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Practice & Innovation

Hunter and New England Diabetes Alliance: innovative and integrated diabetes care delivery in general practice

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Abstract. Evidence-based standardised diabetes care is difficult to achieve in the community due to resource limitations, and lack of equitable access to specialist care leads to poor clinical outcomes. This study reports a quality improvement program in diabetes health care across a large health district challenged with significant rural and remote geography and limited specialist workforce. An integrated diabetes care model was implemented, linking specialist teams with primary care teams through capacity enhancing case-conferencing in general practice supported by comprehensive performance feedback with regular educational sessions. Initially, 20 practices were recruited and 456 patients were seen over 14 months, with significant improvements in clinical parameters. To date 80 practices, 307 general practitioners, 100 practice nurses and 1400 patients have participated in the Diabetes Alliance program and the program envisages enrolling 40 new practices per year, with a view to engage all 314 practices in the health district over time. Diabetes care in general practice appears suboptimal with significant variation in process measures. An integrated care model where specialist teams are engaged collaboratively with primary care teams in providing education, capacity enhancing case-conferences and performance monitoring may achieve improved health outcomes for people with diabetes.

Additional keywords: delivery of health care, diabetes mellitus type 2.

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Introduction

The escalating prevalence of diabetes necessitates innovative changes to health delivery systems. Primary care in Australia is struggling to cope with increased demand and complexity in treating people with type 2 diabetes (T2D). Treatment of diabetes is challenging, and the burden of disease is such that continuing with the current models of care is unlikely to achieve better health outcomes. Changing the landscape of diabetes requires a long-term vision and a multifaceted approach.

The Diabetes Care Project, the largest randomised controlled trial of diabetes patients in Australia (Department of Health 2015) led to three recommendations: need for improvements to continuous quality processes; better integration of primary and specialist services; and better funding models. The study also highlighted that an information technology platform alone did not lead to significant improvements. The Australian National Diabetes Strategy has identified several key principles, including better coordination and integration of services, patient-centred management and improved measurement of behaviours and outcomes (Department of Health 2018).

The Hunter Alliance, a collaborative partnership between Hunter New England Local Health District (HNELHD), Calvary Mater and the Hunter New England Central Coast Primary Health Network (HNECC PHN) was formed in 2014 with a common goal to provide quality care for patients with diabetes, chronic obstructive airways disease (COAD) and palliative care.

The aim of the Diabetes Alliance was to develop a new model of care that would deliver standardised evidence-based practice, integrate and coordinate services, support primary care, improve patient experience, reduce demands on tertiary clinics, reduce diabetes complications and reduce hospitalisations in the long term.

What is known about the topic?

- Primary care in Australia is struggling to cope with increased demand and complexity in treating people with type 2 diabetes.

What does the paper add?

- An integrated care model where specialist teams are engaged collaboratively with primary care teams in providing education, capacity-enhancing case-conferences and performance monitoring may achieve improved health outcomes for people with diabetes.

Initial assessment

The HNELHD in NSW has 910 000 residents living in an area of 131 000 km^2. An estimated 80 000 patients with T2D are managed in 314 general practices by 1032 individual GPs with the help of 700 practice nurses (PN). Equitable and timely access to specialist services has been difficult due to limited specialist resources, with three full-time equivalent (FTE) diabetes specialists in the public hospital, three FTE in private practice and two FTE specialist workforce for endocrinology equating 0.88 FTE per 100 000 population, significantly less compared with the Australian average of 2.2 per 100 000 population (Department of Health 2016), 10 FTE diabetes educators (DE) and the distance involved in serving rural and remote regions. Public specialist services are centred in the metropolitan city of Newcastle, with an 8 h drive to rural towns. Initial attempts at instituting integrated care with GPs, including establishing referral and triage criteria, local clinical guidelines (Health Pathways: a web-based treatment and local referral guidelines) and regular annual professional educational meetings, had limited influence on primary care diabetes management.

Prior to the Hunter Alliance, regional diabetes performance data in relation to accurate prevalence, process and clinical outcome measures were not available, which made service development and implementation difficult.

Methods

Proof of concept pilot project 2015–16

The Hunter Alliance leadership group consulted stakeholders including patient representatives, GPs, primary care organisations (Medicare Local and Hunter Primary Care, now known as Primary Health Network (PHN)) and local health district executives and developed the following vision statements:

(1) Deliver high-quality clinical care for patients with T2D within their usual general practice setting.
(2) Improve timely access for those who would benefit the most from tertiary services.

We envisaged achieving these goals by integrating specialist teams directly with GPs and PNs within the general practice setting and developed a four-part quality-improvement program that included:

(1) Whole practice diabetes data analysis and performance feedback.
(2) Three-day case-conferences in general practice.
(3) Structured educational programs for primary care clinicians.
(4) Regional aggregate diabetes-related data monitoring.

Hunter New England Health Ethics Committee approved this project (15/04/15/5.02). Consent was obtained before each consultation from participating patients.

Whole practice diabetes data analysis and performance feedback

Participating general practices installed a clinical audit tool PEN Clinical Audit Tool (PENCAT) (PenCS, Sydney, NSW, Australia; https://www.pencs.com.au/, verified 17 April 2019) and the entire practice data for active T2D patients were analysed. GPs and PNs were given detailed performance feedback by the visiting endocrinologist, with attention to process and outcome measures.

Case-conferencing at general practice with the aim to support primary care clinicians to work at the top of their scope

Initially, we recruited 20 general practices via expression of interest as a pilot project. Participating practices were required to have an IT system for data extraction, a practice nurse and a GP to participate in case-conferencing in a consultation room, but no other specific requirements. There was no limitation on number of staff in the practice. Medicare billing item numbers 743 (GP), 110 and 823 (physician) were applied for case-conferencing.

Patients were risk-stratified according to the Joslin Diabetes Center criteria (Rosenzweig *et al*. 2002) (see Appendix 1) and consultations were offered to moderate- to high-risk patients, although GPs and PNs were given flexibility to bring any patient whom they thought needed to attend the case-conference for educational and clinical reasons. Case-conference style consultations of 40 min duration with 10 patients per day were conducted in the general practice with their own GP, PN, a visiting diabetes educator and an endocrinologist. This approach delivers holistic patient-centred care, specific education and upskilling for GPs, and patient empowerment. Preparatory work was performed by PNs and PHN practice support development officers (PSDO) for ~30–60 min per patient, depending on the patient and practice organisation. Preparatory work included organising podiatry and eye review, up-to-date pathology and completing a diabetes clinical information sheet to aid consultation at case-conferencing. Preparatory work also served as a practical educational tool for PNs to understand their role in routine diabetes management.

During the case-conference, diabetes classification, complications and comorbidities were reviewed and treatment planning was made. In addition, smoking, nutrition, alcohol, physical activity, psychosocial issues, diabetes-related distress and depression were discussed. Each patient completed a 3-day food and blood glucose profile (all pre- and post-meal levels) and activity diary, which enabled better discussion on the benefits of healthy nutrition such as the Mediterranean diet and exercise for the management of T2D.

Recommendations were then implemented by patients and their usual GP without specialist clinic follow up. Following intensive education from the visiting specialist team, practice

staff were encouraged to offer standardised evidence-based care to their remaining patients without significant specialist input.

Each practice served as their own control group and information was collected at baseline, 6 months and 12 months. Information was collected in three categories:

(1) Metabolic parameters: Haemoglobin A1c (HbA1c), weight, blood pressure (BP), lipid profile (cholesterol, low-density lipoprotein (LDL), triglyceride and high-density lipoprotein (HDL)), urine albumin/creatinine ratio (ACR) and estimated glomerular filtration rate (eGFR).
(2) Changes in clinical processes: including appropriate medication usage (including use of angiotensin converting enzyme (ACE) inhibitors (ACEI) or angiotensin II receptor blockers (ARB) for albuminuria, statin for first-line lipid management), annual cycles of care completion, referrals and attendances to allied health practitioners.
(3) Patient experience: the Patient Activation Measure® (PAM®) (Insignia Health 2019) is a 10- or 13-item survey that assesses a person's underlying knowledge, skills and confidence integral to managing his or her own health and health care. The survey was completed by the patient at the time of consent with either the practice nurse/PSDO/project officer with minimal assistance, as per the survey guidelines. PAM segments individuals into one of four activation levels along an empirically derived 100-point scale. Individuals in the lowest activation level do not yet understand the importance of their role in managing their own health and have significant knowledge gaps and limited self-management skills. Individuals in the highest activation level are proactive with their health, have developed strong self-management skills and are resilient in times of stress or change.

The primary endpoint was improvement in HbA1c. The secondary endpoints were improvements in the metabolic parameters (weight, lipid profile, BP), improvement in patient experience and clinical processes. The analyses were implemented by the Hunter Medical Research Institute (HMRI) statistical consulting unit.

Statistical methods used

Measures reflecting quality of diabetes care were collected in the pre- and post-phase. These included: HbA1c, weight, BP, cholesterol/triglyceride/HDL/LDL, ACEI/ARB use, urine ACR performed, eGFR and 5-year cardiovascular disease (CVD) risk (as per the Swedish CVD risk calculator). In comparing pre- and post-values among those patients seen together between GPs and specialists using the case-conferencing model, a paired *t*-test was used for continuous outcomes and Chi-Square for categorical outcomes. In comparing pre- and post-values among all patients seen in the practices (to check for a 'spill over' effect), an unpaired *t*-test was used for continuous values and Chi-Square for categorical outcomes. In both cases, a two-tailed *P*-value threshold of 0.05 was used to judge significance. Pre- and post-values were not available for all patients, and so those with missing data were omitted from the paired data analysis but included in the unpaired data analysis. Number of tests over a specific time period were also expressed as a ratio of those expected under guideline concordant care; a ratio over one indicates testing a higher rate than recommended by guidelines and a ratio lower than one indicates a lower rate than recommended; pre- and post-ratios were compared using a ratio of ratios. This was analysed in a in a logistic mixed model to handle repeated measures, clustered by practice.

