	421	437	458	481	501	511
30-34	459	494	519	554	580	613	651	689	714	731
35-39	610	650	690	720	760	787	833	871	906	921
40-44	690	756	819	888	954	1003	1046	1118	1156	1178
45-49	854	940	999	1083	1141	1220	1317	1416	1501	1559
50-54	1064	1169	1264	1335	1440	1520	1654	1770	1852	1848
55-59	1211	1345	1487	1642	1782	1895	2055	2225	2345	2452
60-64	1374	1531	1692	1855	2032	2198	2410	2681	2880	3032
65-69	1480	1679	1873	2075	2306	2511	2742	2950	3155	3364
70-74	1409	1625	1853	2106	2326	2538	2808	3017	3234	3509
75-79	1287	1485	1643	1867	2089	2255	2519	2763	2985	3241
80-84	946	1108	1300	1466	1691	1877	2086	2269	2443	2690
85plus	425	516	626	729	826	938	1039	1164	1302	1458
0-19	53	55	57	57	58	60	64	68	70	71
20-44	450	487	524	559	596	627	665	707	736	752
45-64	1111	1225	1332	1439	1543	1640	1776	1919	2027	2093
65-74	1449	1655	1864	2089	2315	2524	2773	2981	3192	3433
75 plus	986	1148	1303	1477	1666	1821	2025	2219	2406	2633
RACE										
White	432	477	522	569	615	655	706	755	797	839
Black	1373	1544	1694	1850	2026	2180	2379	2576	2737	2854
Other	721	768	824	896	974	1070	1207	1401	1546	1614
SEX										
Male	616	683	749	819	889	954	1035	1116	1190	1255
Female	501	558	610	666	726	777	845	915	968	1012
PRIMARY DIAGNOSIS										
Diabetes	124	147	171	197	224	247	280	317	349	375
Hypertension	131	149	166	185	206	221	243	256	264	271
Glomerulonephritis	117	127	135	144	152	160	171	181	190	194
Cystic Kidney	31	33	36	38	41	43	46	49	51	52
Other Urologic	11	12	13	14	15	16	17	19	21	23
Other Cause	70	76	81	87	93	97	104	115	122	126
Unknown Cause	40	40	41	44	46	47	50	51	52	52
Missing Cause	34	35	34	32	29	31	27	25	28	37
CRUDE RATE	*557*	*619*	*678*	*741*	*805*	*863*	*938*	*1013*	*1077*	*1131*

Appendix 5-C

December 31 Point Prevalence Rates per Million Population of Reported ESRD Therapy by State Adjusted for Age, Race, and Sex[6]

