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Patients using diabetes Rx, including the under- and overuse of blood glucose testing (SMBG)

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Summary

Objective – To describe patterns of diabetes and related medication use and quantify the extent of blood glucose monitoring (SMBG) in patients receiving diabetes medications in New Zealand.

Design, setting and participants – Preliminary 12-month cross-sectional sample of national dispensing data for diabetes medications and diabetes management in New Zealand, where patients' identifying data were available (29% available in October 2002, 451338/1583455 dispensings). Data comprised of encrypted NHI-annotated scripts in NZHIS PharmHouse database (all dispensings in New Zealand claimed for reimbursement under the Pharmaceutical schedule). Adjustments were made for incomplete data for oral hypoglycaemic agents.

Main outcome measures – Estimated number of patients using diabetes medication combinations; co-dispensing rates of ACE inhibitors and statins in patients using diabetes medications; usage rates of blood glucose monitoring (SMBG), percentage actual versus ideal SMBG usage.

Results – An estimated 94800 patients used diabetes medications, of whom 32% used both an ACE inhibitor and statin and of whom an estimated 75% were recorded as also having been dispensed SMBG. One fifth of users of oral hypoglycaemics used neither an ACE inhibitor nor a statin. 17,700 patients used insulin alone and 77,100 used an oral hypoglycaemic with/without insulin (20,400 using metformin alone). Twenty percent of presumed Type 2 patients using diabetes medicines included insulin in their regimes. Overall 19% of patients changed regimes during the year (2/3^{rds} escalating their regimes, the other 1/3rd perhaps deescalating); this included 62% of patients starting on diet alone (and using SMBG) escalating to pharmacological therapy by the end of the year, with 19% escalation for metformin users.

There were wide-ranging variations from ideal use of self-monitoring of blood glucose (SMBG), as evidenced by the use of blood glucose test strips by various patient groups compared with predicted need. There was marked under-use of SMBG by patients using insulins compared with ideal, and over-use by patients using metformin alone or diet alone. Overall SMBG use was 44% of ideal. All patients using insulin appeared to have been dispensed SBMG, but with usage rates far lower than ideal. Ten percent of SMBG users appeared to be on diet alone, that is they were not ascribed as having been prescribed any diabetes medications during those 12 months.

Conclusions – [to do: primary conclusions and their implications, suggesting areas for further research if appropriate. Do not go beyond the data in the paper.]

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Objective

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Data source

PHARMAC has analysed encrypted-NHI patient-level PharmHouse utilisation data for patients using diabetes agents. These data related to a cohort of patients who were using any of the Diabetes or Diabetes Management pharmaceutical agents (as listed in the New Zealand Pharmaceutical Schedule) during the one month October 2002 whose prescriptions were annotated with their NHI number and which was captured in PharmHouse data.

The PharmHouse database (administered by NZHIS) contains data on all dispensings in New Zealand claimed for reimbursement under the New Zealand Pharmaceutical Schedule. Data extracted comprised all of subsidised utilisation episodes (prescriptions, dispensings and costs) per item for each patient for the twelve month period October 2002 to September 2003, including all Diabetes drugs and Diabetes Management, ACE inhibitors (including angiotensin-II inhibitors) and statins subsidised under the New Zealand Pharmaceutical Schedule. For simplicity, this cohort is named "October 2002 cohort" measuring 12-months dispensings.

Data were in effect censored at 30 September 2003. This was to mitigate against confusion in the data created by implementation of all-at-once dispensing on 1 October 2003 (where for instance oral hypoglycaemics could be prescribed at once (3-monthly dispensing), whereas insulins and blood glucose test strips remained on monthly dispensing only.

Arguments around the choice of a cohort approach, and then which cohort and measurement period, are discussed in the attached Appendix One.

Methods of analysis

Data extraction

Dispensing episode data were extracted from PharmHouse, limited to those records including patient-identifying data (encrypted NHI numbers) and downloaded to an Access database. Note that the encryption of NHI numbers is performed by NZHIS and is one way, so as to maintain confidentiality of the source data.

Using the unique encrypted NHI numbers, the monthly dispensings records were then cross-tabulated to form patient-based records covering the whole 12-months. These patient-based combinations comprised for each patient their particular combination of Diabetes medications, ACEs, statins and Diabetes Management prescribed and dispensed to them; using the following possible specific medications:

- diabetes medications:
    - insulins:
        - rapid acting insulin analogues – insulin aspart; insulin lispro;
        - short-acting preparations – insulin neutral;
        - intermediate and long-acting – insulin isophane; insulin isophane with insulin neutral; insulin zinc suspension;
    - oral hypoglycaemics:
        - sulphonylureas – glibenclamide; gliclazide; glipizide; tolbutamide;
        - biguanides – metformin;
        - other – acarbose;
    - hyperglycaemic agents – glucagon;

- diabetes management:
  - glucose/blood testing (SMBG) – glucose oxidase;
  - glucose &/or ketones/urine testing – glucose oxidase; sodium nitroprusside;
  - glucose/urine testing – glucose oxidase;
  - insulin syringes and needles - insulin pen needles; insulin syringes;

- agents affecting the renin-angiotensin system:
  - ace inhibitors – captopril; cilazapril; enalapril; lisinopril; perindopril; quinapril; trandolapril;
  - ace inhibitors with diuretics – cilazapril with hydrochlorothiazide; enalapril with hydrochlorothiazide; quinapril with hydrochlorothiazide;
  - angiotension II antagonists – candesartan; losartan;

- lipid modifying agents:
  - statins – atorvastatin; fluvastatin; simvastatin;
  - fibrates – bezafibrate; gemfibrozil;
  - resins – cholestyramine with aspartame; colestipol;
  - other lipid modifying agents – acipimox; nicotinic acid.

