Hospitalizations for People With Type 1 and Type 2 Diabetes Compared With the Nondiabetic Population of Tayside, Scotland

A retrospective cohort study of resource use

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OBJECTIVE — To compare the hospitalizations of people with type 1 and type 2 diabetes with those of the nondiabetic population of Tayside, Scotland.

RESEARCH DESIGN AND METHODS — This was a retrospective cohort study set in Tayside, Scotland. Study subjects were eligible for inclusion if they lived in Tayside from 1 January 1995 to 31 December 1995. The primary end point was hospitalization. Comparisons between people with and without diabetes were assessed using logistic regression modeling.

RESULTS — The fixed population for the year 1995 included 366,849 people registered with a Tayside general practitioner; 7,735 (2.1%) of these had diabetes. Approximately 25% of all study subjects with diabetes had at least one hospital admission, compared with 12% of the nondiabetic population. The length of stay was highest for patients with type 2 diabetes (median of 7 days). People with diabetes accounted for 8.2% of the total bed days and had approximately double the risk of admission. Type 2 diabetic patients had increased risks of myocardial infarction and stroke; both type 1 and type 2 diabetic patients were at increased risk for an endocrine/metabolic admission or renal failure. The risk of ophthalmic admissions, especially for cataract, was much higher in patients with type 1 diabetes compared with the nondiabetic population.

CONCLUSIONS — Type 2 diabetes was associated with more frequent and longer admissions compared with the nondiabetic population. This was due to a higher risk of neurological, cardiovascular, renal, and ophthalmic hospitalizations compared with people without diabetes.

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Diabetes is a major cause of morbidity in the general population. There are few reliable studies, however, that attempt to describe the hospitalization characteristics of people with diabetes compared with the nondiabetic population. Such information is valuable to health professionals who care for people with diabetes and to health care planners, health care economists, and health care policy-makers. Additionally, there are difficulties not only in identifying people with diabetes in the population, but also in differentiating between type 1 and type 2 diabetic patients. The Diabetes Audit and Research in Tayside, Scotland (DARTS) database has been shown to be 96% sensitive, with a positive predictive value of 95% for the diagnosis of diabetes (1). The Medicines Monitoring Unit (MEMO) has access to the validated Scottish Morbiditiy Record (SMR1), which records all hospitalizations in Tayside hospitals; therefore, the numerator of rates of hospitalizations would also be complete (2). Before the current study, the few studies that have looked at resource use for diabetes tended to have methodological difficulties in either defining the population accurately, classifying diabetes accurately, or ascertaining data from various hospitalizations (3,4).

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Abbreviations: CHI, Community Health Index; CVD, cardiovascular disease; DARTS, Diabetes Audit and Research in Tayside, Scotland; FCE, finished consultant episode; ICD-9, *International Classification of Diseases*, *Ninth Revision*; MEMO, Medicines Monitoring Unit; MI, myocardial infarction; OPCS4, Office of Population Censuses and Surveys; PVD, peripheral vascular disease; RR, relative risk; SMR1, Scottish Morbiditiy Record.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

RESEARCH DESIGN AND METHODS

Study population

The study population consisted of all subjects in Tayside who were registered with general practitioners throughout the year 1995 and who were still alive at the end of the year (n = 366,849). Tayside is a geographically compact region of Scotland, with rural and urban communities served by 278 general practitioners and 3 principle hospitals. The percentage of the population of nonwhite ethnic origin is low (1.5%).

Definition of diabetes

The DARTS database was used to define those individuals with diabetes. DARTS has been described in detail elsewhere (1). In brief, the DARTS database contains information on diabetes that has been captured from a number of sources, including hospital diabetes clinics, pharmacies, hospital discharge and biochemistry databases, and the community-based mobile diabetic eye-screening facility (5). Data from these

Table 1—*Characteristics and number of FCEs for the cohorts of type 1 and type 2 diabetic and the nondiabetic population in Tayside, 1995*

Characteristics	Type 1 diabetic patients	Type 2 diabetic patients	Nondiabetic patients	Total
n	864 (0.2)	6,871 (1.9)	359,114 (97.9)	366,849 (100)
Mean age (years)	34.4 ± 15.3	67.6 ± 12.9	41.7 ± 23.1	42.0 ± 23.2
Women	384 (44.4)	3,315 (48.2)	183,996 (51.2)	187,695 (51.2)
Men	480 (55.6)	3,556 (51.8)	175,118 (48.8)	179,154 (48.8)
Total bed days	2,261 (0.5)	35,203 (7.7)	418,796 (91.8)	456,260 (100)
FCEs	478 (0.6)	4,022 (5.4)	70,157 (94.0)	74,657 (100)
Median days per FCE	2	4*	2	3
Patients	221 (0.5)	1,859 (4.0)	44,046 (95.5)	46,126 (100)
Median days per patient	3	7*	3	3