Pilot project evaluation

There were 82 000 active patients from 20 practices and 5746 patients with T2D (7%); 456 patients (8% of entire T2D cohort) were seen over 14 months and 80 GPs and 32 PNs, six endocrinologists and four DEs were involved in the consultations.

Baseline characteristics showed significant gaps in the care of patients with T2D across the entire cohort. Each practice had approximately ~6% of their practice population diagnosed with T2D and another 4% possibly had T2D but not yet diagnosed (estimated prevalence of T2D is 10%). Over the preceding 12 months, 32% had had no record of their BMI; 23% had no record of their HbA1c; of those measured, 10% had poor glycaemia with HbA1c >75 mmol/mol (9%). And 45% of patients had no record of a urine ACR and of those with positive microalbuminuria or hypertension or both, only 40% had received ACEI or ARB therapy. In addition, 30% of patients had documented annual care cycles completed, 30% had never seen a dietitian despite having a BMI >35 kg/m^2 and 35% had never seen a diabetes educator despite being on insulin therapy. Eye and feet examination details were not easily obtained for the majority of patients. For those patients who participated in the case-conferencing, retinal screening and feet examinations were conducted before consultation.

Following the intervention

Overall, 14 out of 20 practices supplied 6-month, follow-up data on the intervention patients. Data on 344 patients from 14 practices were analysed; the remaining six practices did not consent for their data to be released. The HbA1c levels showed highly significant improvement from 60.0 ± 16.2 to 55.3 ± 12.6 mmol/mol ($P < 0.001$); weight improved from 95.5 ± 20.9 to 94.5 ± 21.5 kg ($P = 0.006$); and systolic BP 134 ± 18 to 131 ± 17 mmHg ($P = 0.004$). The absolute 5-year cardiovascular risk improved from 18.4 (9.9 – 30.6) to 16.7 (8.5 – 28.6) % ($P < 0.001$). Patients reported feeling involved, comfortable and supported. As a result, PAM scores improved, showing improved knowledge and confidence in diabetes management.

Patient characteristics are shown in Tables 1 and 2 and Figure 1 shows a consort diagram. Most GPs who participated in the Alliance program expressed very high satisfaction (data shown in Table 3).

Limitations

Comprehensive follow-up data were not uniformly available; six out of 20 practices did not disclose their data despite initially consenting to data sharing. Among the practices who shared their data, follow-up data were not complete. For example, HbA1c levels were not available for 78/344 patients. It is unknown whether these patients had not returned to their practices or practitioners had not checked the parameters. As this project aimed at testing the implementation of evidence-based medicine in the real-life setting in an integrated healthcare system, data

Table 1. Baseline characteristics of patients ($n = 344$) from 14 practices

Variable	
Age (years)	63.2 ± 11.5
Male gender	50.9% (175)
Diabetes duration (years)	9 (5 – 15)
Initial HbA1c (mmol/mol)	60 ± 16
Current smoker	9.6% (33)
Physical activity (<30 min day^{-1})	62.8% (216)
Past medical history	
Peripheral vascular disease	19.2% (25)
Cardiovascular disease	33.1% (114)
Diabetes foot complication	25.9% (89)
Cerebrovascular disease	4.7% (16)
Retinopathy	14.5% (50)
Chronic kidney disease	12.5% (43)
Hospitalisation for diabetes-related condition	10.8% (37)

Table 2. Change in mean scores between baseline and 6 months for intervention patients ($n = 344$) from 14 practices

If 6-month data were not available and the baseline levels were at guideline-recommended levels, the initial value was carried forward (HbA1c ≤55 mmol/mol; BMI ≤30 kg/m^2; total cholesterol <4.0 mmol/L; systolic BP <130 mmHg; urine ACR <3.5 mg/mmol). Values are reported as mean ± standard deviation, median (interquartile range) or % (n). HbA1c, Haemoglobin A1c; BMI, body mass index; ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin II receptor blocker; ACR, albumin/creatinine ratio; CVD, cardiovascular disease

Variable (n = number of patients with parameter collected at both initial assessment and follow up)	Initial	6 months	Missing	P value
HbA1c (mmol/mol) ($n = 266$)	60.0 ± 16.2	55.3 ± 12.6	78	<0.001
Weight (kg) ($n = 264$)	95.5 ± 20.9	94.5 ± 21.5	80	0.006
Total cholesterol (mmol/L) ($n = 263$)	4.3 ± 1.2	4.2 ± 1.1	81	0.03
Systolic BP (mmHg) ($n = 280$)	134 ± 18	131 ± 17	64	0.004
Diastolic BP (mmHg) ($n = 280$)	77 ± 12	74 ± 11	64	<0.001
ACEI or ARB use ($n = 199$)	70.4 (140)	73.4 (146)	145	0.51
Urine ACR <3.5 ($n = 257$)	80.9 (208)	82.9 (213)	87	0.19
Urine ACR >3.5 mg/mmol on ACEI/ARB ($n = 106$)	75.4 (49)	89.2 (58)	41	0.01
Absolute 5-year CVD risk (%, $n = 150$)	18.4 (9.9 – 30.6)	16.7 (8.5 – 28.6)	0	<0.001
PAM activation score (%; $n = 105$)	56.4 (47.4 – 68.5)	63.2 (56.4 – 75.3)	239	<0.001

collection was not made mandatory. Between 3% and 10% of practice patients attend more than one practice for their health care leading to some missing data.

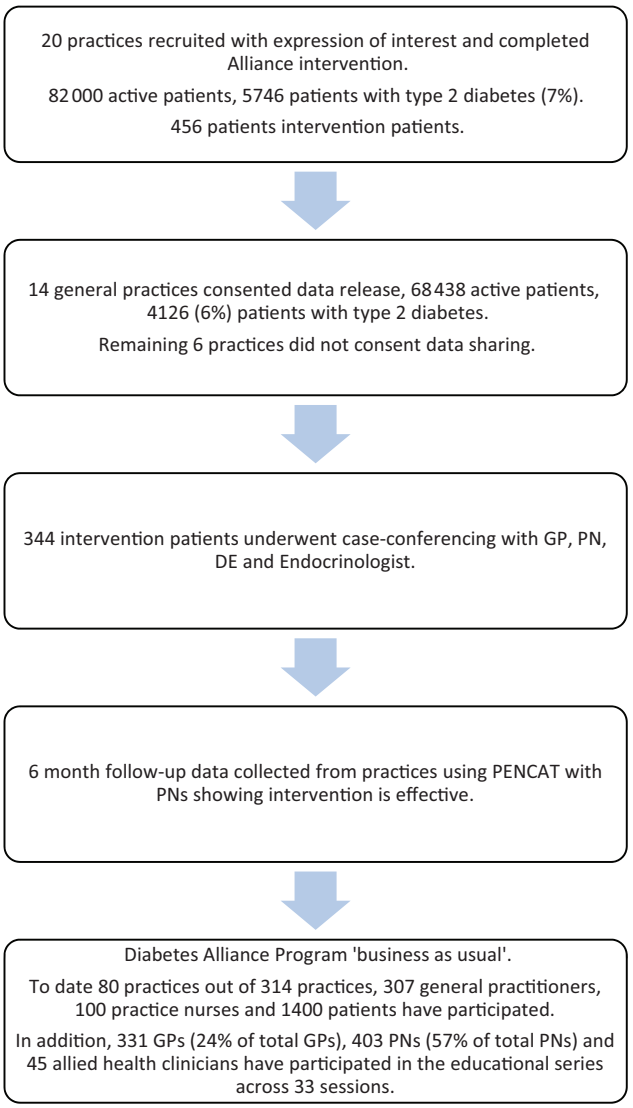

Fig. 1. Consort diagram. Diabetes Alliance, a partnership program with local health district and primary health network, developed an integrated diabetes care model linking specialist teams with primary health care team through capacity-enhancing case-conferences, whole practice diabetes performance feedback, regional diabetes aggregate registry and masterclasses.

Large-scale implementation

Our initial evaluation showed that single-time case-conferencing in the general practice setting with specialist and primary care teams was highly effective in improving glycaemic and metabolic parameters for those patients who participated. Due to overwhelming demand from general practices to participate in this program, the pilot project was promptly changed to 'business as usual' Diabetes Alliance Program (DAP) in 2017 and, to date, 80 practices, 307 GPs and 100 practice nurses have participated with 1400 patients.

To provide ongoing, clinically meaningful performance feedback to participating practices, we partnered with the Commonwealth-funded National Prescribing Service (NPS), MedicineWise (NPS MedicineWise, Surry Hills, NSW,

Table 3. GP satisfaction scales with Alliance intervention

GP questionnaire	Scales	Respondent results (n = 96)
Overall, how would you rate your satisfaction with your participation in this pilot project?	Very satisfied	77
	Satisfied	17
	Neutral	0
	Dissatisfied	0
	Very dissatisfied	2
Please indicate the extent to which the following learning objectives were met. I am now able to identify opportunities for process redesign or clinical/quality/safety improvement as a result of participating in this activity	Entirely met	71
	Partially met	25
	Not met	0
Please indicate the extent to which the following learning objectives were met: I am now able to identify diabetic emergencies and intervene early to improve clinical outcomes	Entirely met	66
	Partially met	29
	Not met	1
Please indicate the extent to which the following learning objectives were met: Participation in this project has enabled me to review current processes for the management of patients with diabetes and implement relevant changes to enhance clinical outcomes for my patients	Entirely met	85
	Partially met	11
	Not met	0
Please indicate the extent to which the following learning objectives were met: Participation in this project has enhanced my knowledge and skills in relation to pharmacological treatment options to suit individualised treatment goals and clinical outcomes for patients	Entirely met	73
	Partially met	23
	Not met	0
How relevant do you think these sessions were to your practice as a GP?	Entirely relevant	94
	Partially relevant	1
	Relevant	1
	Not relevant	0
Please indicate your confidence in assessment, investigation, management and referral for your patients with type 2 diabetes: Confidence PRIOR to participation in the project	Excellent	1
	Good	66
	Fair	26
	Poor	3
Please indicate your confidence in assessment, investigation, management and referral of your patients with type 2 diabetes: Confidence AFTER participation in the project	Excellent	51
	Good	42
	Fair	3
	Poor	0
Please indicate your satisfaction with project officers	Excellent	81
	Good	15
	Fair	0
	Poor	0
Please indicate your satisfaction with the endocrinologist	Excellent	86
	Good	10
	Fair	0
	Poor	0
Please indicate your satisfaction with relevance to your clinical practice	Excellent	96
	Good	9
	Fair	0
	Poor	0
Please indicate your satisfaction with relevance to the patients you care for	Excellent	89
	Good	7
	Fair	0
	Poor	0
Please indicate your satisfaction with timing of clinics	Excellent	73
	Good	21
	Fair	2
	Poor	0
Please indicate your satisfaction with clinic implementation	Excellent	80
	Good	15
	Fair	1
	Poor	0