Adjustments for undercounting of SMBG

For blood glucose test strips (self management blood glucose – SMBG), we then adjusted for undercounting in the sample of those SMBG dispensings direct to patients by Diabetes Supplies Limited. Such dispensings could not be captured in the sample because they were claimed in bulk without individual encrypted NHI patient identifiers. Because this differentially affected SMBG and not other medications (which would be dispensed to individual patients and thus have some chance of being included in sampling), the effect would otherwise be to underestimate SMBG using patients captured in the sample.

Given a lack of information either way[1], we pragmatically adjusted for SMBG undercounting by assuming that these extra dispensings were equally likely to be:

(1) distributed across regimes preferentially according to ideal need[2] – where need is defined below; or

(2) distributed across regimes the same as what actually occurs in those individual patients identifiable through PharmHouse data[3] (NHI-encrypted data).

Given a similar lack of information[4], we likewise estimated related numbers of patients using SMBG (adjusting for the same undercounting from patients dispensed through Diabetes NZ not being to be

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[1] Extra SMBG dispensings distributed preferentially according to need would assume that those patients dispensed SMBG by Diabetes NZ were those with most need, e.g. rapid/short-acting insulin-dependent (hence perhaps more likely to be referred to Diabetes NZ). Conversely, extra SMBG dispensings distributed proportionate to NHI actuals would assume that those patients dispensed SMBG by Diabetes NZ were representative of those dispensed through community pharmacies. Which of these possibilities is likeliest is unknown.

[2] preferentially according to need: for each regime, $Na = N + (E \times \%i)$,
where Na = adjusted no. pyes, N = originally-calculated no. pyes,
E= no. total extra SMBG dispensings likely from Diabetes NZ dispensings, = total $N \times (1 + \%e)$
%i = % of ideal need, calculated [strip years for regime]/[total strip years for all regimes]– where 63% of strip use is needed for the likely 17% of pyes needing >2 SMBG/day

[3] proportionate to NHI actuals: for each regime, $Na = N \times (1 + \%e)$,
where Na = adjusted no. pyes, N = originally-calculated no. pyes,
%e = % extra SMBG NHI-encrypted dispensings likely from Diabetes NZ dispensings

[4] It could be that all patients who are dispensed SMBG through Diabetes NZ obtain only some of their strips this way, with the rest through community pharmacies. Hence all of these patients would be captured in the PharmHouse data, and there would be no extra SMBG patients – just extra SMBG dispensings. Alternatively, it could be that al patients dispensed SMBG through Diabetes NZ obtain strips solely this way. Hence none of these patients would be captured in the PharmHouse data, and all extra Diabetes NZ SMBG dispensings would mean extra SMBG patients. Which of these possibilities is likeliest is unknown.

included in sampling). Here we pragmatically assumed an equal likelihood that patients dispensed SMBG through Diabetes NZ were either always[5] or never[6] also dispensed prescriptions through community pharmacies – and where these extra patients were distributed as average of [preferentially according to need] and [proportionate to encrypted-NHI actuals]. [7]

Calculations for regime combinations, adjusting for undercounting of oral hypoglycaemics

Patient numbers, numbers of dispensings and numbers of dispensing-based person-years were then calculated for each combination. This included those pharmaceutical combinations where patients changed their medication regimes (i.e. changing from one medication combination to another) at any stage during the 12-month period (which would otherwise not be measured by a simple cross-sectional (i.e. block-period cohort) approach).

Because of missing data due to some dispensings for oral hypoglycaemic agents not being captured in the PharmHouse data[8], we adjusted for the consequent undercounting of numbers of patients and dispensings for sulphonylureas and metformin:

- Analysis of IMS unit volumes for the year to September 2002, compared against equivalent PharmHouse data for the same time period, suggests that PharmHouse volumes for metformin were 26% less than expected (26096604 units vs. 35297000), with sulphonylureas being 9% less (26099297 units vs. 28547000).

- We used these data to form unadjusted inflators to account for the missing patients using/dispensings of oral hypoglycaemics – adjusting for the small differences between PharmHouse and IMS unit totals due to IMS measuring stock-holding not usage (where for instance there were 4% higher salbutamol inhaler dispensings with the IMS data compared with PharmHouse actuals).

- This derived adjusted inflators of 1.05 and 1.30 for sulphonylureas and metformin respectively (see Table 1 below) – that is, we increased metformin volumes by one third, sulphonylurea volumes by five percent, and when patients were using both sulphonylureas and together we increased volumes by 24 percent[9]:

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[5] where all patients dispensed through Diabetes NZ were also dispensed through community pharmacies (captured in PharmHouse data), hence no extra patients

[6] where none of the extra dispensings were in patients who were dispensed through community pharmacies; that is, all extra dispensings were in patients who were dispensed SMBG solely through Diabetes NZ (hence not captured in PharmHouse data), hence extra patients

[7] calculated $Na = N + 0.5*[(N + (E \times \%i))/2 + (N \times (1 + \%e))/2]$,
where Na = adjusted no. patients, N = originally-calculated no. patients,
%e = % extra SMBG NHI-encrypted dispensings (and pye) likely from Diabetes NZ dispensings,
E= no. total extra SMBG patients likely from Diabetes NZ dispensings, = total $N \times (1 + \%e)$
%i = % of ideal need, calculated [strip years for regime]/[total strip years for all regimes]

[8] Three-monthly medication costs for metformin and some sulphonylureas were under $6 during the period of measurement. This meant that, even with Pharmacy mark-ups and other add-on expenses, dispensing costs would still be well under the $15 co-payment threshold for those patients without High Use cards or Community Services cards, at which pharmacists claim reimbursement through the NZ Pharmaceutical schedule. Consequently claims would not be made for these dispensings, and prescription and dispensing data for these patient episodes would not be captured in the PharmHouse data.

