research

# Health outcomes in people with type 2 diabetes

## A Record Linkage Study

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**INTRODUCTION** This study pilots a method of measuring health outcomes in a general practice population of patients with type 2 diabetes.
**METHOD** The Diabetic Register of the Perth and Osborne Divisions of General Practice was linked to the Western Australian Health Services Research Linked Database.
**RESULTS** Of the 487 patients in the study, 332 (68%) had been admitted before their diagnosis of diabetes (40% with a diabetes related condition), and 56% were admitted postdiagnosis (55% with a diabetes related condition). The admission rate increased with age and duration of diabetes.
**DISCUSSION** The data show that a large proportion of diabetic patients suffer from serious comorbidity both pre- and post-diagnosis and demonstrate that their hospital admission rate is higher than that in the general population.
**CONCLUSION** The project demonstrates that linked hospital morbidity data can be used to monitor health outcomes in a general practice population of diabetic patients.

Diabetes mellitus is a serious and growing health problem in Australia. The prevalence for all types of diabetes was 2.4% in 1995 compared with 1.9% in 1989/1990.[1,2] It places a large socioeconomic burden not only on diabetics themselves, but on the nation as a whole: the total minimum cost of diabetes in Australia in 1995 was $1 billion.[3] Most of its cost can be attributable to its substantial mortality and morbidity, particularly the complications responsible for cardiovascular, eye and kidney diseases and limb amputations.

Improvement of information about diabetes in Australia has been recommended as a national priority.[4] We tried to provide improved information about the health of diabetic patients by linking a diabetic register to a state health service database to measure health outcomes.

## Methods

We obtained a copy of the Diabetic Register of the Perth and Osborne Divisions of General Practice, and linked it to the WA Health Services Research Linked Database (WA Linked Database) using name, date of birth, sex and address as the principal matching fields.[5] The accuracy of this process has been estimated at greater than 99%.[5]

The WA Linked Database consists of population based birth records, midwives' notifications, cancer registrations, inpatient hospital morbidity data, inpatient and public outpatient mental health services data and death records.[5] It provides a comprehensive account of all hospitalisations in the public and private sectors within Western Australia (WA) from 1972 to present. We assembled a file linking together hospital morbidity data, death data and the diabetic register, and analysed a de-identified version of it.

General practitioners participating in the Diabetic Register completed an information sheet when they saw a diabetic patient and the information was then sent to the general practice divisional office where it was entered onto the register. The Diabetic Register, which began in June 1998, had 602 patients by December

1999. Of these, 57 were excluded from analysis because they did not suffer from type 2 diabetes; 42 because they had no diagnosis date; three because they were under 30 years of age and their linked hospital records indicated a diagnosis of type 1 diabetes; and a further 13 were excluded because they were diagnosed before 1972 when linked hospital records were not available; leaving a total of 487 type 2 diabetic patients. Their mean age at diagnosis was 60.8 years, and their mean duration of diabetes on 31 December 1999 was 5.8 years.

We estimated the number of patients admitted to hospital, (and admitted for a primary diagnosis of a diabetic complication), and the total number of admissions to hospital, (and for diabetic complications), up to 15 years pre- and post-diagnosis. The data were also analysed by duration of diabetes.

To estimate the annual rate of hospital admission according to duration of diabetes, we divided the number of admissions for each year (before and after diagnosis) by total person time at risk in each year. This was performed for the first, and all admissions, and for the first diabetes related, and all diabetes related admissions. We defined 'time at risk' and 'time to first admission' as the interval between diagnosis and 31 December 1999 (or death if earlier), and any admission, respectively.

Patients who were not admitted by 31 December 1999 were censored at this date or at their date of death if that occurred earlier. The analysis was stratified by age at diagnosis, and sex. A Cox proportional hazards regression was performed to calculate the effect of age at diagnosis and sex on the rate of hospital admission.