Australia; http://www.nps.org.au/, verified 17 April 2019) program, as part of a sustainable solution. We installed the GRHANITE™ (GeneRic HeAlth Network Information Technology for the Enterprise) (The University of Melbourne, Melbourne, Vic., Australia; https://www.grhanite.com/, verified 17 April 2019) data extraction tool in each of the participating practices. Most general practice IT systems use Medical Director or Best Practice and are compatible with GHRANITE. If not compatible with GHRANITE, PENCAT was used to extract the data and in-house analysis and the report was given to participating practices. De-identified data from the practice was then incorporated into a NPS MedicineWise 16-page, detailed practice performance report (see Appendix 2 for a sample report). The performance report compares the participating practice with the other DAP practices and 500 Australian practices. The visiting endocrinologist delivers a detailed performance appraisal to the practice team during the visit. In addition, each practice received their own electronic data portal, which enables practices to re-identify at-risk patients shown on the performance report (for instance, those who have high HbA1c levels or those with albuminuria who are not receiving ACEI/ARB) to facilitate proactive diabetes care. Furthermore, each practice receives 6-monthly ongoing reports and further 'top-up' education and case-conferencing visits arranged as needed.

Using the de-identified data from each practice, a regional aggregate diabetes registry was developed for ongoing monitoring of participating practices, as well as for resource planning and service reconfiguration.

Funding enhancement

Workforce investment of 1.0 FTE diabetes specialist, 1.0 FTE diabetes educator, 1.0 FTE project officer, 1.0 FTE administrative officer and NPS data costs of A$700 for data extraction, analysis and reporting per practice per year has been shared between the Health District and Primary Health Network.

The GP practices included in this program had anywhere between 1 and 24 GPs, were heterogeneous in their opening hours and style of billing (bulk billing, gap fee, mixed) and for case-conferencing, all patients were bulk billed. In essence, there were no limitations on practice features and therefore the model is highly generalisable.

Long-term sustainability

The DAP is initiating commissioning of diabetes services within the general practice where a dedicated PN, supported by a dedicated diabetes educator and an endocrinologist, will enhance diabetes care delivery to maximum extent. Once all 314 practices are enrolled in the DAP, 40 practices per year will receive ongoing intervention, with additional commissioning as required for those practices needing further assistance. In addition, a co-commissioned diabetes care delivery model is being developed to integrate diabetes workforce across the local Health District and Primary Health Network.

Regional aggregate data

To date, 80 practices (with ~20 000 T2D patients) are participating in our regional diabetes registry and data analyses show significant variation in clinical process and outcome measures. Many practices do not appear to use the electronic data fields effectively in recording clinical parameters. For instance, although weight was recorded, lack of height means BMI is unknown; 26.2% of patients (range 5.5–68.5%) have no BMI recorded. A median of 21.5% patients have no record of any HbA1c tested in the preceding 12 months (range 6–51.4%). Most practices recorded blood pressure within the preceding 6 months (median 98.6%, range 100–76.7%). Similarly, lipids measurements in the preceding 12 months were conducted on most patients (median 93.3%, range 7.9–98.5%). Albuminuria screening was inadequate (median 41.6%, range 15.6–96.8%). Among those who were found to be hypertensive (BP >140/90) or albuminuric, only 45.7% of practice T2D population received ACEI/ARB (range 32.9–66.0%). Screening for retinopathy and diabetic foot disease is poorly recorded. We are currently monitoring the progress of participating practices on a 6-monthly basis and planning further interventions for those practices requiring significant support. Regional aggregate data are shown in Table 4 and Figure 2.

Spill over effects

As our goal is to improve the entire practice T2D population outcomes, we evaluated the 'spill over' effect of case-conference consultations in general practice to the rest of the diabetes

Table 4. Regional aggregate on performance measures

BMI, body mass index; HbA1c, Haemoglobin A1c; BP, blood pressure; ACR, albumin/creatinine ratio; ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin II receptor blocker

Measure	Median (%)	Range (%)
How many patients with type 2 diabetes have not had smoking status recorded?	3.5	0–25.7
How many patients have not had BMI recorded in the last 12 months?	26.2	5.5–68.5
How many patients have not had an HbA1c recorded in the last 12 months?	21.5	6–51.4
How many patients have not had BP recorded in the last 6 months?	1.4	0–23.3
How many patients have not had lipids recorded in the last 12 months?	6.8	1.5–92.1
How many patients are prescribed a statin?	59.5	42–78.9
How many patients have not had a urine ACR recorded in the last 12 months?	41.6	15.6–96.8
How many patients with elevated BP or urine ACR are prescribed an ACE inhibitor or ARB?	45.7	32.9–66.0
How many patients have not had a foot review recorded in the last 12 months?	50.4	7.9–100.0
How many patients have not had an eye check/referral recorded in the last 12 months?	65.0	16.7–100.0

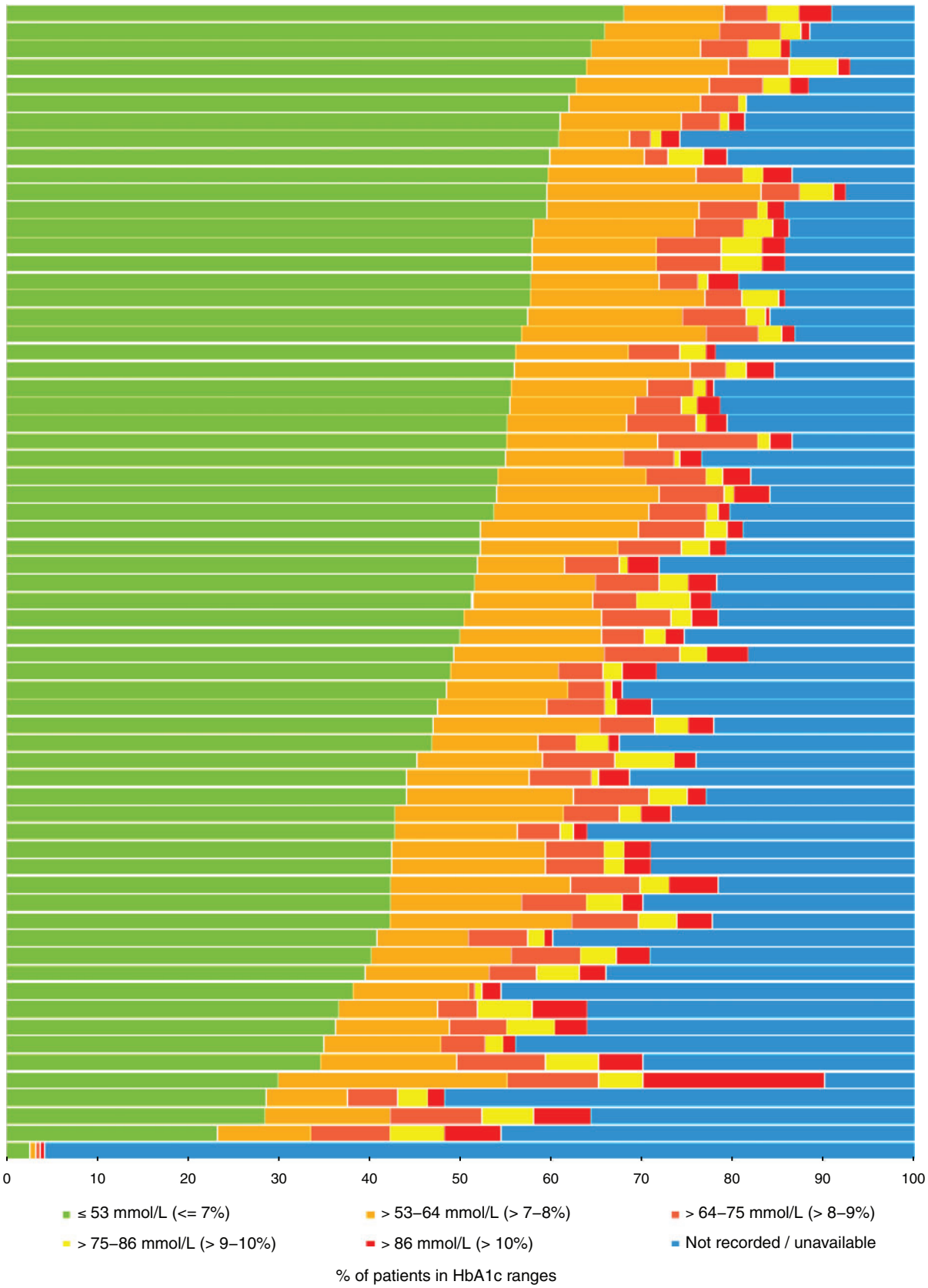

Fig. 2. Individual practice Haemoglobin A1c (HbA1c) ranges, each horizontal row represents practice aggregate HbA1c ranges.

population within the practice, expecting that the knowledge gained during the case-conference intervention from the participating GPs and PNs would 'spill over' to other diabetic patients not seen in case-conference. While we do not have sufficient 6-months follow-up data on all our intervention practices, preliminary assessments (Tables 5 and 6) show increased testing frequency and a modest improvement in clinical parameters in these patients not seen in case-conference.

