Investigation of cardiovascular risk factors in type 2 diabetes in a rural Australian Division of General Practice

Qing Wan, Jane Taggart, Mark F Harris, Upali W Jayasinghe, Warwick Ruscoe, Jill Snow and Gawaine Powell Davies

ABSTRACT

Objective: To examine the changes in cardiovascular disease (CVD) risk factors for a cohort of patients with type 2 diabetes in general practice.

Design and setting: A 4-year retrospective cohort study using extracted data from an active Division of General Practice diabetes register in Australia.

Participants: 628 patients (297 female; 331 male) with type 2 diabetes who participated in the diabetes program of the Southern Highlands Division of General Practice and for whom evaluation data were recorded each year from 2002 to 2005.

Main outcome measures: Changes in the following CVD risk factors over time: body mass index (BMI), serum lipid levels (total cholesterol [TC], low-density lipoprotein cholesterol [LDL-C], high-density lipoprotein cholesterol [HDL-C], total triglycerides [TG]), systolic and diastolic blood pressure (BP), and glycated haemoglobin (HbA_{1c}) level.

Results: After adjusting for age, sex, duration and clustering, there was significant improvement in serum lipid levels (TC and LDL-C; $P < 0.05$) over time; and there was no significant change in BP, HbA_{1c} level or BMI. Older patients had significantly worse systolic BP, but significantly better BMI and lipid levels than younger patients. Longer duration of diabetes was associated with worse systolic BP and HbA_{1c} level, but better HDL-C level. People with higher BMI were likely to have worse systolic BP, and HDL-C and HbA_{1c} levels, but better TC level than those with lower BMI.

Conclusions: Improving BP, HbA_{1c} level and BMI may be more difficult than improving lipid levels. There is a need for more intensive and comprehensive interventions to reduce the total risk of CVD.

MJA 2008; 189: 86–89

Type 2 diabetes affects more than 7.4% of the Australian population older than 25 years.[1] Cardiovascular disease (CVD) is the leading cause of death in Australia, accounting for 36% of all deaths in 2004,[2] and 17% of the burden of disease.[3] People with diabetes are two to four times more likely to develop CVD than those without diabetes,[4] with about 55% of people with diabetes dying from CVD.[5] More than 80% of Australians aged 45–65 years visit a general practitioner at least once a year, and GPs provide most management for patients with hypertension, diabetes and dyslipidaemia.[6] Therefore, improving the quality of preventive care of cardiovascular disorders in patients with diabetes in general practice is an important priority.

We previously conducted research on quality of care for people with diabetes in Australian general practices between 2000 and 2002, when a number of initiatives (eg, National Integrated Diabetes Program) were introduced to improve quality of care in general practice.[7-10] Our research suggested that intermediate outcomes such as glycated haemoglobin (HbA_{1c}) level, blood pressure, and lipid levels improved, but were still below optimal levels by the end of 2002.

In Australia, there have been cross-sectional studies on the clinical status of people with diabetes attending specialist diabetes services since 2002.[11] However, there has been little general practice research that investigates changes in CVD risk factors in people with diabetes. Our aims in this study were to examine the changes in CVD risk factors for a cohort of patients with type 2 diabetes between 2002 and 2005 in general practice. Our results are expected to inform future policy and practice relating to the management of patients with diabetes in Australian general practice.

METHODS

Context

The Southern Highlands Division of General Practice (SHDGP) is a rural Division, established in 1994, located 130 km south-west of Sydney. In 1995, the SHDGP began collecting diabetes clinical data in CARDIAB (a Division-based electronic diabetes register system[12]) from local general practices, and employed a diabetes educator. SHDGP provided various services, including identifying patients at risk and those who should be on insulin, one-to-one and group education for patients with diabetes, an exercise and lifestyle program, ongoing professional development for GPs, supporting practices with care planning, and electronic messaging of diabetes data from practice software to SHDGP. We found previously that GPs who use Division-based electronic diabetes registers are more likely to provide better-quality patient care than those who do not.[13]