Data are *n* (%), means ± SD, or *n*. *$P < 0.0001$, Kruskal-Wallis test.

sources identify patients by a unique patient identifier, known as the Community Health Index (CHI) number (1). For the purpose of this study, individuals were classified as having type 1 diabetes if they were 0–35 years of age at diagnosis and were currently taking insulin; patients were classified as having type 2 diabetes if they were treated through diet control or with oral hypoglycemic agents or if they were >35 years of age at diagnosis, irrespective of treatment. These definitions were in accordance with the 1985 World Health Organization criteria.

Hospitalizations

For each member of the fixed population, the MEMO database (2), which contains the SMR1 records of patient-specific admissions to all Tayside hospitals, was searched for the year 1995. The MEMO database contains information regarding all hospital admissions, including acute, chronic, emergency, and 1-day admissions. It does not include accident and emergency visits unless these led to admission. Each SMR1 record contains the CHI number, which facilitates record linkage, along with one primary and five other possible diagnostic codes (from the *International Classification of Diseases, Ninth Revision* [ICD-9]), and up to four Office of Population Censuses and Surveys (OPCS4) procedure codes. Each SMR1 record consists of a finished consultant episode (FCE)—a period of time in the hospital under the care of a particular specialist. The primary ICD-9 code was mainly used in the analysis of FCEs. (However, because amputation procedures were rarely the primary reason for an FCE and therefore would have led to the erroneous estimation of no amputations, the primary, secondary, and tertiary codes were used in the analysis of amputation.) To obtain accurate total lengths of admission, a single admission may consist of multiple FCEs. From the planning and cost aspects, though, it is the FCE that must be identified, and so this study concentrated on this measure of hospital resources as the primary outcome. We also tabulated the total number of bed days and median days of hospitalization per patient.

Statistical methods

The number of FCEs for the population groups of diabetic (type 1 and type 2) and nondiabetic patients was tabulated, along with their demographic characteristics. In addition, the total and median number of hospital days were tabulated. The latter was compared using Kruskal-Wallis tests. FCEs were classified and tabulated (see APPENDIX) into the broad groups of neurological, cardiovascular, renal, endocrine/metabolic, ophthalmic, and other admissions (4). Logistic regression modeling (6) was carried out with the class of FCE as a binary outcome to compare the proportions of individuals who had ever had an FCE in type 1 and type 2 diabetes relative to the nondiabetic population, adjusted for age as a continuous variable and sex. This was also repeated for the individual primary ICD9 codes for complications of interest, such as myocardial infarction (MI) (410), stroke (codes 435 and 436), peripheral vascular disease (code 443), renal failure (codes 584–586 and 588), and cataract (code 366). In addition, the OPCS4 codes for amputation of the lower limb (section X09–X11) for primary, secondary, or tertiary reason for FCE were compared in the three groups. All analyses were performed using SAS software, version 6.12.

RESULTS — In 1995, there were 366,849 people registered with Tayside general practitioners; 864 (0.24%) had type 1 diabetes and 6,871 (1.87%) had type 2 diabetes (Table 1). People with type 2 diabetes were the oldest group. In the population as a whole, there were slightly more women (51%) than men. The diabetic groups, however, had higher proportions of men, especially in the type 1 diabetic group (56%).

During 1995, there were a total of 74,657 FCEs and 456,260 bed days. Of the total number of FCEs, 0.64% were for people with type 1 diabetes, whereas 5.4% were for people with type 2 diabetes (Table 1). The proportion of the cohorts who ever had an FCE was 25.6% of those with type 1 diabetes, 27.1% of those with type 2 diabetes, and 12.3% of those in the nondiabetic group.

Study subjects with type 1 diabetes accounted for 0.5% of the total number of bed days, whereas those with type 2 diabetes accounted for 7.7% of the total. Length of FCE and bed days per patient were significantly higher for those with type 2 diabetes, with median bed days per FCE of 4 days

Table 2—*Number and proportion of patients who ever had an FCE by class of complication (APPENDIX) in the cohorts of type 1 and type 2 diabetic patients and the nondiabetic population in Tayside, 1995*

Characteristics	Type 1 diabetic patients	Type 2 diabetic patients	Nondiabetic patients	Total
n	221	1,859	44,046	46,126
Neurological	5 (2.26)	115 (6.19)	1,233 (2.80)	1,353 (2.93)
CVD	18 (8.14)	511 (27.49)	5,357 (12.16)	5,886 (12.76)
Renal	12 (5.43)	113 (6.08)	1,200 (2.72)	1,325 (2.87)
Endocrine	33 (14.93)	42 (2.26)	57 (0.13)	132 (0.29)
Ophthalmic	53 (23.98)	282 (15.17)	1,780 (4.04)	2,115 (4.58)

Data are *n* or *n* (%).