Structured educational opportunities specifically designed to meet the needs of the practice

We developed a series of interactive educational sessions (three-part series, each 3 h in duration) covering relevant and contemporary topics in diabetes, delivered in the evenings across the health district. To date, 331 GPs (24% of total GPs), 403 PNs (57% of total PNs) and 45 allied health clinicians have participated in the educational series across 33 sessions.

Usefulness

The DAP is a comprehensive integrated care initiative with an emphasis on practice-level data analysis, performance feedback with suggestions for improvement and case-conferences within practices to impart practical knowledge to the primary care team and educational sessions. The emphasis of our intervention is not limited to participating patients, but encompasses diabetes patients across the whole practice. This program builds on specialist teams collaborating with primary care teams to support all clinicians to work confidently at the top of their scope.

This model has allowed more new patients to be seen in tertiary clinics, as there was no regular follow up needed for these participating patients because GPs and PNs take the responsibility for implementing specialist recommendations.

This model can be useful in building capacity across primary care for many chronic diseases such as heart failure, chronic kidney disease, COAD and mental health conditions. Qualitative

Table 5. Predicted number of tests (95% CI) per compliance for all diabetic patients pre- and post-intervention

Relative risk (RR) shows the ratio of the post- to pre-frequency of testing along with 95% confidence interval (CI). Results conditioned on uncertainty associated with random effects. Confidence intervals for predictions and RR are bootstrapped. HbA1c, Haemoglobin A1c; BMI, body mass index; BP, blood pressure; uACR, urine albumin/creatinine ratio; eGFR estimated glomerular filtration rate; HDL, high-density lipoprotein; LDL, low-density lipoprotein

Test	Interval	Pre (95% CI)	Post (95% CI)	Relative Risk (95% CI)
HbA1c	6	1.12 (1.02 – 1.24)	1.20 (1.03 – 1.34)	1.07 (0.92 – 1.19)
Weight	6	1.38 (1.21 – 1.54)	1.59 (1.36 – 1.84)	1.16 (1.01 – 1.31)
BMI	6	1.08 (0.93 – 1.26)	1.30 (1.09 – 1.54)	1.19 (1.06 – 1.44)
Systolic BP	6	2.35 (2.12 – 2.53)	2.79 (2.51 – 3.11)	1.19 (1.09 – 1.31)
Diastolic BP	6	2.35 (2.13 – 2.53)	2.80 (2.48 – 3.11)	1.19 (1.09 – 1.30)
uACR	12	1.40 (1.25 – 1.57)	1.53 (1.30 – 1.76)	1.09 (0.91 – 1.31)
eGFR	12	2.31 (2.09 – 2.59)	2.67 (2.27 – 3.02)	1.16 (0.97 – 1.30)
Serum creatinine	12	2.32 (2.05 – 2.57)	2.71 (2.33 – 3.10)	1.17 (1.02 – 1.33)
Triglyceride	12	1.84 (1.59 – 2.08)	2.21 (1.83 – 2.62)	1.21 (1.02 – 1.41)
HDL	12	1.67 (1.49 – 1.88)	1.79 (1.54 – 2.02)	1.07 (0.91 – 1.26)
LDL	12	1.64 (1.47 – 1.80)	1.74 (1.46 – 1.97)	1.07 (0.91 – 1.26)
Total cholesterol	12	1.81 (1.56 – 2.07)	2.18 (1.78 – 2.55)	1.20 (1.00 – 1.38)

Table 6. Predicted mean test value (95% confidence interval (CI)) for all diabetic patients pre- and post-intervention

Absolute difference (95% CI) between pre- and post-means are also shown. HbA1c, Haemoglobin A1c; BMI, body mass index; BP, blood pressure; uACR, urine albumin/creatinine ratio; eGFR, estimated glomerular filtration rate; HDL, high-density lipoprotein; LDL, low-density lipoprotein

Test	Pre (95% CI)	Post (95% CI)	Difference (95% CI)
HbA1c (%)	7.98 (7.76 – 8.18)	7.85 (7.59 – 8.07)	–0.14 (–0.27 to –0.01)
Weight (kg)	98.98 (96.76 – 101.21)	98.24 (95.95 – 100.33)	–0.74 (–1.36 to –0.25)
BMI	34.76 (34.03 – 35.60)	35.33 (34.44 – 36.26)	0.57 (0.11 – 1.05)
Systolic BP	134.62 (132.87 – 136.12)	135.11 (133.22 – 136.81)	0.49 (–1.02 – 1.68)
Diastolic BP	77.57 (76.15 – 78.65)	76.65 (75.14 – 78.13)	–0.92 (–1.63 to –0.11)
uACR (mg/mmol)	10.70 (5.29 – 15.77)	16.98 (10.36 – 23.74)	6.27 (–0.26 – 14.08)
eGFR	75.83 (73.69 – 77.94)	74.87 (72.50 – 77.32)	–0.96 (–2.12 – 0.11)
Serum creatinine (mmol/L)	84.19 (80.28 – 87.76)	85.97 (82.15 – 90.29)	1.78 (–0.91 – 4.86)
Triglyceride (mmol/L)	1.67 (1.48 – 1.87)	1.26 (1.11 – 1.46)	–0.41 (–0.55 to –0.28)
HDL (mmol/L)	1.11 (1.08 – 1.14)	1.10 (1.07 – 1.14)	–0.01 (–0.03 – 0.01)
LDL (mmol/L)	2.14 (2.01 – 2.25)	2.06 (1.90 – 2.19)	–0.08 (–0.19 – 0.03)
Total cholesterol (mmol/L)	4.28 (4.17 – 4.39)	4.21 (4.06 – 4.33)	–0.07 (–0.20 – 0.04)

comparison of processes of care under the current and Diabetes Alliance model is shown in Table 7.

Wider benefits included partnership and trust building between specialist and primary care, which has allowed hand over of existing patients at tertiary hospital clinics to their GPs following DAP intervention, facilitated telephone discussion and resolution of clinical questions rather than routine referral, and appropriate and timely referrals to specialist services when required. Many PNs and GPs reported increased competency and confidence in treatment escalation, including commencement of injectable therapy such as glucagon-like peptide-1 (GLP-1) analogue and insulin.

Discussion

Many lessons were learned during our intervention. Most importantly, engaging the principal GP and PN was of significant benefit. Detailed data feedback was helpful to support GPs and PNs to improve their process measures. Specialist teams also gained significant knowledge about primary care work flow, resource limitations and facilitated reconfiguration of services to accommodate interventions towards those who needed it the most, such as rural and remote regions. Reviewing regional aggregate data was helpful to understand the 'big picture' and currently strategic planning is underway to address persistent poor performance. It is also unclear how long the effects of the Diabetes Alliance visit last and how much of this learning 'spills over' to other patients not seen with the specialist and GP; this is currently being measured with NPS 6-monthly performance data.

Barriers identified

Some practices showed limited improvements with the DAP intervention. Though we are yet to explore the reasons, our initial experience indicates that the presence of an enthusiastic PN and a supportive principal GP, regular proactive scheduling of appointments with call and recall systems, were the likely winning factors. Smaller practices with four to six GPs had better DAP exposure as opposed to larger practices with many GPs (>12) where exposure to all GPs was difficult within 3 days; we are exploring further ways to enhance this exposure. Unfortunately, PNs are not mandatory in general practice in Australia; chronic disease management is facilitated by the presence of a PN as the main case manager and coordinator of care. Moreover, when specialist teams make the case for quality improvement recommendations to the practice, there is no legal binding or contractual agreement or influence on fund holding. Extensive educational input from the visiting specialist team focuses mainly on clinical factors, therapeutics and adherence to existing guidelines for GP care of patients with T2DM, but cannot fully address necessary practice organisational process changes, which would enable GP teams to improve care and maintain continuous quality improvement. There may be potential for the program to foster between-practice collaboration, incorporating the methodology of the Australian Primary Care Collaboratives Program (Knight *et al*. 2012), enabling GP teams to learn from each other about successful practice process changes resulting in improved care. Similar to our intervention, joint specialist case conferences have been conducted through Western Sydney Diabetes initiatives and has shown very similar efficacy (Meyerowitz-Katz *et al*. 2018).

The Steno 2 trial demonstrated significant reductions in cardiovascular events and mortality by up to 50% in at-risk diabetic patients through a multifactorial intervention including appropriate use of medicines and behaviour modification almost two decades ago (Gæde *et al*. 2003). However, large-scale implementation of such intervention is still far from reality. Recent publication from the National Diabetes Audit (NHS Digital 2018), England, has demonstrated significant improvements in diabetes care process, as outlined by the National Institute for Health and Care Excellence (NICE) UK, with ~95% of patients with diabetes receiving biochemical assessments such as HbA1c, cholesterol and creatinine; however, only 47% received all eight care processes; for example, further improvements needed in urine microalbuminuria screening. Commissioning of services, benchmarking against loco-regional and national standards and regular auditing appears to be essential elements of quality improvement. Currently, Australian health care is shared with Commonwealth-funded outpatient and primary care and State-funded public hospitals, which poses several challenges to overcome barriers of data linkage, information exchange and integration. Unless supported with appropriate policy changes, the DAP is unable to address the issues of persistent poor performance within the practice. Further research is needed to

Table 7. Qualitative comparison of processes of care under the current and Diabetes Alliance model

Current model	Alliance model
Consultations at hospitals	Consultations close to patients at their GP practices
No case finding	Case finding
Recommendations made to GPs, may not be implemented by GPs (various factors)	During case-conference, GP takes ownership of recommendations and implements it
Little upskilling for primary care team (letters only)	Intense upskilling including practice nurses, 'live demonstrations'
Limited information for specialists, consultations slowed for data collections (across multiple laboratories)	Full comprehensive information available in the GP database, saves time
Requires multiple follow ups and develops dependency on specialist teams, 'I have been coming for years'. **More referrals to outpatients**	No routine follow up from specialists, all follow ups at GP practice from primary care team, liaise with specialist if any concerns. **Less referrals to outpatients**
Limited partnership value	Excellent partnership
Did not attend rate = 30%	Did not attend rate = <3%
Limited follow-on effects	Potential to improve entire practice cohort

systematically study the 'implementation failure' in primary care and interventions to improve our population outcomes.