Rates of hospital admission for diabetic complications were also investigated. The specific diabetic complications monitored are shown in Table 1.[6] While these conditions may occur inde-

**Table 1. ICD-9-CM codes for diabetes complications[6]**

| Category | Condition | ICD-9-CM Code |
|---|---|---|
| Macroangiopathy | Hypertension | 401-405 |
| | Ischaemic heart disease | 410-414 |
| | Cardiomyopathy, conduction disorders | 425-426 |
| | Dysrhythmias | 427 |
| | Heart failure | 428 |
| | Cerebrovascular disease | 434-438 |
| | Atherosclerosis | 440 |
| | Peripheral vascular disease | 443 |
| | Disorders of arteries, arterioles and capillaries | 447-448 |
| Eye problems | Retinopathy | 36201-36212, 369 |
| | Rubeosis iridis | 36442 |
| | Macular oedema | 36283 |
| | Glaucoma | 365 |
| | Cataract | 366 |
| Nephropathy | Nephrotic syndrome | 581 |
| | Nephritis and nephropathy | 583 |
| | Renal failure | 584-586 |
| | Renal diabetes | 2714 |
| Neuropathy | Autonomic neuropathy | 7135 |
| | Peripheral neuropathy | 3371, 3379 |
| | Proximal neuropathy | 3572 |
| | Mononeuropathy | 354, 355 |
| | Radiculopathy | 7292 |
| | Amyotrophy | 3581 |
| | Dorsal sclerosis | 340 |
| | Charcots neuroarthropathy | 5363 |
| | Postural hypotension | 4580 |
| | Gastroparesis | 5363 |
| Feet problems | Feet and lower limb ulcers | 7071, 7078, 7079 |
| | Gangrene | 7854 |
| | Endarteritis obliterans | 4178 |
| | Charcot neuroarthropathic foot | 7135 |
| Collagen disturbance | Dupuytren's contracture | 7286 |
| | Hammer toe | 7354 |
| | Necrobiosis lipoidica diabeticorum | 7093 |
| | Granuloma annulare | 69589 |
| Infections | Cystitis | 595 |
| | Pyelonephritis, Perinephric abscess, Acute papilliary necrosis | 590 |
| | Candidiasis | 112 |
| | Furunculosis | 680 |
| | Pneumonia | 4824, 48283 |
| | Tuberculosis | 010 - 018 |
| | Cryptococcosis | 1175 |
| | Coccidioidomycosis | 114 |
| | Histoplasmosis | 115 |
| | Blastomycosis | 116 |
| | Mucormycosis | 1177 |
| | Malignant otitis external | 38014 |
| | Cholecystitis | 574 |
| | Influenza | 4871 |
| Other | Bone change | 7318 |
| | Haemochromatosis | 2750 |
| | Emaciation | 261 |
| | Xanthoma | 2722 |
| Complications with a specific diabetic code | | 2500-2509 |

**From: Bell J, Hockaday T. Diabetes mellitus. In: Weatherall D, Ledingham J, Warrell D, eds. Oxford Textbook of Medicine. 3rd edn. Oxford: Oxford University Press, 1996:1448-1504.**

pendently of diabetes, they are known to occur in diabetic patients, and they are usually adversely affected by concomitant diabetes. The percentage of patients hospitalised for diabetic related complications was calculated by dividing the number of patients who had been hospitalised for each complication after diagnosis, by the total number of patients in the sample.

## Results

### Hospital admission

Sixty-eight percent of patients on the Diabetic Register had been admitted to hospital before diagnosis, and 56% after. The pattern for number of diabetic people admitted was similar (Table 2). However, in contrast, the percentage of admissions for diabetic complications, compared with overall admissions, was almost double following the diagnosis of diabetes.

The annual incidences of hospital admission for first and for all admissions are shown (Figure 1, 2). The cumulative incidence of both overall admission and diabetes related admission increased with time since diagnosis.

By 10 years after diagnosis, 79.8% of participants had been admitted to hospital at least once (Table 3). Males had higher rates at 6-10 years following diagnosis; the cumulative incidence of admission at 10 years was 79.5% for females and 82.7% for males. The cumulative incidence rose with age: all patients aged 70 years or older were admitted within 10 years after diagnosis compared to 69% of those aged 49 years or younger.

Patients aged 70 years or older were twice as likely to be admitted as the youngest age group (Table 4). No significant effect was found for sex or between the younger age groups.