Table 3—*Number and proportion of patients who ever had an FCE by individual complication (APPENDIX) in the cohorts of type 1 and type 2 diabetic patients and the nondiabetic population in Tayside, 1995*

Characteristics	Type 1 diabetic patients	Type 2 diabetic patients	Nondiabetic patients	Total
n	221	1,859	44,046	46,126
MI	2 (0.90)	95 (5.11)	940 (2.13)	1,037 (2.25)
Stroke	2 (0.90)	79 (4.25)	748 (1.70)	829 (1.80)
PVD	3 (1.36)	40 (2.15)	204 (0.46)	247 (0.54)
Amputation*	2 (0.90)	20 (1.07)	69 (0.16)	91 (0.20)
Renal failure	8 (3.62)	33 (1.77)	182 (0.41)	223 (0.48)
Cataract	9 (4.07)	132 (7.10)	1,540 (3.50)	1,681 (3.64)

Data are *n* or *n* (%). *Primary, secondary, or tertiary OPCS4 for FCE.

and median days per patient of 7 days, compared with both subjects with type 1 diabetes and nondiabetic subjects (Table 1). There were no other significant differences.

The largest difference in proportions of subjects by admission class of FCE was seen for cardiovascular disease (CVD) (defined in the APPENDIX), which was responsible for 27% of all patient FCEs for those with type 2 diabetes compared with 12% for the nondiabetic group (Table 2). Patients with type 1 diabetes had the lowest proportion for CVD. Patients with type 2 diabetes also tended to have the highest proportion (6%) of patients hospitalized for neurological complications.

People with diabetes had higher proportions of renal complications, mainly due to renal failure in type 1 diabetes, compared with nondiabetic subjects (Table 3). Patients with type 1 diabetes had a higher proportion of ophthalmic complications (24%) than nondiabetic patients (4%), as did those with type 2 diabetes (15%). The most frequent complication of type 1 diabetes was ophthalmic admission compared with CVD admission for type 2 diabetes. Admissions for cataract were more likely in patients with type 2 diabetes than in nondiabetic subjects (Table 3); however, cataract accounted for most of the ophthalmic admissions in nondiabetic patients. People with type 2 diabetes suffered from a more diverse range of ophthalmic complications, such as retinopathy, maculopathy, and glaucoma, than the nondiabetic group.

The proportions of FCEs for MI, peripheral vascular disease (PVD), and stroke were higher in the type 2 diabetic group relative to the nondiabetic group (Table 3). Although admissions for amputation of the lower limb were rare overall, such admissions were more likely in patients with diabetes compared with nondiabetic subjects.

Patients with type 1 and type 2 diabetes had significantly greater risk of any FCE relative to nondiabetic subjects, with relative risk (RR) of 2.89 (95% CI 2.48–3.37) and RR of 1.83 (1.73–1.93) for type 1 and type 2 diabetes, respectively, after adjusting for age and sex (Table 4). A similar pattern was seen for the other categories, with both type 1 and type 2 diabetic patients having significantly higher risk of all categories of admission compared with nondiabetic patients, and with type 1 diabetic patients having a higher risk than type 2 diabetic patients. There were significantly greater rates of endocrine/metabolic complications in both diabetes groups (Table 4), mainly due to diabetic ketoacidosis and hypoglycemia. The risk of renal failure was large in those with type 1 diabetes compared with nondiabetic subjects (Table 5). The risk of MI, stroke, PVD, amputation, renal failure, and cataract were all significantly higher in the type 2 diabetic group compared with the nondiabetic group. For patients with type 1 diabetes, the risks of MI or stroke were higher than those for nondiabetic patients, but the differences were not statistically significant. Patients with type 1 diabetes had significantly higher risk of PVD, amputation, renal failure, and cataract compared with nondiabetic patients (Table 5). As expected, older age was significantly associated with higher risk of all hospitalization classes. Men were significantly more likely to be hospitalized for MI, CVD, PVD, and stroke, whereas women were significantly more likely to have an ophthalmic hospitalization.