The targets for diabetes care in this study (levels of $HbA_{1c} \leqslant 7\%$, total cholesterol [TC] < 4.0 mmol/L, low-density lipoprotein cholesterol [LDL-C] < 2.5 mmol/L, total triglycerides [TG] < 2.0 mmol/L, high-density lipoprotein cholesterol [HDL-C] ⩾ 1.0 mmol/L, and blood pressure [BP] < 130/85 mmHg) were based on the Australian guidelines for diabetes management in general practice in 2002. The only change between 2002 and 2005 was a small reduction in the BP target from 130/85 mmHg to 130/80 mmHg.[14]

Study population and sample

Based on population estimates using age and sex distributions from AusDiab (Australian Diabetes, Obesity and Lifestyle Study), an average of 85.8% of people with diagnosed diabetes in the SHDGP area were on the SHDGP register each year during the study period.[15,16] The remainder were assumed to have diabetes but not attend general practice, or to attend general practice but not consent to have their data registered with SHDGP. A cohort of patients with type 2 diabetes attending the annual evaluation during the study period was identified.

Sample size calculations on HbA_{1c} level confirmed that, after adjustment for clustering, 628 patients would have sufficient power ($1-\beta = 0.8$ and $\alpha = 0.05$) to detect an effect size of 0.13 between 2002 and 2005.

Data collection

De-identified patient information was extracted from CARDIAB. Criteria for data cleaning and management were based on the procedures used in our previous study,

1 Patient characteristics*

	2002	2005
BMI (kg/m^2)	30.9 (30.2–31.6)	30.7 (30.1–31.3)
Diastolic BP (mmHg)	79.5 (78.7–80.3)	76.9 (75.9–77.9)
Systolic BP (mmHg)	135.1 (133.7–136.5)	135.5 (133.9–137.1)
TC (mmol/L)	5.1 (5.0–5.2)	4.7 (4.6–4.8)
HDL-C (mmol/L)	1.3 (1.3–1.4)	1.4 (1.4–1.4)
LDL-C (mmol/L)	2.8 (2.7–2.9)	2.4 (2.3–2.5)
TG (mmol/L)	2.2 (2.1–2.3)	2.0 (1.9–2.1)
HbA_{1c}	7.1% (7.0%–7.2%)	7.2% (7.1%–7.3%)
Current smoker	10.6% (10.5%–10.7%)	11.3% (11.2%–11.4%)

BMI = body mass index. BP = blood pressure.
HBA_{1c} = glycated haemoglobin level.
HDL-C = high-density lipoprotein cholesterol level.
LDL-C = low-density lipoprotein cholesterol level.
TC = total serum cholesterol level.
TG = triglycerides level.
* Values are mean (95% CI). ◆

the Divisions Diabetes and CVD Quality Improvement Project (DDCQIP).[16]

Ethics approval

Ethics approval for this study was obtained from the Human Research Ethics Committee of the University of New South Wales.

Study variables and outcomes

Study variables included age, sex, duration of diabetes, BP, HbA_{1c} level, serum lipid levels, and smoking. Study outcomes were changes in these variables over time.

Analysis

SPSS version 14.0 (SPSS Inc, Chicago, Ill, USA) and MLwiN[17] (Centre for Multilevel Modelling, University of Bristol, Bristol, UK) were used to analyse the data. Comparisons were conducted by multilevel multivariate linear regression adjusting for age, sex and the duration of diabetes; this took into account the multiple observations (GPs and evaluation time) on the same patients and clustering.[18] To achieve the most parsimonious multivariate model, non-significant factors were excluded by backward elimination. Therefore, only the factors significantly associated with the outcomes ($P < 0.05$) were included in the final multilevel model.

RESULTS

During the study period, more than 90% of GPs in SHDGP (2002, 45/45; 2003, 46/46; 2004, 48/48; 2005, 50/54) participated in the diabetes program and provided annual clinical evaluation data. Our extraction generated 5358 patient records with all types of diabetes from 2002 to 2005. There were 3977 (74.2%) with type 2 diabetes (2002, 915; 2003, 927; 2004, 1053; 2005, 1082). A cohort of 628 patients (297 women; 331 men) with type 2 diabetes (on average, 63.2%) participated in the SHDGP diabetes program and attended the evaluation each year for the 4 years.