[9] This adjuster for patients using both sulphonylureas and metformin took into account that undercounting of metformin component would be partly offset by the greater likelihood of being counted because dispensed a sulphonylurea. Hence, before applying the 1.30 inflator for metformin undercounting, we first deflated numbers for the sulphonylurea component; hence the inflator for combined sulphonylurea/metformin use was derived 1.30/1.05 = 1.24.

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Table 1

IMS pharmaceutical index data
A10B oral antidiabetics
12 months to September 2002
'units' = no. of packs (where in PharmHouse "units" = total units tabs) - hence total units tabs = no. IMS "units" packs x tabs/pack

	IMS "units"	IMS equivalent PharmHouse Units	PharmHouse actuals 10/01-09/02	PharmHouse/ IMS	IMS/ PharmHouse (unadj inflator)	PharmHouse/ IMS incl stockholding	adjusted inflator (for IMS stockholding over-count)
sulphonylureas	298,000	28,547,000	26,099,297	91%	1.09	95%	**1.05**
biguanides	86,600	35,297,000	26,096,604	74%	1.35	77%	**1.30**
sulphonylureas+metformin							**1.24**
both	384,600	63,844,000	52,195,901	82%	1.22	85%	1.17

	IMS "units"	IMS equivalent PharmHouse Units	PharmHouse actuals 10/01-09/02	PharmHouse/ IMS	IMS/ PharmHouse (reqd inflator)	adjusted inflator (for IMS stockholding over-count)
glibenclamide	32,400	3,240,000	3,048,347	94%	1.06	1.02
gliclazide	137,700	13,770,000	12,267,583	89%	1.12	1.08
glipizide	125,100	11,247,000	10,432,905	93%	1.08	1.03
tolbutamide	2,900	290,000	350,462	121%	0.83	0.79
total	298,100	28,547,000	26,099,297	91%	1.09	**1.05**
reference group*: salbutamol MDI and BAD inhalers from IMS R 3A4 short-acting b2 stimulants, inh (salbutamol inh)	294,068,800	281,974,816	96%	1.04		1.00

*likely to be high volume (stability/prescision), expensive (hence avoiding co-payment undercounts), and in a stable market - gives an estimate of degree of over-counting by IMS data c.f. PharmHouse (stock-holding vs. actual usage)

Having inflated numbers of patients using sulphonylureas and/or metformin (be it alone or in combination with insulins) and dispensings, we then adjusted the numbers of patients who were not using any sulphonylureas or metformin. This was to account for an unknown proportion of the increased numbers of patients using sulphonylureas and/or metformin being originally miscoded as not using any sulphonylurea or metformin (when in fact they had – hence adjusted for by the inflator). This adjustment was based on two alternative possibilities:

1. Miscoding of patients as not using sulphonylurea or metformin (when in fact they had used either or both but had not been captured in the PharmHouse data) would mean that numbers of patients not using sulphonylureas or metformin would be over-estimates, with some being counted twice. To rectify this would require subtracting the same number of patients from non-sulphonylurea/non-metformin groups as what had been added to the sulphonylurea or metformin groups – with the proviso that revised numbers never fell below zero. This adjustment would mean reconciling the two classes of patients/dispensings.

2. Alternatively, some of the increased patients using sulphonylureas and/or metformin would be genuinely new patients, not miscoded and originally miscounted as "non-sulphonylurea/non-metformin" patients. Rather, these would be patients not captured by any of the PharmHouse data – they did not receive any other diabetes medicines or SMBG and hence were not measured in the original cohort. This would mean that all patients coded as non-sulphonylurea/non metformin were correctly coded, since they never received any oral hypoglycaemics.

Because it is unknown which of the two possibilities is likeliest, we pragmatically assumed each was equally likely – and used the average of the numbers calculated by each method. We adjusted for both SMBG and no SMBG use separately (see Table 1 below).

Table 2

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Patient categories						unadjusted nos. patients			adjustments				adjusted nos.		
Count of tblQryCombinations_TblFinalData_Encrypted HCU ID						SMBG			type of adjustment	size of inflators/adjustments			adjusted nos.		
Insulins	Insulin - rapid- or short-acting	Insulin - intermediate- & long-acting	Sulphonylurea	Metformin	Acarbose	yes	no	Total		SMBG adjuster	no SMBG adjuster	overall adjuster	adj SMBG	adj no SMBG	Total adj
yes	yes	yes	yes	yes	yes	2		2	inflated	1.24		1.24	2		2
					no	108	9	117	inflated	1.24	1.24	1.24	134	11	145
				no	yes	2		2	inflated	1.05		1.05	2		2
					no	60	9	69	inflated	1.05	1.05	1.05	63	9	72
			no	yes	yes	9		9	inflated	1.30		1.30	12		12
					no	402	53	455	inflated	1.30	1.30	1.30	521	69	590
				no	yes	10	2	12	unchanged/reconciled	0.84	1.00	0.86	8	2	10
					no	2,661	440	3,101	unchanged/reconciled	0.97	0.98	0.97	2,587	431	3,018
		no	yes	yes	no	11	2	13	inflated	1.24	1.24	1.24	14	2	16
				no	no	8	1	9	inflated	1.05	1.05	1.05	8	1	9
			no	yes	no	6	3	9	inflated	1.30	1.30	1.30	8	4	12
				no	no	60	12	72	unchanged/reconciled	0.75	0.69	0.74	45	8	53
	no	yes	yes	yes	yes	13	2	15	inflated	1.24	1.24	1.24	16	2	19
					no	755	159	914	inflated	1.24	1.24	1.24	934	197	1,130
				no	yes	12		12	inflated	1.05		1.05	13		13
					no	308	60	368	inflated	1.05	1.05	1.05	323	63	386
			no	yes	yes	12	3	15	inflated	1.30	1.30	1.30	16	4	19
					no	979	210	1,189	inflated	1.30	1.30	1.30	1,270	272	1,542
				no	yes	15	3	18	unchanged/reconciled	0.76	0.77	0.76	11	2	14
					no	1,830	446	2,276	unchanged/reconciled	0.87	0.88	0.87	1,588	395	1,982
no	no	no	yes	yes	yes	35	14	49	inflated	1.24	1.24	1.24	43	17	61
					no	3,987	2,110	6,097	inflated	1.24	1.24	1.24	4,930	2,609	7,539
				no	yes	11	5	16	inflated	1.05	1.05	1.05	12	5	17
					no	2,566	1,750	4,316	inflated	1.05	1.05	1.05	2,691	1,835	4,527
			no	yes	yes	4	4	8	inflated	1.30	1.30	1.30	5	5	10
					no	2,417	2,066	4,483	inflated	1.30	1.30	1.30	3,135	2,679	5,814
				no	yes		4	4	unchanged/reconciled		0.50	0.50		2	2
					no	2,933	1	2,934	unchanged/reconciled	0.70	-	0.70	2,040		2,040
Total						19216	7368	26584		1.06	1.17	1.09	20,430	8,627	29,057