CONCLUSIONS — The main findings of our study were that patients with diabetes had approximately twice the annual number of FCEs compared with subjects without diabetes (25 vs. 12%). Additionally, for patients with type 2 diabetes, the duration of stay was significantly longer (7 vs. 3 days). In comparison, patients with type 1 diabetes did not stay longer than nondiabetic subjects. There was a preponderance of MI and stroke in patients with type 2 diabetes and microvascular disease and a lack of glycemic control in those with type 1 diabetes. For all categories, the risk of FCE was highest for patients with type 1 diabetes, followed by those with type 2 diabetes, and lowest for nondiabetic subjects. There is now good evidence that control of blood pressure and glycemia improves outcome in people with type 1 and type 2 diabetes (7). Our data provide some of the first and most accurate information that can be used to price hospitalization in unselected people with diabetes, which is a major health cost driver.

A previous U.K. study estimated that 5.4% of FCEs and 9.4% of bed days were for patients with diabetes (3). Although the

Table 4—*RR and 95% CI for those who ever had an FCE by class of complication (APPENDIX) in the cohorts of type 1 and type 2 diabetic patients, compared with the nondiabetic population in Tayside, 1995*

	Type 1 diabetic vs. nondiabetic patients		Type 2 diabetic vs. nondiabetic patients	
Category	RR (95% CI)	*P*	RR (95% CI)	*P*
Any FCE	2.89 (2.48–3.37)	0.0001	1.83 (1.73–1.93)	0.0001
Neurological	3.87 (1.60–9.39)	0.003	1.97 (1.62–2.39)	0.0001
CVD	2.60 (1.62–4.16)	0.0001	2.33 (2.11–2.56)	0.0001
Renal	6.51 (3.66–11.57)	0.0001	2.55 (2.09–3.11)	0.0001
Endocrine	283 (181–443)	0.0001	29.7 (19.0–46.4)	0.0001
Ophthalmic	47.3 (34.8–64.2)	0.0001	3.22 (2.83–3.67)	0.0001

Data are adjusted for age and sex. See APPENDIX for ICD-9 codes.

Table 5—*RR and 95% CI for those who ever had an individual FCE complication (APPENDIX) in the cohorts of type 1 and type 2 diabetic patients compared with the nondiabetic population in Tayside, 1995*

	Type 1 diabetic vs. nondiabetic patients		Type 2 diabetic vs. nondiabetic patients	
Category	RR (95% CI)	*P*	RR (95% CI)	*P*
MI	2.04 (0.51–8.21)	0.32	2.05 (1.65–2.54)	0.0001
Stroke	3.90 (0.96–15.77)	0.057	1.94 (1.53–2.45)	0.0001
PVD	12.58 (3.98–39.8)	0.0001	4.27 (3.02–6.04)	0.0001
Amputation*	31.50 (7.51–131.9)	0.0001	5.79 (3.49–9.60)	0.0001
Renal failure	35.7 (17.2–73.8)	0.0001	3.99 (2.74–5.83)	0.0001
Cataract	9.33 (4.75–18.3)	0.0001	1.63 (1.36–1.95)	0.0001

Data are adjusted for age and sex. *Primary, secondary, or tertiary OPCS4.

results are similar to ours, this previous study did not take into account population migration or death, and the study population was poorly defined. We found that 6.0% of FCEs and 8.2% of bed days were for patients with diabetes. Our results were based on a large population of 366,849 people, 2.1% of whom had diabetes. By definition, the population was fixed, thus eliminating possible errors due to population migration and death. In addition, comparisons of the rates of admission were adjusted for age and sex in the statistical analyses, as the three groups were likely to differ in these characteristics.

Our main finding that 25% of patients with diabetes had an FCE was consistent with a population-based U.S. study, which found an annual admission rate of 26% in younger-onset patients and 31% in older-onset patients, surrogates for type 1 and type 2 diabetes, respectively (8). In children and young adults with type 1 diabetes, the rate of admission has been shown to be 5.5–8.9% per year, which indicates that most admissions for type 1 diabetes are in the older age-groups and mainly due to lack of glycemic control (9,10). We found a strong association of increased hospitalization with age. We also found that men were more likely to be hospitalized for MI, CVD, PVD, and stroke compared with women. Predictors for admission in patients with type 1 diabetes who are <18 years of age have been shown to be glycosylated hemoglobin levels and race as well as less education, lower socioeconomic class, and not having two biological parents at home (8–10). Previous studies suggest that duration of admission is variable between and within individual countries, ranging between 4.9 and 10.7 days, with an average of ~8 days (4,11,12). Our values of 3 and 7 days for type 1 and type 2 diabetes, respectively, were shorter than most. The major strength of our data is the information on the nondiabetic control group, which showed that patients with type 2 diabetes were in the hospital 4 days longer than patients without diabetes (median 7 vs. 3 days). In contrast, there was no significant difference in the length of stay for patients with type 1 diabetes compared with nondiabetic patients. The difference in admission duration in our study was larger than that demonstrated in the U.S. and probably reflects longer stays in hospital for nondiabetic patients in the U.S. (4).