Conclusion

Integrated care requires close partnership arrangement between primary care, specialist care and local health district. The Diabetes Alliance Program initiative is only one aspect in the multipronged approach that is required to transform health care of people with diabetes in Australia, but it showcases an effective innovative model that could be translated across the country.

Conflicts of interest

The authors declare that they have no conflict of interest.

Acknowledgements

We sincerely thank all our patients who participated in this program. We thank our Health District and Primary Health network executive team for their sponsorship and support, NPS MedicineWise for their data management and feedback, GPs, practice nurses, Primary Health Network support staff, diabetes educators and endocrinologists who overwhelmingly supported this program. We wish to acknowledge Professor Soffia Gudbjörnsdottir, Director, National Diabetes Register, Sweden for sharing her knowledge and wisdom in establishing diabetes registry. This research did not receive any specific funding.

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Appendix 1. Joslin criteria for diabetes mellitus disease severity index.

	Very High Risk	High Risk	Moderate Risk	Low Risk
Glycemic control	HbA_{1c} ≥10% Hypoglycemia: severe/unconscious Frequent DKA (≥2/y)	HbA_{1c} ≥9% Hypoglycemic >3 times per week DKA <2/y	HbA_{1c} <9% and >7%	HbA_{1c} ≤7%
Cardiovascular disease	CHF: new or a change in treatment CABG or PTCA: recent/≤ mo New MI/other CVD event: recent/≤ mo Angina: unstable	CHF: stable, no change in treatment >6 mo CABG: History of (>6 mo) MI: History of (>6 mo) Angina: stable CAD CVA	Use of HTN, lipid medications Any 1 of the following risk factors (current/Hx): current smoker; BMI >27/obesity; triglycerides >400 mg/dL; LDL > 130 mg/dL; HTN/BP >130/85 mm Hg; microalbuminuria/proteinuria; PVD (levels 2, 3, and 4); LVH; autonomicneuropathy	No risk factors, signs and symptoms, or evidence of cardiac disease
PVD/peripheral neuropathy	Amputation: <1 y ago Ulcer/infection: recent/current Bypass: recent, <1 y Gangrene: current Charcot foot: active Acute ischemic foot	Amputation: > 1 y ago Ulceration/infection: History of > 1 y ago Bypass for PVD > 1 y Gangrene: History of >1 y ago Charcot: chronic	Peripheral neuropathy PVD Sensation: diminished or absent Ischemic changes Intermittent claudication Abnormal NIVS	Intact sensation (pinprick ≥2) and pulses or vibratory sense
Eye disease	PDR: high risk Retinal detachment Vitreous hemorrhage CSME Glaucoma: neovascular Postoperative care New blindness/vision loss	PDR: early NPDR: severe/very severe Early macular edema Pregnancy Mononeuropathy	PDR: quiescent NPDR: moderate Cataract: visually significant Glaucoma: chronic	No retinopathy NPDR: mild Cataract: not visually significant
Renal disease	Dialysis Transplant (recent) Chronic renal failure	Transplant >1 y Nephrotic syndrome Overt nephropathy Proteinuria: A/C ratio >300 μg/mg Serum creatinine >2.0 mg/dL	Microalbuminuria A/C ratio 20–300 μg/mg	A/C ratio <20 μg/mg Protein - negative
Autonomic neuropathy	(category not used)	Gastroparesis Hypoglycemia unawareness Neurogenic bladder Autonomic neuropathy Orthostatic hypotension Sexual dysfunction	(category not used)	No autonomic neuropathy

A/C ratio indicates ratio of albumin to creatinine concentration in the urine; BMI, body mass index; BP, blood pressure; CABG, coronary artery bypass graft; CAD, coronary artery disease; CHF, congestive heart failure; CSME, clinically significant macular edema; CVA, cerebrovascular accident; CVD, cardiovascular disease; DKA, diabetic ketoacidosis; HbA_{1c} , glycosylated hemoglobin; HTN, hypertension; LDL, low-density lipoprotein cholesterol level; LVH, left ventricular hypertrophy; MI, myocardial infarction; NIVS, noninvasive vascular studies; NPDR, nonproliferative diabetic retinopathy; PDR, proliferative diabetic retinopathy; PTCA, percutaneous transluminal coronary angioplasty; and PVD, peripheral vascular disease.

Appendix 2. NPS MedicineWise practice report: managing type 2 diabetes.

NPS MEDICINEWISE
MEDICINEINSIGHT

Our Alliance

Practice Report: Managing type 2 diabetes

Data at 1 May 2018

Welcome to the MedicineInsight report on managing type 2 diabetes

About this report

Sections 1 to 5 of this report present a range of information about how your practice team delivers care to patients with type 2 diabetes. They are intended to help you identify:

- the profile of your patients with type 2 diabetes
- the prevalence of lifestyle factors contributing to morbidity in patients with type 2 diabetes
- how many of your patients are reaching treatment goals
- which treatments your patients with diabetes are using
- where data quality improvements can be made and the benefits of making them.

Section 6 reviews the completeness of your overall data.

NPS MedicineWise recognises that every practice is different, with different patient populations, teams and work processes. In order to ensure relevance to each participating practice, we have separated this report into key sections, so that your practice can focus on what is important to you. Your MedicineInsight CSS will help you understand the data (what it can and can't tell you). Your CSS can also indicate appropriate NPS MedicineWise resources that can help optimise your patient care.

Notes:

- **Your practice** - indicates data from your practice's clinical information system
- **All HNE practices** - refers to aggregate data from all HNE practices participating in MedicineInsight
- **All practices** - refers to aggregate data from all MedicineInsight practices
- When we refer to **patients in this report,** we are looking at patients who are 'active' in your practice. An 'active patient' has visited the practice 3 or more times in the last 2 years and is not recorded as deceased or inactive in the clinical information system.
- **Patients with type 2 diabetes** are defined as those with a code or entry indicating diabetes (excluding gestational diabetes or any diagnosis ever of type 1 diabetes) in any of the history, reason for visit or reason for prescription fields.
- Aggregated data from all MedicineInsight practices are included for comparison purposes.
- Data are extracted from discrete fields within the software, not progress notes.
- A **'coded' diagnosis** means the field was filled by clicking on a selection from a list or dropdown rather than only typing into a field.
- In patient lists, patients are **assigned to a GP** if they have seen that GP in at least 2 out of their last 3 visits. Otherwise, they are assigned to the GP seen at the last visit.
- An **unavailable** result means the data were recorded but cannot be retrieved in a meaningful way.

Further information and feedback

Feedback on this report is always welcome. If you have any questions or feedback about this report, please contact MedicineInsight on 1300 721 726 or email medicineinsight@nps.org.au

1 PRACTICE PROFILE

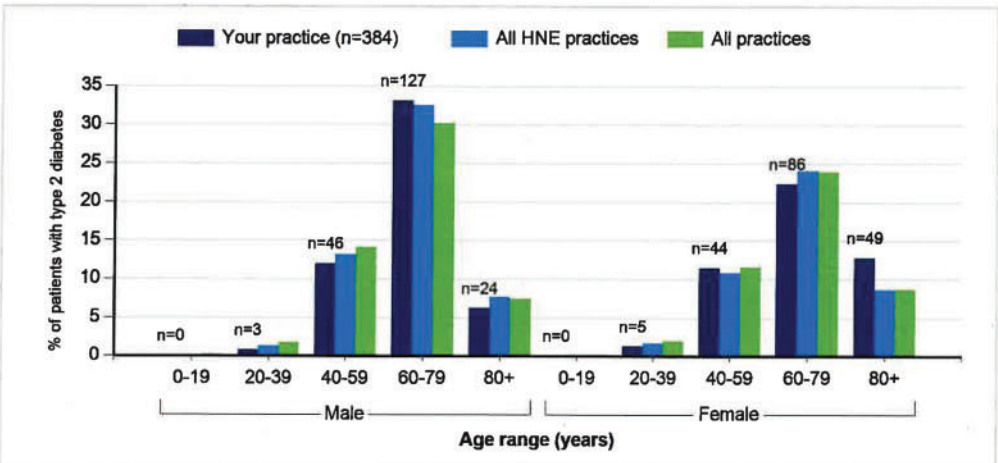
The prevalence of known diabetes in the Hunter New England and Central Coast Primary Health Network area is reported to be 5.5% compared to the national rate of 5.1% (as per NDSS data), with 86% of those with diabetes having type 2 diabetes.[1] However the estimated prevalence as per Hunter New England population health is 10.5%.[2]

This section shows the demographics of people with type 2 diabetes in your practice. A number of key characteristics of these patients are also displayed.

Who are your patients with type 2 diabetes?