Reconciled: assumes that some pts coded as non-oh are miscoded because they did receive oh and are included in inflated oh nos.
Unchanged: assumes that all patients coded as non-oh are correctly coded, since they did not receive oh; inflated oh nos. are therefore patients spuriously not identified

Population estimates

Numerical estimates for New Zealand were then derived through scaling by numbers of dispensings with NHI numbers compared with total PharmHouse dispensings for the same time period. This calculated both New Zealand wide estimated numbers of patients using particular medication combinations at any time during the 12 months (hierarchical order) and numbers of patient-months that each medication combination was used over the whole year.

To calculate numbers of patients with diagnosed diabetes putatively using diet alone (+/– blood glucose test strips (SMBG)) without specific diabetes medication treatments, we simplistically subtracted calculated numbers of users of diabetes medications from Ministry of Health estimates of 115000 patients with diagnosed diabetes.

Assessing under-/over-use of SMBG

To examine actual versus ideal use of SMBG, we firstly defined five mutually-exclusive groups of patients according to the following treatment-based hierarchy:

1. insulin +/- oral hypoglycaemic (oh), needing >2 SMBG/day;
2. inter-/long-acting insulin +/- oh, needing no more than 2 SMBG/day;
3. oral hypoglycaemics w/o insulin – sulphonylurea (+/- metformin or acarbose);
4. residual oral hypoglycaemics w/o insulin – metformin and/ or acarbose alone; and
5. no diabetes Rx.

We then defined ideal use of SMBG in each group as follows:

1. insulin +/- oral hypoglycaemics, needing >2 SMBG per day. These are patients using insulin, including oral hypoglycaemics with any rapid/short-acting insulin only, and including patients using inter-/long-acting insulin alone who have Type 1 diabetes, but exclude patients using oral hypoglycaemics with inter-/long-acting insulin only. Ideal use defined as 4 SMBG test strips/day
2. oral hypoglycaemics + inter-/long-acting insulin only, and inter-/long-acting insulin alone when used in patients with Type 2 diabetes – ideally 2 strips per day
3. sulphonylurea (+/- metformin or acarbose) – weighted average of 0.48 strips per day, derived from:

- ideally 4 to 8 strips per week for patients with HbA_{1C} >=7.0% (based on BNF 47 and NZGG diabetes guidelines), where these accounted for 47% in UKPDS 35[10] (see Table 3 below),
- perhaps once a week for patients with HbA_{1C} <7.0% (53% in UKPDS 35)

4. metformin and/ or acarbose alone – ideally perhaps one strip per week (broadly based on BNF 47, NZGG diabetes guidelines and PTAC subcommittee advice), = 1/7th of a strip per day,
5. no diabetes Rx (diet alone) – ideally one strip per day in every tenth patient, whilst contemplating regime escalation (broadly based on BNF 47 and NZGG diabetes guidelines), = 0.1 strips per day.

Table 3

UKPDS 35 Table 2. Incidence of complications in patients with type 2 diabetes by category of updated mean haemoglobin A_{1c} concentration (%).

	Events/person years	pye	%pye
<6%	229/9195	9195	24%
6% to <7%	391/11 432	11432	30%
7% to <8%	369/8464	8464	22%
8% to <9%	268/5605	5605	15%
9% to <10%	159/2542	2542	7%
>=10%	88/1334	1334	3%
total		38572	100%
<7%		20627	53%
>=7%		17945	47%

Rates per 1000 person years' follow up adjusted in Poisson regression model to white men aged 50 to 54 years at diagnosis of diabetes and followed up for 7.5 to <12.5 years, termed "10 years" (n=4585)

The definitions of ideal SMBG use were based on international guidelines re insulin use[11] [12], the advice of the expert focus group on SMBG convened by PHARMAC[13], the PTAC Diabetes Subcommittee, the NZGG diabetes guidelines, and the BNF:

- The expert focus group considered that:
  - for patients treated with a sulphonylurea (alone or in combination with other medications), testing be individualised to be conducted at times of hypoglycaemic risk, or when HbA_{1C} levels are in excess of 7%. It did not recommend routine testing that does not result in treatment changes;
  - for patients treated with metformin, a glitazone, or acarbose, no routine testing should be recommended when HbA_{1C} levels are well controlled;
  - for patients controlled by diet alone, no routine testing should be recommended when HbA_{1C} levels are well controlled.

- The expert focus group also considered that there would be exceptions to the above recommendations: where patients were required to test for occupational reasons; during periods of illness; during changes in medication regimes; following diagnosis where blood glucose levels are poorly controlled by treatment; in children and adolescents; and gestational diabetes. The focus group did not discuss testing frequency for patients with Type 1 diabetes.