Changes in risk factors over the period

At baseline, systolic BP, TC, LDL-C and TG were all higher than the targets for general practice diabetes management (Box 1).[14] By Year 4 of the study, BP, HbA_{1c} level and smoking tended to be worse compared with baseline values, but BMI and lipid profile tended to improve. After adjusting for age, sex, duration, and clustering at patient and practice levels (Box 2), only TC

2 Coefficients (95% CI) and variances (95% CI) for the relationships between risk factors and other factors in the final multilevel regression model

Risk factors	Body mass index	Systolic BP	Total cholesterol	HDL-cholesterol	LDL-cholesterol	Triglycerides	HbA_{1c}
Coefficients (95% CI)							
Age	–0.33 (–0.41 to –0.25)	0.15 (0.09 to 0.21)	–0.13 (–0.19 to –0.07)	0.06 (0.00 to 0.12)	–0.10 (–0.16 to –0.04)	–0.14 (–0.20 to –0.08)	—
Sex*	0.23 (0.09 to 0.37)	—	0.20 (0.08 to 0.32)	0.34 (0.24 to 0.44)	—	—	–0.13 (–0.25 to –0.01)
Duration	—	6.18 (3.30 to 9.06)	—	2.44 (0.26 to 4.62)	—	—	10.00 (7.14 to 12.86)
Linear trend†	—	—	–0.10 (–0.14 to –0.06)	—	–0.11 (–0.15 to –0.07)	—	—
Body mass index	—	0.08 (0.02 to 0.14)	–0.07 (–0.13 to –0.01)	–0.11 (–0.17 to –0.05)	—	—	0.10 (0.04 to 0.16)
Systolic BP	0.02 (0.00 to 0.04)	—	—	—	—	—	—
HbA_{1c}	—	—	—	—	—	0.10 (0.06 to 0.14)	—
Lipids‡	HDL-C: –0.03 (–0.05 to –0.01)	—	—	—	—	—	TG: 0.94 (0.90 to 0.98)
Variance (95% CI)							
Patients	0.81 (0.71–0.91)	0.29 (0.21–0.37)	0.47 (0.39–0.55)	0.22 (0.18–0.26)	0.47 (0.39–0.55)	0.43 (0.37–0.49)	0.46 (0.38–0.54)
Evaluation year	0.04 (0.02–0.06)	0.63 (0.57–0.69)	0.34 (0.30–0.38)	0.20 (0.18–0.22)	0.31 (0.27–0.35)	0.31 (0.27–0.35)	0.31 (0.27–0.35)

BP = blood pressure. HbA_{1c} = glycated haemoglobin. HDL = high-density lipoprotein. LDL = low-density lipoprotein. * Sex: 0 = male, 1 = female. † Linear trend: trend of changes over 4 years. ‡ Lipids included total cholesterol, HDL-cholesterol, LDL-cholesterol, and total triglycerides. Standardised variables were used if continuous response variables had skewed distributions. Only significant coefficients and variances ($P < 0.05$) were included in the final regression model. ◆

and LDL-C significantly improved over the 4 years.

Associations between patient characteristics and risk factors

In the multilevel analysis, older patients had worse systolic BP, but better BMI and lipid profile than younger patients (Box 2). Compared with men, women had worse BMI and TC, but better HDL-C and HbA_{1c} level. Longer duration of diabetes was associated with worse systolic BP and HBA_{1c} level, but better HDL-C. People with higher BMI were likely to have worse systolic BP, HDL-C and HbA_{1c} level, but better TC than those with lower BMI.

DISCUSSION

After adjusting for age, sex, duration and clustering, we observed significant improvement in serum lipid levels (TC and LDL-C) over time, but no significant change in BP, HbA_{1c} level or BMI. This suggests that improving BP, HbA_{1c} level and BMI may be more difficult than improving lipid levels.