In conclusion, this study provided an accurate description of the hospitalization activity of those with type 1 and type 2 diabetes relative to the general nondiabetic population. It demonstrated higher bed-day occupancy and higher risks of neurological, cardiovascular, renal, and ophthalmic hospitalization compared with nondiabetic subjects.

APPENDIX—Data for chronic complications in diabetes are presented in Table A1.

Table A1—*Chronic complications in diabetes*

Complications	ICD-9 and OPCS4 codes
Neurological complications	
Amyotrophy	358.1
Diabetic bone changes (Charcot's joint)	731.8
Embolic stroke, occlusion of arteries	434
Extraocular muscle palsy	356.8
Hemorrhagic stroke	430–432
Late effects of cerebrovascular disease	438
Mononeuropathy of upper and lower limbs	354, 355
Diabetic arthropathy	713.5
Occlusion and stenosis of precerebral artery	433
Other and ill-defined cerebrovascular disease	437
Peripheral autonomic neuropathy	337.1
Polyneuropathy due to diabetes	357.2
Radiculopathy	729.2
Stroke, unspecified	436
Transient ischemic attack	435
Diabetes with neurological complications	250.5
Cardiovascular complications: artery	
Aortic and other aneurysms	441, 442
Atherosclerosis	440
Diabetic ulcers	707
Embolism and thrombosis, stricture of artery	444, 447.1, 785.4, 885–887
Gangrene and amputations	895–897
Hypertension (all types)	401–405
Peripheral vascular disease	443
Postural hypotension	458
Unspecified circulatory system disorders	459
Diabetes with peripheral circulatory disorders	250.6
Amputation of leg	X09
Amputation of foot	X10
Amputation of toe	X11

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Table A1—*Continued*

Complications	ICD-9 and OPCS4 codes
Cardiovascular complications: heart	
Angina	413
Arrhythmia	426, 427
Arteriosclerotic cardiovascular disease	429.2
Cardiomegaly	429.3
Cardiomyopathy	425
Chronic ischemic heart disease including angina	411
Congestive heart failure	428
Diabetes with cardiovascular complications	250.7
Myocardial degeneration	429.1
Myocardial infarction	410, 412
Other chronic ischemic heart disease	414
Chest pain	786.5
Cardiovascular complications: vein	
Phlebitis and thrombophlebitis, portal vein thrombosis and thrombolism and venous embolism	451, 452
Other venous embolism and thrombolism	453
Varicose veins of lower extremities	454
Renal complications	
Acute pyelonephrithis, kidney infections	590
Bladder dysfunction	596
Cystitis	595
Glomerular lesions, glomerulosclerosis/Kimmelstiel-Wilson syndrome	587
Nephritis/nephrotic syndrome	580, 583
Proteinuria, albuminuria	791
Pyleophephritis, unspecified	590.8
Renal failure and its sequelae	584–586, 588
Unspecified disorders of the kidney	593
Urinary tract infection	599.0
Diabetes and renal complications	250.3
Endocrine/metabolic complications	
Diabetic ketoacidosis	250.1
Hypoglycemia	251
Dwarfism obesity syndrome 1	258.1
Glycogenosis	271
Hemochromatosis (iron disorder)	275.0
Hypercholesterolemia	272.0
Hyperchylomicronemia	272.3
Hyperkalemia	276.7
Hypertriglyceridemia	272.1
Hyperviscosity	273.3
Lancereaux's disease (diabetes marked emaciation)	261
Lipoidosis	272.7
Other specified endocrine disorders	259.8
Secondary hyperlipoproteinemia	272.4
Xanthoma	272.2
Ophthalmic complications	
Cataract	366
Diabetic retinopathy	362
Glaucoma (including neurovascular)	365
Iritis	364.4
Optic neuropathy (disorders of the optic nerve and visual pathways)	377
Other retinal disorders (e.g., proliferative retinopathy, retinal edema, retinitis, and retinal microaneurysms)	362.0, 365.6, 362.8, 362.9
Visual disturbance, low vision, blindness	368–369
Diabetes with ophthalmic complications	250.4

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