## Diabetic complications

The most common complication for which patients were admitted to hospital

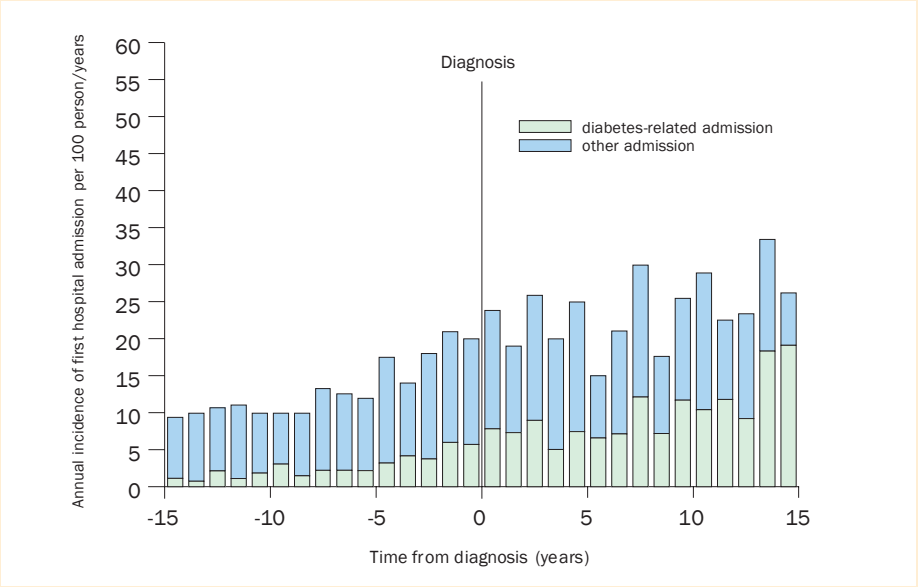


**Figure 1. Annual incidence of first hospital admission before and following diagnosis of type 2 diabetes**

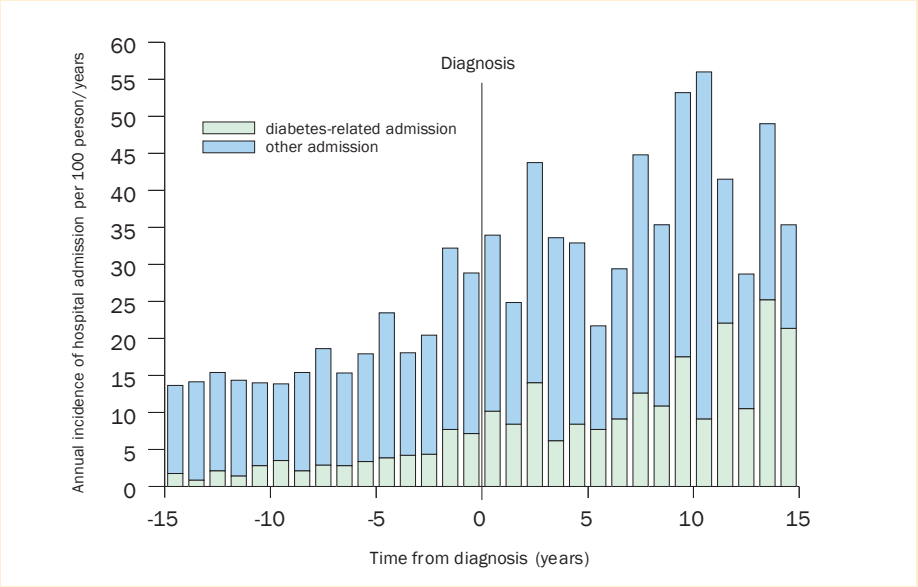


**Figure 2. Annual incidence of hospital admission prior to and following diagnosis of type 2 diabetes**

**Table 2. Hospital admissions pre- and post-diagnosis**

| | Pre-diagnosis | Post-diagnosis |
|---|---|---|
| Number admitted | 332 | 272 |
| Number admitted for diabetic complications | 132 | 149 |
| **Percentage for diabetic complications** | **40%** | **55%** |
| Number of admissions | 1791 | 1027 |
| Number of admissions for diabetic complications | 291 | 319 |
| **Percentage for diabetic complications** | **16%** | **31%** |