State	Year 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Alabama	502.91	846.03	898.42	963.66	1040.86	1103.20	1187.38	1276.71	1383.82	1455.08
Alaska	267.69	314.11	328.30	376.26	420.64	441.68	713.91	1100.24	884.37	618.17
Arizona	556.27	623.95	678.97	737.61	800.98	833.09	873.60	933.33	965.35	1000.59
Arkansas	542.66	576.24	630.62	698.12	741.88	807.00	906.93	1003.66	1057.74	1120.86
California	550.57	600.29	654.66	710.89	754.28	792.68	862.78	922.55	965.65	987.79
Colorado	422.04	477.95	514.95	553.49	597.19	625.73	666.79	681.64	710.44	741.31
Connecticut	588.56	639.36	691.98	757.56	816.66	860.55	919.08	990.65	1058.74	1097.48
Delaware	741.77	769.75	844.31	927.03	1048.61	1088.46	1142.66	1212.49	1278.08	1310.43
District of Columbia	1386.39	1577.59	1754.37	1946.68	2153.13	2400.29	2506.78	2700.86	2945.19	3041.20
Florida	634.92	687.96	750.59	812.59	878.21	925.64	962.97	1024.16	1095.50	1132.25
Georgia	717.05	790.99	856.07	937.93	1016.90	1080.10	1169.53	1254.79	1316.78	1349.87
Hawaii	773.99	833.42	871.81	912.05	962.83	1060.44	1174.38	1242.04	1276.51	1336.22
Idaho	377.98	421.33	477.82	496.91	507.86	548.60	588.09	608.39	651.62	718.76
Illinois	627.23	669.86	734.38	803.65	862.11	928.77	1008.87	1088.99	1143.74	1184.70
Indiana	556.31	605.57	656.34	700.87	768.40	830.67	864.19	936.55	1003.17	1044.52
Iowa	506.74	554.98	605.58	643.48	710.25	750.17	798.73	824.79	873.47	906.25
Kansas	472.61	525.11	591.95	639.09	681.42	709.46	768.02	807.50	844.48	915.59
Kentucky	512.39	554.41	603.49	665.72	733.91	784.59	790.44	872.29	917.18	959.41
Louisiana	772.27	851.20	929.90	1006.02	1088.15	1163.11	1252.41	1355.83	1422.30	1508.52
Maine	421.18	452.59	495.15	517.87	567.01	610.95	675.08	748.97	783.28	817.66
Maryland	674.62	738.83	825.96	912.91	987.70	1051.99	1106.50	1202.14	1314.56	1367.95
Massachusetts	543.90	582.04	628.28	677.78	742.34	794.85	847.66	901.87	942.15	969.58
Michigan	566.94	636.11	696.05	749.82	825.22	890.78	967.61	1039.36	1118.04	1161.57
Minnesota	522.31	563.50	618.45	661.05	705.13	743.59	793.56	843.39	889.10	936.43
Mississippi	769.77	843.89	919.81	992.32	1084.46	1174.54	1293.19	1380.17	1476.32	1547.60
Missouri	574.58	642.41	704.86	763.30	818.25	883.52	943.39	1020.07	1081.48	1122.25
Montana	424.61	493.83	546.92	584.75	620.92	657.53	690.70	767.42	784.12	839.89
Nebraska	466.45	523.83	568.88	607.45	687.93	725.11	786.72	859.93	883.30	949.45
Nevada	521.00	548.75	561.78	597.83	633.38	656.55	691.13	731.00	764.28	788.43
New Hampshire	403.52	466.60	500.57	536.87	558.99	581.16	618.66	652.12	648.31	667.54
New Jersey	658.83	711.45	782.34	856.71	924.90	971.26	1052.11	1120.39	1175.49	1210.40
New Mexico	592.41	644.50	706.52	772.38	826.18	859.27	915.67	1008.73	1069.43	1134.56
New York	634.23	682.20	733.50	798.42	866.07	926.57	1001.75	1068.13	1123.14	1169.10
North Carolina	653.52	715.55	790.91	859.79	947.93	1029.65	1115.98	1186.94	1260.01	1324.69
North Dakota	437.28	563.11	624.58	687.86	748.50	812.92	880.45	880.66	888.48	915.61
Ohio	579.30	639.77	696.97	749.97	811.55	864.67	917.25	1005.04	1077.71	1119.83
Oklahoma	472.18	532.70	591.21	634.50	691.27	755.01	823.67	900.02	943.85	1001.51
Oregon	471.59	517.64	560.29	610.36	632.58	663.98	708.95	741.37	776.06	793.98
Pennsylvania	641.18	697.24	766.94	826.91	888.18	936.47	1018.94	1110.63	1170.43	1218.04
Rhode Island	552.92	625.12	667.52	734.41	786.17	839.17	911.24	964.92	1022.06	1034.45
South Carolina	789.10	867.92	950.19	1018.01	1098.61	1170.75	1276.60	1384.59	1468.98	1521.97
South Dakota	536.87	563.96	599.72	633.71	659.50	724.47	794.73	895.01	973.95	1021.43
Tennessee	602.97	689.06	737.93	805.57	873.18	911.19	1000.80	1076.62	1134.84	1179.75
Texas	608.06	667.40	733.79	796.06	863.35	921.27	991.76	1047.30	1111.40	1153.34
Utah	424.91	454.68	463.75	496.09	514.11	565.80	599.27	635.29	642.94	661.08
Vermont	439.10	471.12	481.37	541.63	559.16	572.53	615.89	704.31	738.97	816.62
Virginia	661.50	711.64	763.26	834.14	904.86	965.01	1001.61	1076.13	1165.60	1239.08
Washington	470.83	512.96	549.14	581.58	600.32	637.16	682.62	722.15	757.20	776.73
West Virginia	534.94	588.14	623.70	682.19	723.70	780.88	830.75	901.22	963.08	1052.12
Wisconsin	556.14	614.64	654.65	713.55	781.04	823.53	885.19	940.06	994.03	1038.71
Wyoming	382.16	431.75	436.97	470.74	463.96	499.72	544.18	597.14	636.97	677.64