Strengths and limitations

Cohorts of patients from primary care disease registers can provide useful information on trends in quality of care for diabetes. However, this depends on the coverage of GPs and the population with diabetes. There was a high engagement of GPs (more than 90%) and a high proportion of patients with diabetes enrolled with the register (85.8%) in this study. Our data were retrospectively extracted from the practices without the selection bias that may occur in patients selected for a trial. Finally, we used multilevel analyses to adjust for clustering of patients recruited from general practices. Like all cohort studies and in the absence of a control group, it is not possible to attribute changes to particular interventions or policy. Furthermore, the conclusions may be generalised to other areas only with caution — the strong engagement of GPs with SHDGP may not be typical of other Divisions.

Changes of risk factors

In Australia, the management of hyperlipidaemia is mostly carried out by GPs.[6] In the SHDGP cohort, both TC and LDL-C decreased over the study period. This achievement may be attributed to greater attention by GPs to lipid pharmacotherapy and dietary education in patients with type 2 diabetes. Lipid levels tended to be better among older patients. This suggests that GPs may be providing more active treatment, there may be better compliance with treatment among older patients, or younger age may be associated with other worse risk factors (eg, BMI). There were no significant changes to the Pharmaceutical Benefits Scheme guidelines for prescribing lipid therapy over the study period. However, more recently there have been changes that will make it easier for GPs to offer pharmacotherapy to patients with diabetes.[19]

Compared with lipid management, control of BP and HbA_{1c} level is a more complex task. After adjusting for clustering, there were no significant changes over the study period in systolic BP, HbA_{1c} level or BMI (Box 2). Trend data from the United Kingdom Prospective Diabetes Study Group suggest that these physiological markers tend to worsen with time.[20,21] Thus, the absence of a negative secular trend for these indicators in our study is encouraging. It suggests the diabetes care in SHDGP may have prevented what might otherwise have been worse results. However, the low performance against targets for those indicators (Box 1) indicates a need for more comprehensive and intensive pharmacological and behavioural interventions to reduce these risk factors.

BMI did not improve over time and was associated with worse BP and HDL-C in our study. Currently, excess weight has replaced smoking as the most common risk factor for CVD in the Australian population.[22] The control of weight is even more challenging than control of BP and hyperlipidaemia, as it requires very active patient self-management.

Comparisons with other national and international studies

Box 3 compares our study with two other studies from Australian general practice: the national DDCQIP cohort,[8] and a smaller regional cohort from rural south-east Queensland (SEQ).[23] The significant changes in systolic BP and HbA_{1c} level in DDCQIP were not seen in the SHDGP study. In the SEQ study, BP improved, but HbA_{1c} level did not. An important reason for these differences may be the selection of practices and patients. Both the DDCQIP and SEQ

3 Comparison of risk factors among four studies

Characteristic	SHDGP		DDCQIP		SEQ		Steno-2	
No. of patients	628		3002		404		80	
Men	52.7%		48.6%		na		78.8%	
Age (years)	65.0		62.9		64.0		55.1	
Diabetes duration (years)	5.8		5.7		6		5.5	
Follow-up (years)	3		2		1		7.8	
Area	1 Division		16 Divisions		1 practice		1 diabetes centre	
Outcome	**Baseline**	**Change**	**Baseline**	**Change**	**Baseline**	**Change**	**Baseline**	**Change**
BMI (kg/m^2)	30.9	–0.2	30.5	–0.1	32.0	0.0	30.2	1.5
DBP (mmHg)	79.5	–2.6*	79.8	–1.6*	78.1	–7.0*	85.0	–14*
SBP (mmHg)	135.1	0.4	138.2	–2.0*	140.5	–3.1*	146.0	–12*
TC (mmol/L)	5.1	–0.4*†	5.1	–0.3*	5.2	–0.5*	5. 4	–1.3*
HDL-C (mmol/L)	1.3	0.1	1.2	0.02	1.2	0.02*	1.0	0.2
LDL-C (mmol/L)	2.8	–0.4*†	3.0	–0.3*	3.0	–0.4*	3.3	–1.2*
TG (mmol/L)	2.2	–0.2	2.2	–0.2*	2.3	–0.3*	2.2	–0.5*
HbA_{1c} (mmol/L)	7.1	0.1	7.4	–0.2*	7.4	–0.1	8.4	–0.5*
Current smoker	10.6%	0.7%	11.2%	–1.6%	12.6%	–2.2%	40%	1.5%