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[10] Stratton IM, Adler AI, Neil HA, Matthews DR, Manley SE, Cull CA, Hadden D, Turner RC, Holman RR. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ. 2000 Aug 12;321(7258):405-12. http://bmj.bmjjournals.com/cgi/content/full/321/7258/405

[11] International Diabetes Center. Type 1 diabetes practice guidelines http://www.guidelines.gov/summary/summary.aspx?view_id=1&doc_id=4158

[12] International Diabetes Center. Type 2 diabetes practice guidelines http://www.guidelines.gov/summary/summary.aspx?view_id=1&doc_id=4159

[13] Meeting of focus group on self-monitoring of blood glucose, 2 March 2004 at PHARMAC . #78136

- The NZ diabetes guidelines state that testing before meals and at bed time on one or two days a week is reasonable for people with stable Type 2 diabetes, although for those with controlled diabetes on diet-only therapy, periodic HbA_{1C} monitoring may be sufficient.[14]

- The BNF notes that all sulphonylureas may cause hypoglycaemia but this is uncommon and usually indicates excessive dosage. Hypoglycaemia does not usually occur with metformin.[15]

- The commentary of the Working Group of the RCGP diabetes guidelines cautions that professionals need to reconsider the almost automatic assumption by many that self-monitoring is beneficial. "[Self monitoring] needs to be seen in the context of packages of self-care for the individual. If self-care packages are not considered important for particular individuals for whatever reason, there is little point in advocating self-monitoring in isolation."[16]

We finally used item counts for the relevant treatment groups to calculate actual use (total strip year equivalents, = no. patient-year equivalents x actual strips/pt/day = total dispensings x 50 strips/disp/365 days/year) , then relating these to ideal use (total no. patient-year equivalents x ideal use strips/pt/day).

All calculations are in spreadsheets #83507 v.2, #82966 and #83003 (linking from #81295, #80532, #81294, #81939, #80777, #81309).

Results

Numbers of dispensings and effects of scalers

For the October 2002 cohort measured over the 12 months October 2002-September 2003, we downloaded 642259 dispensing episode records with encrypted NHI information (257101 scripts). These comprised 451338 dispensings for diabetes medications/Management and 190921 dispensings for ACEs etc or lipid modifying agents.

These 451338 dispensings of diabetes medications/Management represent 28.5% of possible dispensings when compared with all PharmHouse dispensings of diabetes medications/Management over that same 12 month period (n=1583455).

To derive the NZ-wide estimates, we used the above 28.5% (viz. cohort sample/total PharmHouse dispensing rate for diabetes Rx over the 12 months October 2003-September 2004) to inflate for patient numbers (where total estimated no. for New Zealand = no. in sample / 28.5%).[17]

We lastly applied the inflators to adjust for undercounting of sulphonylurea or metformin use and possible over-counting of non-sulphonylurea/non-metformin use (as detailed in the methods section) – which increased overall numbers of patients by 14 percent (see tables in following results).

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[14] Best Practice Evidence-based Guideline. Management of Type 2 diabetes. NZ Guideline Group, December 2003. P29. http://www.nzgg.org.nz/guidelines/0036/Diabetes_full_text.pdf

[15] BNF 47 http://bnf.org/bnf/index.htm 6.1.2.1 Sulphonylureas, 6.1.2.2 Biguanides.

[16] RCGP Clinical Guidelines Type 2 Diabetes 2001 (ScHARR) - Blood Glucose management http://www.nelh.nhs.uk/guidelinesdb/html/fulltext-guidelines/Bloodglucose2.html

[17] No adjustment was made for (negligible) seasonal and growth-related differences and differences between the PharmHouse diabetes Rx/Management totals for the financial year 2002/03 (1 July to 30 June, n=1573083) versus the October 2002-September 2003 period (1583455).

Numbers of patients using diabetes medications

Before adjustment, the sample identified 5449 patients who at any time during the 12-month period had used insulin alone (23% of all patients at any time during the year using diabetes medications). A further 3228 residual patients at any time had used oral hypoglycaemics with an insulin (but had at no time used insulin alone) (14%); a residual 10478 used a sulphonylurea +/- metformin etc at any time (but at no time using any insulin) (44%); and a residual 4495 used metformin alone at any time (and at no time using any other diabetes medications) (19%).

Following adjustment for undercounting of oral hypoglycaemic use, there were 5054 patients using insulin alone at any time during the 12-month period (0.93 that of the unadjusted number; 19% of all patients at any time during the year using diabetes medications); 3993 residual patients using oral hypoglycaemics with an insulin at any time (1.24 of unadjusted; 15% of diabetes medication patients); 12143 residual using a sulphonylurea +/- metformin etc at any time (1.16, 45%); and 5826 using metformin alone at any time (1.30, 22%).

These equated to NZ-wide 12-month period prevalence estimates of:

- 17730 patients using insulin alone at any time,
- 14011 patients using oral hypoglycaemics with an insulin (but at no time using insulin alone),
- 42603 patients using sulphonylurea +/- metformin etc at any time (but at no time using any insulin), and
- 20441 patients using metformin alone at any time (and at no time using any other diabetes medications).

This totalled 94786 using any diabetes medications at any time, and hence 20214 other patients using diet alone without any diabetes medications during the whole year (to equal 115000 total patients with diabetes).

Of the above 17730 patients using insulin alone, 10775 patients used a rapid/short-acting insulin +/- intermediate/long-acting insulin, and 6955 used only an intermediate/long-acting insulin.