**Table 3. Summary of cumulative incidence of hospital admission over time**

| | | Percent hospitalised by years after diagnosis | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 10 |
| | Overall | 23.57 | 35.12 | 47.41 | 53.01 | 58.27 | 79.76 |
| **By sex** | | | | | | | |
| | Female | 22.94 | 35.37 | 48.16 | 53.20 | 58.52 | 79.52 |
| | Male | 24.91 | 35.76 | 47.66 | 54.08 | 59.62 | 82.73 |
| **By age** | | | | | | | |
| | <=49 | 14.76 | 26.65 | 36.10 | 41.03 | 48.46 | 69.05 |
| | 50-59 | 23.72 | 32.43 | 47.39 | 52.18 | 57.15 | 85.19 |
| | 60-69 | 26.22 | 38.89 | 49.17 | 53.86 | 57.04 | 79.35 |
| | >=70 | 29.93 | 47.05 | 59.46 | 71.12 | 81.95 | 100.00 |

**Table 4. Risk factors for hospitalisation**

| | Hazard ratio | 95% confidence limits | Significance |
|---|---|---|---|
| Females | 1 | | |
| Males | 1.17 | 0.92 – 1.50 | 0.197 |
| Age group | | | |
| 40-49 | 1 | | |
| 50-59 | 1.34 | 0.94 – 1.93 | 0.109 |
| 60-69 | 1.36 | 0.96 – 1.94 | 0.086 |
| >=70 | 2.08 | 1.41 – 3.08 | <0.001 |

**Table 5. Prevalence rates for hospital admission (primary diagnosis) for diabetic complications**

| Diabetic complication | % cases |
|---|---|
| **Macroangiopathy** | 15.6 |
| Ischaemic heart disease | 10.5 |
| Cardiac dysrhythmias | 2.1 |
| Heart failure | 1.4 |
| Cerebrovascular disease | 2.7 |
| **Eye problems** | 13.8 |
| Cataract | 13.3 |
| **Neuropathy** | 1.2 |
| Mononeuropathy | 1.0 |
| **Foot problems** | 0.6 |
| Foot and lower limb ulcer | 0.6 |
| **Infections** | 3.3 |
| Cholecystitis | 2.3 |

was macroangiopathy, for which 15.6% were admitted to hospital following diagnosis of diabetes (Table 5). The next most prevalent complication was eye problems (13.8%), a large proportion of which were cataracts (13.3% of all complications).

## Discussion

We found diabetic patients experienced increasing risk of hospital admission following diagnosis with an average hospitalisation rate of approximately 35 per 100 person years, which compares with an average rate of 28 per 100 person years for the general population of WA.[7] By 10 years after diagnosis, approximately 80% of patients had been hospitalised at least once, in line with previous work.[8]

That hospital admissions for diabetic complications before a diagnosis of diabetes were quite common suggests many patients had diabetes before diagnosis. We found similar rates of diabetic complications requiring hospital admission for heart disease, cataract, and stroke to the 1995 ABS National Health Survey.[1] There were discrepancies with lower observed kidney disease, blindness, glaucoma and amputation in our data, which may result from differences in hospital and self reported data or due to the relatively small sample of diabetic patients not reflecting the whole range of diabetic complications.

These data came from a pilot project and includes a small sample of patients. In the future we hope to expand the number of divisions involved to provide greater population coverage and better representation of patients. This may provide an effective mechanism for monitoring diabetic patients with serious health problems as well as disease management over time. The scope of the project could also be broadened to evaluate the relationship between the level of primary care and morbidity and mortality outcomes.

## Conclusion

Health outcomes for diabetic patients can be monitored in terms of hospital admissions for diabetic complications. This can be achieved systematically by linkage of diabetic registers to hospital morbidity data. Such monitoring is important in measuring the quality and effectiveness of primary health care for patients with type 2 diabetes.

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### Implications of this study for general practice

- The hospital admission rate of diabetes patients remains higher than in the general population (35 vs 28 per 100 person years).
- Diabetic patients suffer serious comorbidity requiring admission.
- Diabetic patients who are older and have long standing disease are at highest risk of hospital admission.
- Outcomes of populations of diabetic patients can be monitored by linkage of general practice diabetic registers to hospital data.


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