Appendix 5-D

First Admission Standardized Hospitalization Ratios for 1995-1997 by State for All Dialysis Patients: Rates by Individual Years and Aggregate Rate for the Period, Based on 1997 Rates Adjusted for Age on January 1, Race, Sex, and Diabetic Status[6]

State	YEAR 1995-1997	1995	1996	1997
All	1.03	1.04	1.03	1.00
Alabama	1.09	1.13	1.09	1.07
Western Mountain States**	0.84	0.82	0.87	0.85
Arizona	0.91	0.92	0.95	0.88
Arkansas	1.19	1.26	1.21	1.11
California and Hawaii	0.95	0.96	0.95	0.94
Colorado	0.89	0.91	0.89	0.86
Connecticut	1.06	1.07	1.07	1.03
Pennsylvania and Delaware	1.15	1.18	1.18	1.10
District of Columbia	1.16	1.17	1.17	1.15
Florida	1.03	1.04	1.04	1.01
Georgia	1.14	1.20	1.15	1.08
Illinois	1.08	1.10	1.08	1.06
Indiana	1.02	1.03	1.02	1.01
Iowa	0.93	0.95	0.90	0.94
Kansas	1.02	0.97	1.06	1.02
Kentucky	1.10	1.11	1.15	1.04
Louisiana	1.20	1.23	1.23	1.16
Maryland	1.05	1.11	1.04	1.00
Massachusetts	1.02	1.05	1.02	1.00
Michigan	0.96	0.97	0.95	0.96
Minnesota	0.92	0.92	0.93	0.91
Mississippi	0.99	0.98	1.01	1.00
Missouri	0.96	1.01	0.94	0.92
Nebraska	0.89	0.88	0.95	0.85
New England*	1.01	1.07	1.00	0.98
New Jersey	1.17	1.24	1.16	1.11
New Mexico	0.95	1.00	1.00	0.88
New York	1.00	1.02	1.03	0.95
North Carolina	1.10	1.11	1.11	1.07
Dakotas	0.86	0.84	0.85	0.87
Ohio	1.07	1.07	1.08	1.05
Oklahoma	1.03	1.09	1.06	0.95
Oregon	0.90	0.90	0.90	0.88
Rhode Island	1.01	0.98	1.04	1.01
South Carolina	1.01	1.01	1.02	1.00
Tennessee	1.04	1.08	1.05	0.99
Texas	0.98	0.98	0.99	0.98
Utah	0.73	0.74	0.70	0.75
Virginia	1.02	1.05	1.04	0.99
Washington	0.89	0.93	0.89	0.85
West Virginia	1.29	1.38	1.34	1.19
Wisconsin	0.93	0.92	0.94	0.92
Guam	0.88	1.33	0.78	0.91
Marianna Islands	0.72	0.88	0.90	0.33
Puerto Rico and Virgin Islands	1.00	1.01	0.98	1.00

Some states have been combined due to the small number of dialysis units
*New England includes Maine, Vermont and New Hampshire
**Western Mountain States include Nevada, Wyoming, Idaho, Montana and Alaska
Patients who died from AIDS are excluded from all calculations.
Deaths resulting from street drugs and accidents unrelated to treatment are not counted.
Includes only dialysis patients who have reached day 91 of ESRD by the end of the year.