Of the above patient estimates, 98% of patients using insulin alone also were dispensed SMBG (17372/17730), 93% of those using an oral hypoglycaemic with insulin (12976/14011); 67% of patients using sulphonylurea +/- metformin etc (28708/42603); and 57% of patients using metformin alone (11602/20441) were dispensed SMBG. Overall, 3/4ths of patients using diabetes medications were dispensed SMBG (70657/94786).

The above features are summarised in the following table and graph:

Table 4

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Estimates of diabetes Rx use in New Zealand, from encrypted NHI-annotated scripts for patients in October 2002 (PharmHouse data Oct'02-Sept'03)

key:	
numbers in font 7 italicised	sample (NHI-annotated scripts)
numbers in font 10	extrapolation to NZ population - adjusting for sampling and seasonality

Sample and seasonal adjustments

(sample - no. scripts diab Rx/Mngmt)	*189662*	inflators for undercounting of oral hypoglycaemics in PharmHouse data:	
sample - no. patients diab Rx/Mngmt	*26584*	sulponylureas	1.05
sample - no. items diab Rx/Mngmt	*451338*	metformin	1.30
forecast db - no. items diab Rx/Mngmt	1,583,455	both	1.24
% sample/PharmHouse (items)	28.5%		

**includes pts dispensed insulin syringes or needles w/o insulins (n= 199-29=91 in sample); excludes pts dispensed urine tests only (n=28 in sample)*

	insulin alone	oral hypoglycaemics + insulin	sulphonylurea +/- metformin etc.	metformin etc. alone	diet alone - no diabRx therapy	total diab Rx users	grand total
(unadjusted no. pts)	*5449* 19,117	*3228* 11,325	*10478* 36,761	*4495* 15,770	*32027*	*23650* **82,973**	115,000
(inflator for undercounting of oral hypoglycaemics)	0.93	1.24	1.16	1.30	0.63	1.14	
no. of patients (adjusted)*	*5054* 17,730	*3993.5* 14,011	*12143.42* 42,603	*5826.5* 20,441	20,214	*27017* 94,786	115,000
% of pts using diabetes Rx	19%	15%	45%	22%		100%	

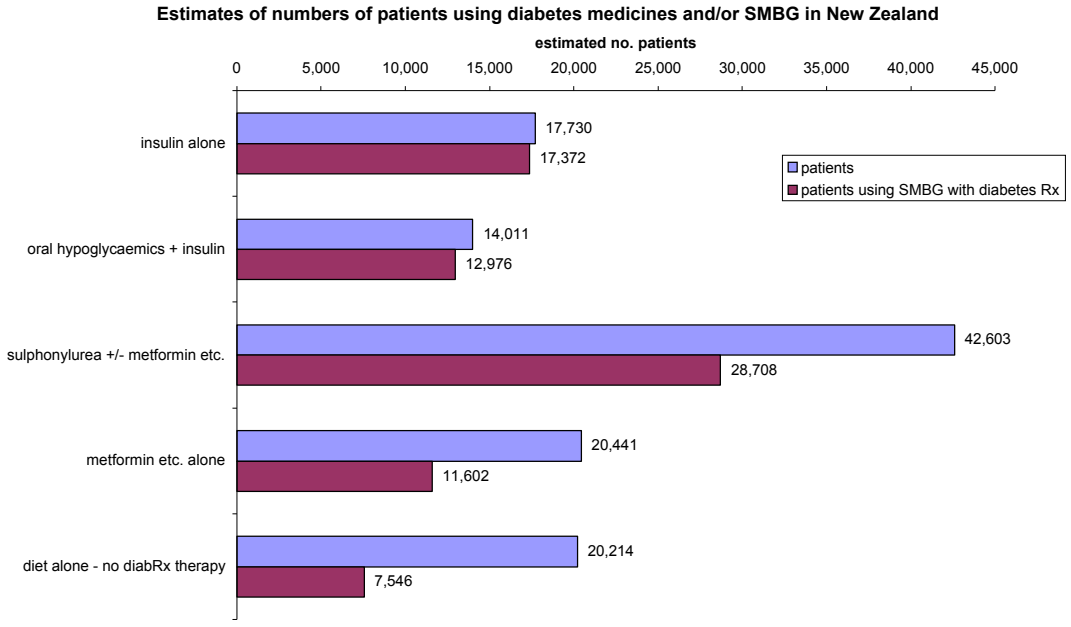
*12-month period prevalence, = the number of patients using a diabetes Rx combination at any time during the 12 months measurement period;
adjusts for some metformin and sulphonylurea dispensings not being captured in PharmHouse data

3071	10,775	- pts rapid/short-acting insulin +/- intermediate/long-acting insulin alone
1487	5,216	- pts intermediate/long-acting insulin alone, Type 1 diabetes
14%	15,992	- [subtotal: presumed Type 1 diabetes (r/s-acting ins +/- i/l-acting ins, or i/l-acting insulin alone in Type 1 diabetes)]
496	1,739	- pts intermediate/long-acting insulin alone, Type 2 diabetes (estimate)

no. pts using SMBG with diabetes Rx*‡	17,372	12,976	28,708	11,602	7,546	70,657	78,203
- adjusted for extra Diabetes NZ disps‡‡‡							
% of all pts using diabetes Rx who are using SMBG‡‡‡	98%	93%	67%	57%	37%	75%	68%

‡average of unadjusted and fully adjusted no. pts using diab Rx also using SMBG, divided by total no. pts using diab Rx;
assumes an equal likelihood that patients dispensed SMBG through Diabetes NZ were either [always] or [never] also dispensed through community pharmacies; i.e. where either:
- unadjusted: all patients dispensed through Diabetes NZ were also dispensed through community pharmacies (captured in PharmHouse data), hence no extra patients
- fully adjusted: none of the extra dispensings were in patients who were dispensed through community pharmacies;
that is, all extra dispensings were in patients who were dispensed SMBG solely through Diabetes NZ (hence not captured in PharmHouse data), hence extra patients;
then assumes these extra patients were distributed as average of [preferentially according to need] and [proportionate to encrypted-NHI actuals]

Figure 1



Of the NZ-wide estimate of 17730 patients using insulin alone, perhaps 15992 could be presumed to have Type 1 diabetes (comprising 10775 patients using rapid/short-acting insulin +/- intermediate/long-acting insulin alone, and an estimated 5216 patients on intermediate/long-acting insulin alone who might have

Type 1 diabetes[18]). The remaining 1739 patients on intermediate/long-acting insulin alone might be presumed to have Type 2 diabetes (estimate); combined with the above 14011 patients using oral hypoglycaemics with an insulin, then perhaps 16% of presumed Type 2 patients use an insulin, with 20% of presumed Type 2 pts on diabetes Rx including insulin in their regimes.