	Your practice		All HNE practices	All practices
	Number of patients	%	%	%
All active patients in your practice	3,458			
Those with type 2 diabetes	384	11.1	6.5	5.7
Those with type 2 diabetes (diagnosis coded)	377	10.9	6.3	5.5
All active Aboriginal and Torres Strait Islander patients in your practice	163			
Those with type 2 diabetes	10	6.1	7.0	7.2
All active patients with type 2 diabetes	384			
Those seen in an aged care facility (in the last 12 months)	3	0.8	0.9	1.1

Age and gender profile of active patients in your practice with type 2 diabetes

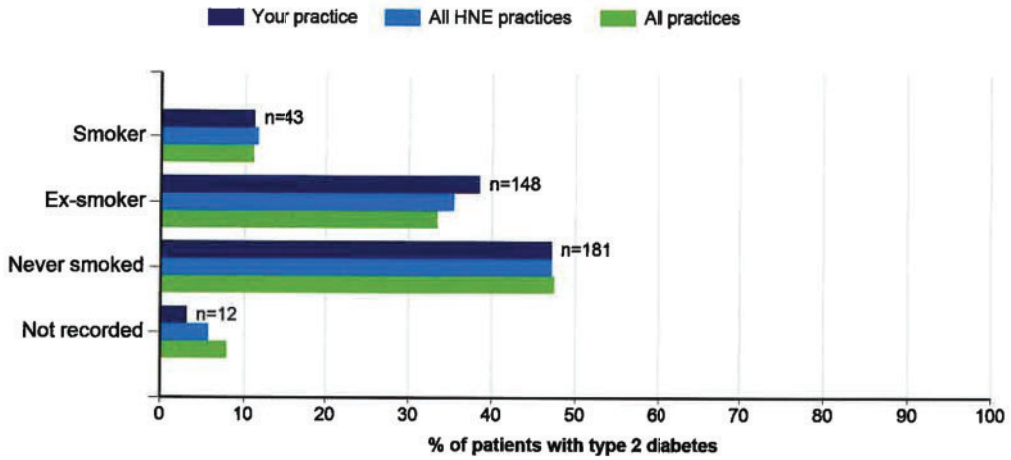


Point for reflection

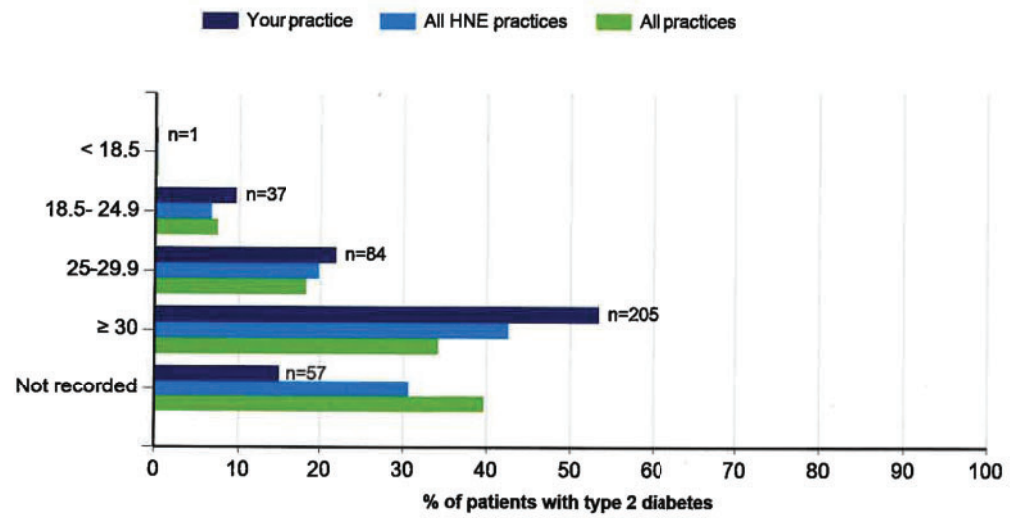
- Do these figures match your estimates of people with type 2 diabetes at your practice?

What modifiable lifestyle factors may be contributing to morbidity and mortality?

Current smoking status of your patients with type 2 diabetes



BMI (in kg/m2) in the last 12 months of your patients aged over 16 years with type 2 diabetes



Waist circumference recorded in the last 12 months in your patients aged over 16 years with type 2 diabetes

	Your practice		All HNE practices	All practices
	Number of patients	%	%	%
Patients with type 2 diabetes who had their waist circumference recorded in the last 12 months	167	43.5	35.4	25.9

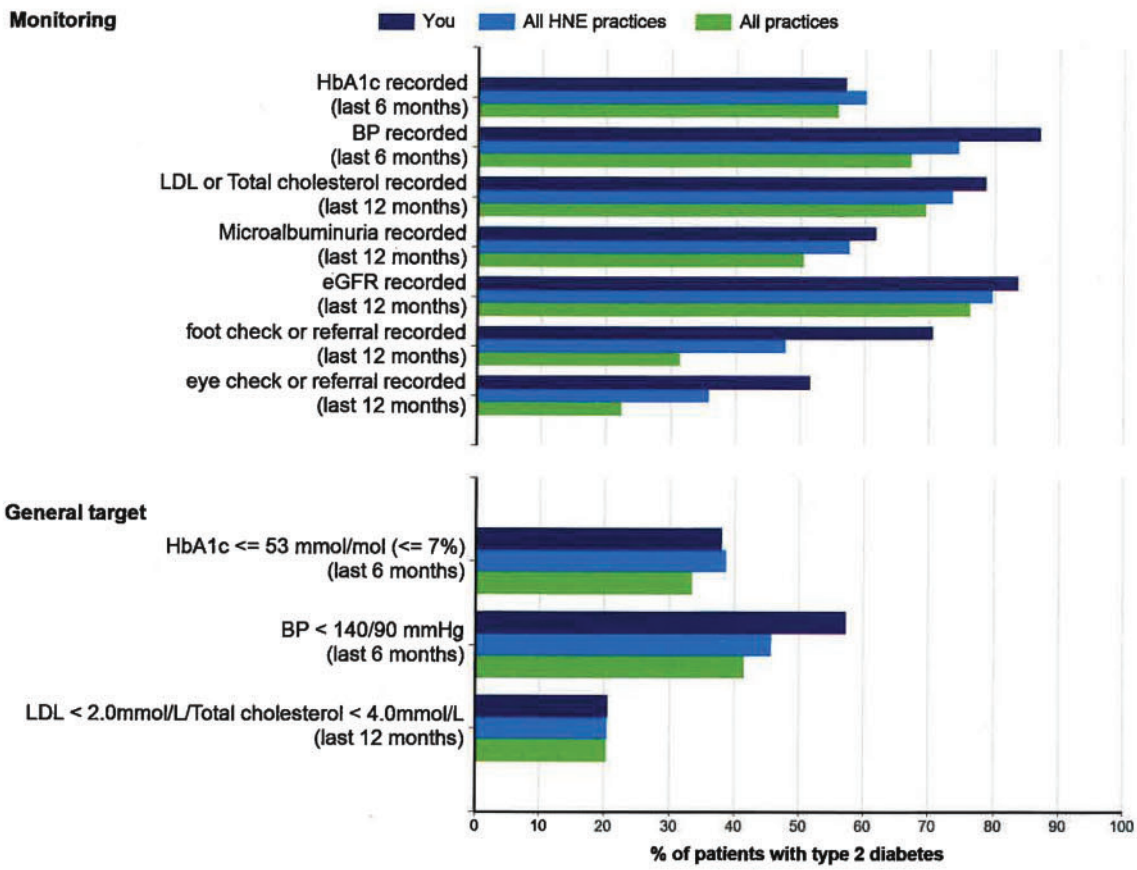
List 1 - your patients with type 2 diabetes who do not have smoking status or a recent BMI recorded.

2 MONITORING & TARGETS

General recommendations for monitoring [3]

3-6 monthly	Annually (if stable)
o HbA1c	o visual acuity (2-yearly retinal screening in absence of retinopathy)
o weight	o renal function (urine ACR and eGFR)
o blood pressure	o lipid profile
o feet (if at risk or symptomatic, otherwise annually)	o psychological well-being
o SNAP profile	o modifiable lifestyle factors

General Monitoring and targets for your patients with type 2 diabetes



List 2 - all of your patients with type 2 diabetes with recent results and monitoring and includes age, Aboriginal Torres Strait Islanders status, last visit date, current diabetes meds and usual GP

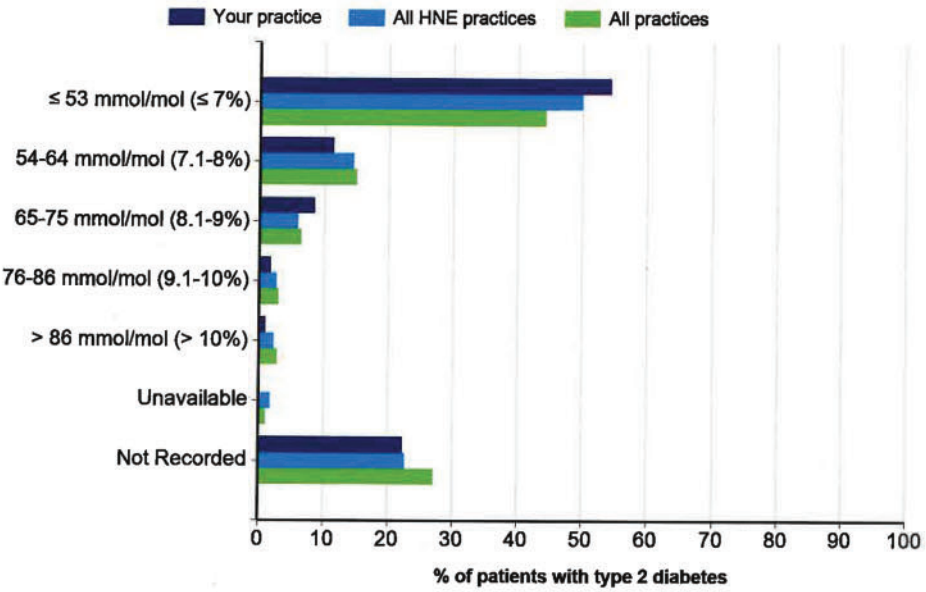
Point for reflection

- Managing type 2 diabetes requires regular assessment and timely treatment of microvascular and cardiovascular risk factors.