Appendix 5-E

Attributable Risk Fraction

"Estimation of etiological fraction of morbidity … attributable to diabetes "[8]

"Published reports have documented that diabetes is underreported dramatically as a comorbidity on hospital discharge abstracts and on death certificates (13,27,29). Consequently, the morbidity and mortality costs associated with chronic complications and general medical conditions among people with diabetes would be underestimated by relying on secondary medical codes to identify diabetes as a comorbidity. Therefore, an attributable risk methodology based on a known population of people with diabetes with a complete health resource utilization record was used to determine the excess prevalence or relative risk of disease conditions among people with diabetes in comparison to that of people without diabetes. "

"For each demographic group, the etiological fraction for the six diabetes-related chronic complications (e.g., neurological disease, peripheral vascular disease, cardiovascular disease, renal disease, ophthalmic disease, other diabetes-related chronic complications) and for general medical conditions was calculated to estimate the proportion of resulting morbidity and mortality attributable to diabetes according to the following formula:

$$E_i = P(R_i - 1)/[P(R_i - 1) + 1],$$

where E_i indicates the etiological fraction [or *attributable risk fraction*] of disease *i* or mortality from cause *i* (i.e., the fraction of disease prevalence or mortality that is attributable to diabetes; *P* represents the proportion of the population exposed to the risk factor (i.e., the rate of prevalence of diabetes); and R_i indicates the relative risk of disease i or mortality from cause i among people with diabetes (i.e., the ratio of the prevalence among people with diabetes to that among people without diabetes) (23). Confidence intervals for the etiological fractions were calculated using standard SUDAAN methods (30). The number of encounters for chronic complications of diabetes and general medical conditions attributable to diabetes was calculated by multiplying the corresponding etiological fraction for each condition-demographic category by the corresponding total number of encounters. "

Given the fact that Vermont diabetes prevalence is higher than the rate used in their calculations, then the attributable risk fraction for Vermont is

$$E'_i = P' (R_i'-1)/[P' (R_i'-1) + 1]$$

Where E'_I is the attributable risk fraction for Vermont for the ith disease, and P' prevalence of diabetes in Vermont. If one assumes that the U.S. R_I equals R_i‘ for Vermont, then one can use the two formulae above to solve for

$$E'_i = P' E_I / [P' E_i + P(1 - E_i)]$$

The ADA article used a prevalence of 2.86 percent. An estimated Vermont prevalence of 4.1 percent was used to calculate the Vermont Attributable risk fraction for each disease listed. The table below is from the ADA article.

Table 3—*Etiological fraction of selected medical conditions among people with and without diabetes*

	<45 years*	<65 years				≥65 years			
Medical condition	All races	White	Nonwhite	Men	Women	White	Nonwhite	Men	Women
Neurological disease	2.8	4.6	20.6	13.3	3.0	7.7	4.6	5.5	7.8
Peripheral vascular disease	5.7	10.1	11.0	9.1	11.0	7.7	8.8	10.4	5.0
Cardiovascular disease	6.4	13.7	25.5	13.2	18.8	9.4	21.4	8.5	12.9
Renal disease	2.1	4.0	5.7	7.9	3.5	12.7	16.1	16.5	11.3
Ophthalmic disease	4.0	6.7	15.4	7.5	8.6	3.0	10.1	4.4	3.1
Other chronic complications	2.4	3.6	8.3	3.0	4.6	8.5	30.1	5.5	10.4
General medical conditions	1.2	2.0	3.7	2.2	1.7	6.8	17.2	8.5	6.9

Data are %. *Adjusted for race.

Vermont Attributable Risk Fractions Diabetics and Non-diabetics	White <45	<65	65+
Neurological symptoms	4.0%	6.5%	10.7%
Peripheral vascular disease	8.0%	13.9%	10.7%
Cardiovascular disease	8.9%	18.5%	12.9%
Renal complications	3.0%	5.6%	17.3%
Ophthalmic complications	5.6%	9.3%	4.2%
Other complications	3.4%	5.1%	11.8%
General Medical	1.7%	2.8%	9.5%

Number of Vermont Inpatient Hospitalizations 1992-96	<45	<65	65+
Neurological symptoms	418	2,966	5,130
Peripheral vascular disease	536	2,394	2,288
Cardiovascular disease	2,426	18,685	19,783
Renal complications	1,267	3,329	1,420
Ophthalmic complications	111	328	239
Other complications	1,153	3,275	1,792
General Medical	111,456	260,685	79,474

VT Hospitalizations /100k Population Attributable to Diabetes 1992-96	<45	<65	65+
Neurological symptoms	0.4	5.4	9.5
Peripheral vascular disease	0.9	9.5	4.2
Cardiovascular disease	4.7	105.3	44.2
Renal complications	0.8	4.5	4.2
Ophthalmic complications	0.1	0.8	0.2
Other complications	0.8	4.7	3.6
General Medical	41.0	177.1	129.8

Appendix 5-F

CDC Method to Relate Diabetes to other Diseases

An interesting picture emerges if the relationship between diabetes and a disease other than diabetes is considered when the other disease is the first-listed in the discharge record. This approach has been used by CDC[1] , and relates the first listed disease with diabetes listed in positions two through seven in the list of diagnoses.