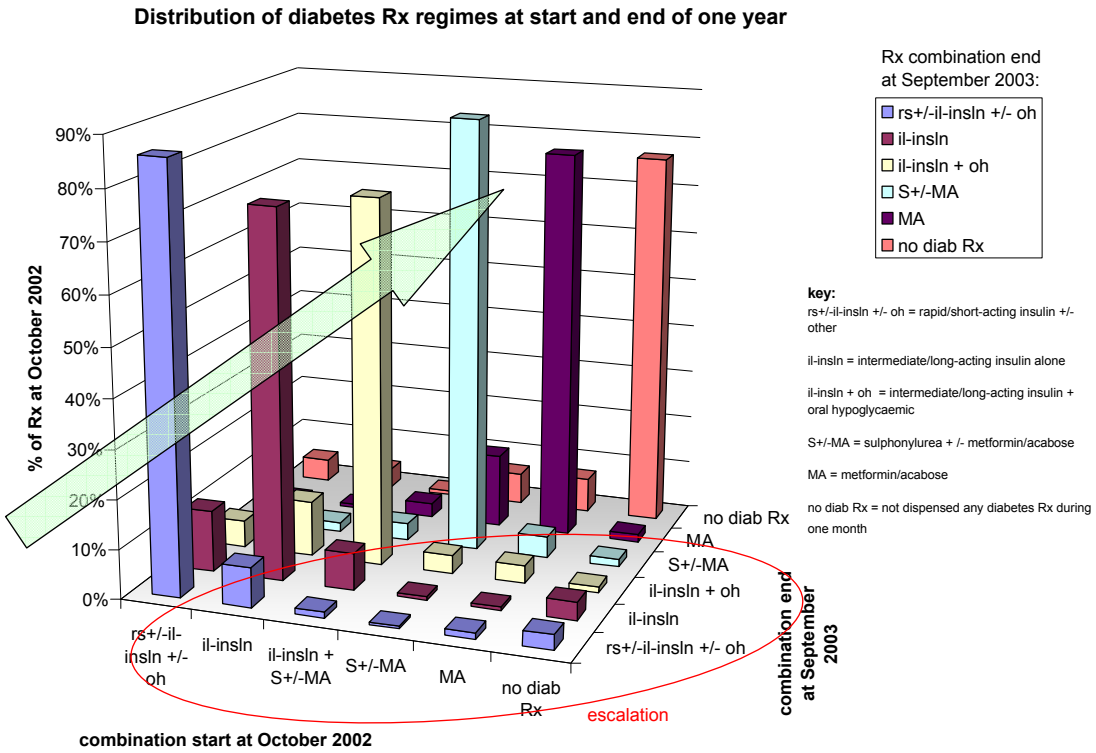
Table 5

Insulin use by patients with presumed Type 2 diabetes - estimates for New Zealand - from encrypted NHI-annotated scripts for patients in October 2002 (PharmHouse data Oct'02-Sept'03)	
no. of presumed Type 2 pts using insulin +/- oral hypglycaemics	15,749
(no. of presumed Type 2 pts using interm-/long-acting insulin alone)	*1,739*
(no. of presumed Type 2 pts using oral hypoglycaemic + insulin)	*14,011*
presumed no. patients with Type 2 diabetes	*99,008*
presumed no. patients with Type 2 diabetes using diabetes Rx	*78,794*
% of presumed Type 2 pts using insulin	16%
% of presumed Type 2 pts on diabetes Rx using insulin	20%

Regime changes

There was some movement across regimes, where overall 8% of patients escalated their regimes during the year. In particular, by the end of the year perhaps 23% of patients starting on diet alone escalated to pharmacological therapy, with perhaps a 13% escalation for metformin users – see Figure 2 below.

Figure 2



However, missing data make it difficult to interpret regime changes, and it is unclear with "descalations" how much is simply due to there being no relevant dispensing data for the September 2003 month. This

[18] source: PHARMAC analysis of IMS Medical Index data October 2002, where Type 1 diabetes accounted for perhaps 75% of patients using intermediate/long-acting insulins

is where 32% of patients dispensed diabetes medicines during October 2002 were not recorded as having been dispensed during September 2003.

Further details are in Table 6 below.