BMI = body mass index. DBP = diastolic blood pressure. DDCQIP = Divisions Diabetes and CVD Quality Improvement Project.[8] HbA_{1c} = glycated haemoglobin level. HDL-C = high-density lipoprotein cholesterol level. LDL-C = low-density lipoprotein cholesterol level. na = not available. SBP = systolic blood pressure. SEQ = south-east Queensland cohort.[23] SHDGP = Southern Highlands Division of General Practice (this study). Steno-2 = Steno-2 cohort study.[24] TC = total cholesterol level. TG = total triglycerides level. * $P < 0.05$ in the unilevel *t* test. † $P < 0.05$ in the multilevel analysis. ◆

studies involved a more selective group of volunteer practices and patients than the SHDGP cohort.

Internationally, our study can be compared with the Steno-2 cohort study[24] (Box 3) and the National Health and Nutrition Examination Survey (NHANES) cross-sectional surveys in the United States.[25] Steno-2 showed better improvements in BP, lipids and HbA_{1c} level. As a clinical trial, Steno-2 had a more selective study group with worse risk factors at baseline than in our study. Both NHANES and our study showed significant reductions in TC. However, NHANES also showed a significant decrease in systolic BP and an increase in BMI (whereas we found no change). This may be due to less aggressive management of BP in Australia than in the US, or may be an artefact of differences in the nature of the studies (NHANES is a repeated cross-sectional study rather than a cohort study).

Our research provides evidence of the quality of preventive care in cardiovascular risk for people with type 2 diabetes in one Division of General Practice. Despite national initiatives and an active Division program, after adjusting for covariates and clustering, only lipid levels improved over the 4 years. HbA_{1c} level, BP and BMI did not change significantly. This indicates the continuing challenge of managing these risk factors comprehensively in primary care, and the importance of very active treatment to targets identified in evidence-based guidelines.

ACKNOWLEDGEMENTS

This study was supported by a grant from the Australian Government Department of Health and Ageing. We thank all the GPs, general practice staff, Division staff and patients with diabetes for their cooperation and commitment to the Division's diabetes program.

COMPETING INTERESTS

None identified.

AUTHOR DETAILS

Qing Wan, MB BS, MPH, MMed, Research Officer, Centre for Primary Health Care and Equity[1]
Jane Taggart, BEd, DipPE, MPH, Senior Research Associate, Centre for Primary Health Care and Equity[1]
Mark F Harris, FRACGP, MD, Professor, General Practice[1]
Upali W Jayasinghe, MSc, PhD, Senior Statistician, Centre for Primary Health Care and Equity[1]
Warwick Ruscoe, MB BS, RACGP, Chief Executive Officer[2]
Jill Snow, RN, Diabetes Nurse Consultant[2]
Gawaine Powell Davies, BA, MHP, Chief Executive Officer, Centre for Primary Health Care and Equity[1]
1 School of Public Health and Community Medicine, University of New South Wales, Sydney, NSW.
2 Southern Highlands Division of General Practice, Bowral, NSW.
Correspondence: q.wan@unsw.edu.au