Hospitalizations Involving Diabetes, Vermont 1992-1996					**Age-standardized Rates per 10,000**				
	Hospitalizations				Hospitalization Rate Among				
First Listed	Total	Diabetes Involved (Diagnoses 2 –7)			Diabetics		Non	Diabetes Attributable	
Diagnosis	Number	Number	Percent	US %	low	high	diabetics	low	high
Circulatory System	62757	12928	40.2%	33.7%	241	274	143	97	130
Diabetes	3370	944	10.5%	14.4%					
Respiratory System	25750	2833	8.8%	8.8%	62	71	54	8	17
Digestive System	29230	2426	7.6%	8.2%	72	81	76	-4	6
Injury & Poisoning	26407	2086	6.5%	6.5%	68	77	60	8	17
Genitourinary System	14858	1322	4.1%	5.0%	38	43	40	-2	3
Musculoskeletal Sys. and Connective Tissue	16810	1311	4.1%	4.0%	38	43	47	-8	-3
Neoplasms	17597	1302	4.1%	4.2%	26	30	51	-25	-21
Skin and Subcutaneous Tissue	4006	921	2.9%	2.9%	31	35	10	21	25
Mental disorders	16170	906	2.8%	2.3%	47	53	44	3	9
Other Endocrine, Nutritional, Metabolic, Immunity	4654	698	2.2%	2.9%	20	23	10	10	12
Infectious & parasitic	5328	565	1.8%	2.8%	17	19	11	6	8
Nervous, sense	5697	456	1.4%	1.4%	16	18	14	2	4
Pregn., childbirth, Puerperium	39913	80	0.2%	0.4%	13	15	94	-81	-79
Other - not listed above	57422	919	2.9%						

Of the hospitalizations with diseases of the circulatory system as the first-listed disease, between 97 and 130 hospitalizations per 10,000 can be attributed to diabetes. These rates are standardized to US 1940 for comparison purposes, so that different age distributions for the sub-populations will not be a factor. The majority of hospitalizations for diseases of the skin and subcutaneous tissue are diabetes related and between 21 and 25 hospitalizations per 10,000 can be attributed to diabetes. Neoplasms and Diseases of Pregnancy, Childbirth and Puerperium are less likely to be the first-listed diagnosis for diabetics than for non-diabetics even with the age-standardization.

References and Notes

1. Centers for Disease Control and Prevention, *Diabetes Surveillance,* Atlanta, GA, 1997

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4. Ray NF, Thamer M, Taylor T, Fehrenbach SN, Ratner R: Hospitalization and expenditures for the treatment of general medical conditions among the U.S. diabetic population in 1991. J Clin Endocrinol Metabol 81:3671-3679, 1996

5. *Population and Housing Estimates: Vermont.* Vermont Department of Health, Burlington, VT. 1996.

6. United States Renal Data System 1999 Annual Data Report

7. Diabetes in America, 2nd Ed. National Institutes of Health and National Institute of Diabetes and Digestive and Kidney Diseases. 1995 NIH Publication No. 95-1468

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9. Fryback, M; Klein, Klein, Dasbach, Ron and Peterson: Short questionnaires about visual function to proxy for measured best corrected visual acuity. A.R.V.O. Annual Meeting Abstract #3562 conference proceedings p 1422, 1993

10. Figures 12 and 13, 14 and 15, and 16 and 17 show different total percents in each pair of graphs. This is due to differences in the number of records with valid values for age group and for time since diagnosis. Time since diagnosis is the difference between age and the age of first diagnosis. There are more respondents who give their age than who give both their age and age of first diagnosis. In order to get these percentages the same, one would have to restrict both analyses to those folks who give valid answers to both questions. The error bars indicate that these two estimates are not significantly different from one another.