Individualised targets

Use the general HbA1c target of 53 mmol/mol (7%) for most people with type 2 diabetes. An HbA1c target greater than 53 mmol/mol (7%) may be appropriate in people with type 2 diabetes who have a history of severe hypoglycaemia, a limited life expectancy or co-morbidities, or who are elderly.[3]

Most recent HbA1c in the last 12 months

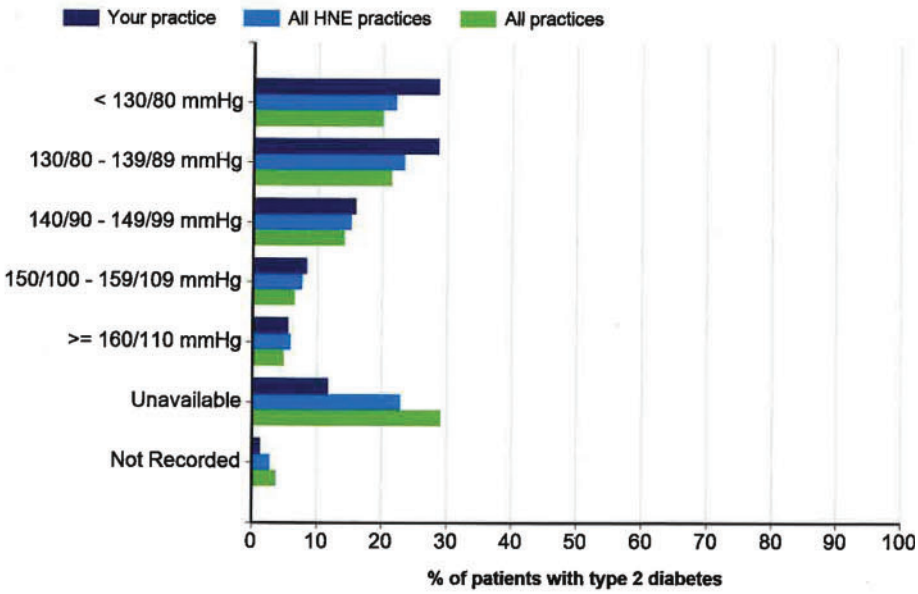


List 3 - all of your patients with type 2 diabetes who have not had a HbA1c recorded in the last 12 months.

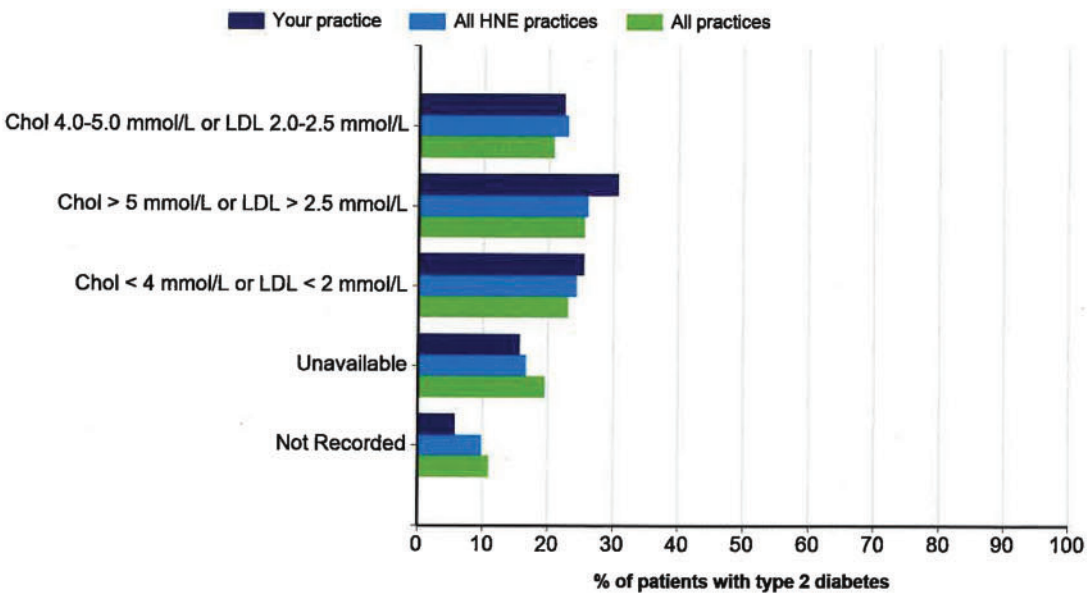
Point for reflection

- Does your practice have an agreed approach to review patients with type 2 diabetes at your practice? (time since last HbA1c, HbA1c > 86mmol/mol, patient factors)?

BP ranges for patients with type 2 diabetes in last 6 months



Lipid ranges for patients with type 2 diabetes in last 12 months



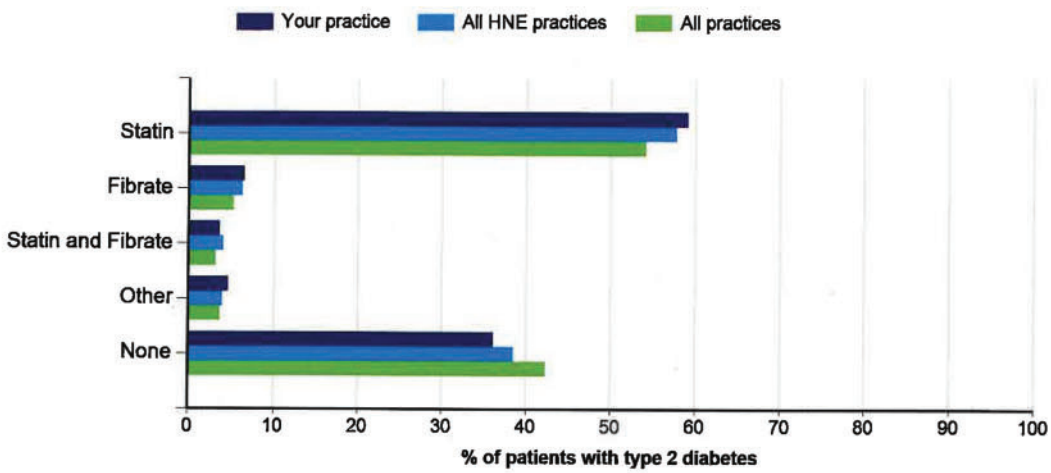
3 MANAGEMENT

Cardiovascular prevention

People with type 2 diabetes are twice as likely to die from cardiovascular disease as people without diabetes (over a five year period).[3]

Controlling blood pressure and lipid levels appears to be more effective in reducing adverse cardiovascular disease outcomes than tightening blood glucose levels alone.[5]

What lipid-lowering treatment are your patients with type 2 diabetes using?



Note: includes fixed-dose combination medicines of a lipid lowering medicine with a medicine from a different class.

List 4 - all of your patients with type 2 diabetes using a statin and not achieving target cholesterol < 4 mmol/L or LDL < 2 mmol/L.

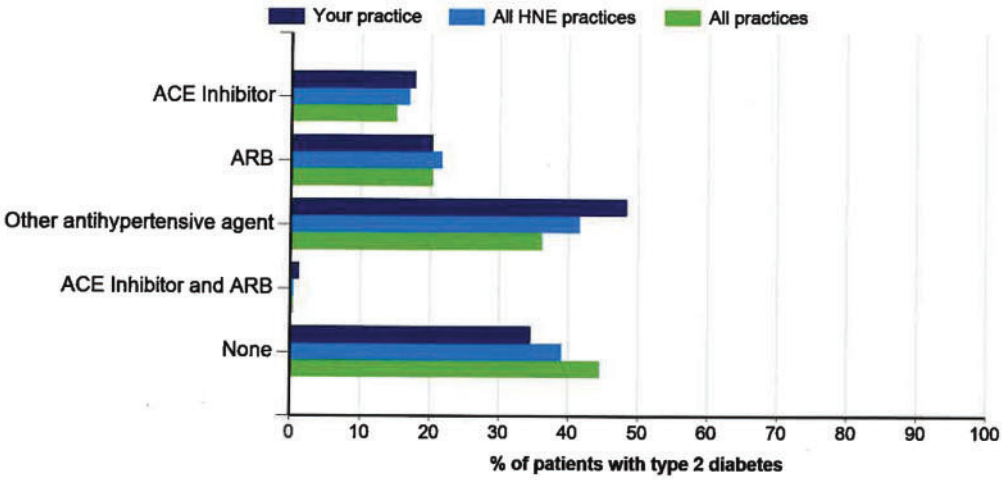
List 5 - all patients not using a lipid-lowering medicine with a total cholesterol > 4 mmol/L or LDL > 2 mmol/L or age > 60 years.

Point for reflection

- Statins are the most effective lipid-lowering medicines and should be used as first-line therapy. [3,4]

What antihypertensive treatment are your patients with type 2 diabetes using?

All antihypertensive classes have a similar effect on blood pressure. Guidelines recommend that blood pressure-lowering therapy in people with diabetes should preferably include an ACE-inhibitor or angiotensin II receptor antagonist.[6]

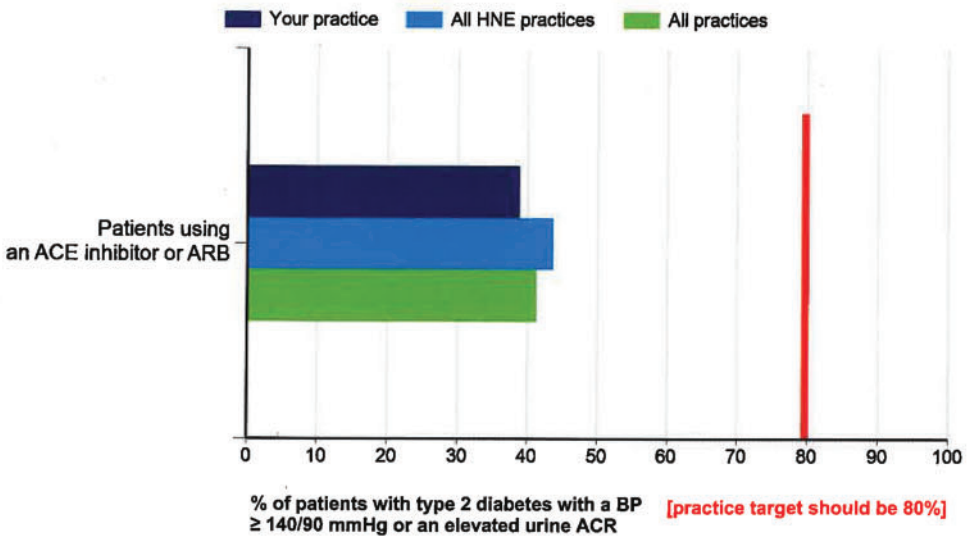


Note: includes fixed-dose combination medicines of an antihypertensive medicine with a medicine from a different class.