REFERENCES

1 Dunstan DW, Zimmet PZ, Welborn TA, et al. The rising prevalence of diabetes and impaired glucose tolerance: the Australian Diabetes, Obesity and Lifestyle Study. *Diabetes Care* 2002; 25: 829-834.
2 Australian Institute of Health and Welfare. Australia's health 2006. Canberra: AIHW, 2006. (AIHW Catalogue No. AUS 73.)
3 Begg S, Vos T, Barker B, et al. The burden of disease and injury in Australia 2003. Canberra: AIHW, 2003. (AIHW Catalogue No. PHE 82.)
4 Wu T, Brooks B, Yue D. Macrovascular disease: the sword of Damocles in diabetes. In: Turtle JR, Kaneko T, Osato S, editors. Diabetes in the new millennium. Sydney: Endocrinology and Diabetes Research Foundation, University of Sydney, 1999.
5 Geiss LS, Herman WH, Smith PJ, National Diabetes Data Group. Diabetes in America. Bethesda, Md: National Institute of Diabetes and Digestive and Kidney Diseases, 1995: 233-257.
6 General practice in Australia: 2004. Canberra: Australian Government Department of Health and Ageing, 2005.
7 Wan Q, Harris MF, Jayasinghe UW, et al. Quality of diabetes care and coronary heart disease absolute risk in patients with type 2 diabetes mellitus in Australian general practice. *Qual Safety Health Care* 2006; 15: 131-135.
8 Georgiou A, Burns J, McKenzie S, et al. Monitoring change in diabetes care using diabetes registers: experience from Divisions of General Practice. *Aust Fam Physician* 2006; 35: 77-80.
9 Australian Government Department of Health and Ageing. National Integrated Diabetes Program. http://www.health.gov.au/internet/wcms/publishing.nsf/content/pq-diabetes-integ (accessed Jan 2008).
10 Australian Government Department of Health and Ageing. Chronic disease management (CDM) Medicare items. http://www.health.gov.au/internet/wcms/publishing.nsf/content/pcd-programs-epc-chronicdisease.htm (accessed Jan 2008).
11 National Association of Diabetes Centres. Australian National Diabetes Information Audit and Benchmarking (ANDIAB) 2006. http://www.health.gov.au/internet/wcms/publishing.nsf/Content/pq-diabetes-pubs-andiab06 (accessed Jan 2008).
12 Burns JR, Bonney M, Powell Davies G, Harris MF. Utilisation of the CARDIAB database system to promote quality of care in Australian general practice. *Health Informatics J* 2004; 10: 177-184.
13 Harris MF, Priddin D, Ruscoe W, et al. Quality of care provided by general practitioners using or not using Division-based diabetes registers. *Med J Aust* 2002; 177: 250-252.
14 Harris P, Joyner B, Phillips P, Webster C. Diabetes management in general practice. 9th ed. Sydney: Beaver Press, 2002.
15 Centre for Primary Health Care and Equity. Development of the standard national questions and population health estimates to support the implementation of the national performance indicators for Divisions of General Practice. Sydney: UNSW, 2006. http://notes.med.unsw.edu.au/CPHCEWeb.nsf/page/Reports (accessed Jan 2008).
16 Georgiou A, Burns J, Wan Q, et al. Divisions Diabetes and CVD Quality Improvement Project: analysis of Division-based diabetes register recall data (2000–2002). Sydney: Centre for General Practice Integration Studies, School of Public Health and Community Medicine, University of New South Wales, 2004.
17 Goldstein H, Rasbash J, Plewis I, et al. A user's guide to MlwiN. London: Institute of Education, University of London, 1998.
18 General practice in Australia: 2000. Canberra: Australian Government Department of Health and Aged Care, 2000: Table 4.31.
19 Australian Government Department of Health and Ageing. Pharmaceutical Benefits Schedule 2007. General statement for lipid-lowering drugs prescribed as pharmaceutical benefits. http://www.pbs.gov.au/html/healthpro/browseby/explanatory-notes?ref=section2-gec10 (accessed Jan 2008).
20 Stratton IM, Adler AI, Neil HAW, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. *BMJ* 2000; 32: 405-412.
21 UK Prospective Diabetes Study Group. Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. *BMJ* 1998; 317: 703-713.
22 Australian Institute of Health and Welfare. Chronic disease and associated risk factors in Australia, 2006. Canberra: AIHW, 2006. (AIHW Catalogue No. PHE 81.)
23 Ackermann EW, Mitchell GK. An audit of structured diabetes care in a rural general practice. *Med J Aust* 2006; 185: 69-72.
24 Gaede P, Vedel P, Larsen N, et al. Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. *N Engl J Med* 2003; 348: 383-393.
25 Saydah SH, Fradkin J, Cowie CC. Poor control of risk factors for vascular disease among adults with previously diagnosed diabetes. *JAMA* 2004; 291: 335-342.

(Received 1 Aug 2007, accepted 11 Dec 2007) ❑