List 6 - all of your patients with type 2 diabetes using both an ACE inhibitor and an ARB. Current evidence suggests combining an ACE inhibitor and ARB is potentially harmful. Please review and modify therapy as necessary.

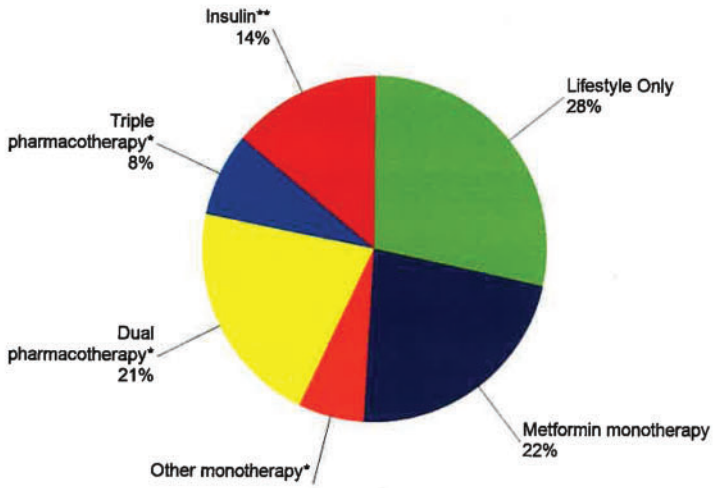
List 7 - all patients not using an antihypertensive medicine with BP ≥ 140/90 mmHg.

How many of your patients with a BP ≥ 140/90mmHg or an elevated urine ACR are taking an ACE inhibitor or ARB?



List 8 - all patients with microalbuminuria [UACR > 2.5 mg/mmol in men and > 3.5 mg/mmol in women] not prescribed an ACE inhibitor or ARB.

Glycaemic management



**excluding Insulin* ***alone or in combination*

Which of your patients might benefit from intensification of treatment?

Most recent HbA1c	Lifestyle only	Metformin monotherapy	Other monotherapy*	Dual therapy*	Triple therapy*	Insulin**
	n=109	n=86	n=24	n=81	n=30	n=54
≤ 53 mmol/mol (≤ 7%)	68	55	15	43	14	14
54-64 mmol/mol (7.1-8%)	5	8	2	19	5	5
65-75 mmol/mol (8.1-9%)	1	2	1	6	7	16
76-86 mmol/mol (9.1-10%)	0	0	1	0	2	4
> 86 mmol/mol (>10%)	1	0	0	0	0	3
Not Recorded	33	21	5	13	2	12

List 9 - your patients with an HbA1c above 53 mmol/mol (7%); includes age, current treatment, last visit date and usual GP.

4 CO-ORDINATION OF CARE

Optimal management and regular monitoring of people with type 2 diabetes can be supported by a range of mechanisms such as GP management plans and practice incentive payments.

This section describes some information on how care is provided for patients with type 2 diabetes in your practice. It may assist you to identify opportunities in your practice to further utilise existing Medicare chronic disease management arrangements.

Consultations* and referrals in your patients with type 2 diabetes.

Consultations* and encounters

	Your practice		All HNE practices	All practices
	n	%		
Your patients with type 2 diabetes	384			
Referral to diabetes educator within the last 12 months	1	0%	3%	2%
Referral to dietitian within the last 12 months	30	8%	8%	4%
Total PN consultations in last 12 months	487			
PN Consultations with patients with type 2 diabetes	459	94%	28%	30%
PN Encounters in last 12 months	6,020			
PN encounters with patients with type 2 diabetes	1972	33%	18%	16%

Management plans

Total patients with type 2 diabetes	384		%	%
Number of patients with a management plan (ie developed or reviewed in last 12 months; including multidisciplinary care)	250	65%	63%	51%
Number of patients with an Annual Cycle of Care plan completed in the last 12 months	198	52%	31%	20%
GP Mental Health Plan developed or reviewed within the last 12 months	16	4%	4%	4%

*Note: *Consultations (as opposed to encounters) are based on Medicare item numbers.*

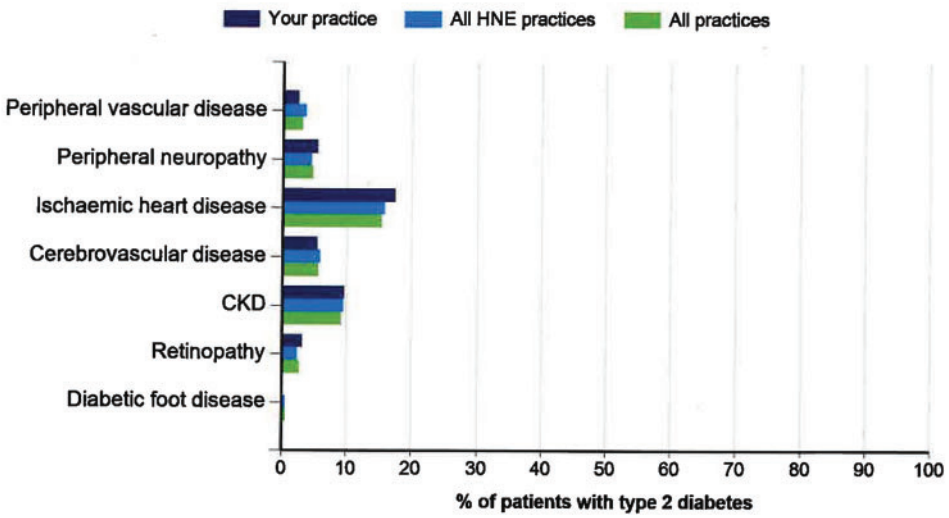
List 10 - your patients who have not had an annual cycle of care completed or reviewed, or a management plan developed or reviewed within the last 12 months.

Points for reflection

- Are there clear roles for the provision of care for patients with type 2 diabetes at your practice?
- Do you feel you are optimally using the management plans for your patients with type 2 diabetes?

5 COMPLICATIONS

In how many of your patients have coded complications of type 2 diabetes been recorded?

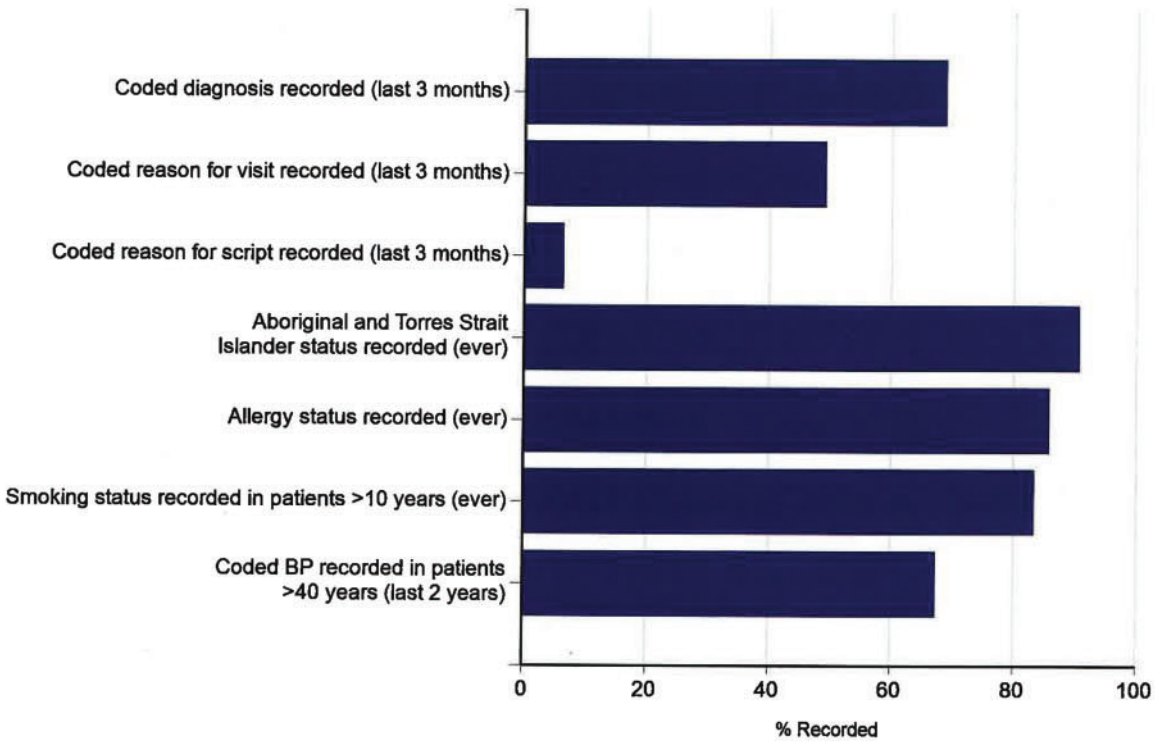


6 GENERAL DATA QUALITY

It is important that the data entered into your clinical information system is complete. Where possible, instead of just recording information in the free text progress notes, it is helpful to use designated boxes (eg, BP or BMI box) and select from dropdown lists when possible. This can have a range of benefits including:

- more accurate reporting of care provided during consultations, allowing review with assistance from MedicineInsight or other service providers
- easy transfer of information to other care providers when patients move
- easy transfer of information to My Health Record
- reporting for accreditation

The graph below indicates the completeness of data entered into your clinical information system for a range of common measures.



Points for reflection

- How important is data quality to you and your practice? What is your practice approach to ensuring data entered into the clinical software is of high quality?
- Who is responsible for driving and maintaining data quality at the practice?
- How does this reflect any actions committed to regarding data quality at the last visit?

Agreed clinical practice improvement step

Visiting Endocrinologist

Principal General Practitioner or equivalent