Table 6 Regime changes during the year

		regime at end (Sept '03)									
		rs+/-il-insln	il-insln	il-insln + oh	oh		no diab Rx	no comb diab Rx recorded Sept'03	Total	% "attrition" (no comb diab Rx recorded Sept'03/Total)	subtotal comb diab Rx recorded Sept'03
regime at start (Oct '02)		rs-insln	il-insln	il-insln + S+/-MA	S+/-MA	MA	no diab Rx	no comb diab Rx recorded Sept'03			
rs+/-il-insln +/- oh		1631	155	23	10	25	59	897	2800		
il-insln		247	1470	149	15	14	74	841	2810	30%	1969
il-insln + oh		64	132	871	44	42	15	342	1510		
oh	S+/-MA	43	128	238	5990	299	102	2668	9468		
	MA	12	18	85	437	2302	46	1346	4246	29%	9700
no diab Rx		82	73	15	114	124	248	1108	1764	63%	656
total		2079	1976	1381	6610	2806	544	7202	22598	32%	15396

		regime at end (Sept '03) group 1 order end							on start regime at end	escalating	deescalating
		rs+/-il-insln	il-insln	il-insln + oh	oh		no diab Rx	Total			
regime at start (Oct '02)		rs-insln	il-insln	il-insln + S+/-MA	S+/-MA	MA	no diab Rx				
rs+/-il-insln +/- oh		1631	155	23	10	25	***956***	2800			
il-insln		247	1470	149	15	14	***915***	2810	52%	**8.8%**	38.9%
il-insln + oh		64	132	871	44	42	***357***	1510			
oh	S+/-MA	43	128	238	5990	299	***2770***	9468	63%	**4.3%**	32.4%
	MA	12	18	85	437	2302	***1392***	4246	54%	**13.0%**	32.8%
no diab Rx		82	73	15	114	124	***1356***	1764	77%	**23.1%**	
total		2079	1976	1381	6610	2806	7746	22598			

1,812

		regime at end (Sept '03)						
		rs+/-il-insln	il-insln	il-insln + oh	oh		no diab Rx	Total
regime at start (Oct '02)		rs-insln	il-insln	il-insln + S+/-MA	S+/-MA	MA	no diab Rx	
rs+/-il-insln +/- oh		7%	1%	0%	0%	0%	4%	12%
il-insln		1%	7%	1%	0%	0%	4%	12%
il-insln + oh		0%	1%	4%	0%	0%	2%	7%
oh	S+/-MA	0%	1%	1%	27%	1%	12%	42%
	MA	0%	0%	0%	2%	10%	6%	19%
no diab Rx		0%	0%	0%	1%	1%	6%	8%
total		9%	9%	6%	29%	12%	34%	100%

% pts remaining on same regime throughout year	60.3%
% pts escalating their regime during the year	**8.0%**
% pts deescalating their regime during the year	31.7%

Person-years using diabetes medications

Patient years of diabetes medication use in the adjusted sample totalled 23064.1 of the 27017 patients using diabetes medications at any stage during the year – in broad terms, equivalent to on average 10.2 months use per patient during the year (23064.1/27017 x 12).

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For NZ-wide estimates, patient years of diabetes medication use totalled 80917.2 (of the above 94786 patients using diabetes medications at any stage during the year). The distribution of person-years exposure (pyes) to the various diabetes medication combination regimes was similar to that of patient numbers, with differences reflecting differences in dispensing rates per patient across the regimes. Insulin alone accounted for 16123.5 pyes (20% of diabetes medication pyes), oral hypoglycaemics + inter-/long-acting insulin had 9310.0 pyes (12%), sulphonylurea +/- metformin etc. had 36671.9 pyes (45%), and metformin etc. alone 18811.9 pyes (23%) (see tables 9, 7 and 8 for details).

Table 9 Estimates of person-years using diabetes medications

		insulin alone		oral hypoglycaemics + insulin		sulphonylurea +/- metformin etc.		metformin etc. alone		diet alone - no diabRx therapy		total diab Rx users	grand total
no. pyes on regime	*4595.7*	16123.5	*2653.7*	9310.0	*10452.7*	36671.9	*5362.0*	18811.9	*5761.8*	20214.3	*23064.1*	80,917.2	101,131
% of diabetes Rx pyes		20%		12%		45%		23%				100%	
ideal SMBG use (strip patient year-equivalents)		60338		21442		17550		2687		2021		102,018	104,039
ideal SMBG use /pt-equivalent/day		3.74		2.30		0.48		0.14		0.10		1.26	1.03
actual SMBG use		17281		4981		14600		5264		3166	*12007.5*	42,126	45,292
dispensed daily use in pt users (strips/pt/day)		1.07		0.54		0.40		0.28		0.16		0.52	0.45
% under/over-use (where ideal use = 100%)		29%		23%		83%		196%		157%		41%	44%
SMBG absolute under/over-use (strip pyes)		-43057		-16461		-2950		2577		1144		-59,892	-58,747

Table 10 Further details of estimates of person-years using diabetes medications

category		(unadjusted data)			oh undercount adjusters		Data in sample, adjusted for oh undercounts			
group 1	group 2	(unadjusted) Count of Encrypted HCU ID (records)	(unadjusted no. pts)	(unadjusted pyes)	total	SMBG	no. pts on regime at any time during yr	disp-based pye	no. SMBG pts	strip yrs*
rs+/-il-insln +/- oh	rs-insln	1115		234.8	0.74	0.75		174.1		603.2
	rs+il-insln	3801		2,109.1	0.97	0.97		2,052.6		1,587.8
	rs-insln + S+/-MA	49		14.2	1.16	1.16		16.4		19.2
	rs-insln + MA	78		20.3	1.30	1.30		26.3		40.3
	rs+il-insln + S+/-MA	137		42.3	1.17	1.17		49.4		50.4
	rs+il-insln + MA	462		241.2	1.29	1.29		310.1		141.1
il-insln	il-insln	4897		2,719.9	0.87	0.87		2,369.0		1,795.1
il-insln + oh	il-insln + S+/-MA	1383		690.5	1.23	1.23		852.2		442.9
	il-insln + MA	1712		1,134.4	1.23	1.23		1,399.2		419.4
oh	S+/-MA	13750		9,019.2	1.16	1.16		10,452.7		3,660.6
	MA	7326		4,136.7	1.30	1.30		5,362.0		1,351.6
no diab Rx	no diab Rx	7089		0.0	0.70	0.70		0.0		809.4
Total		41799	26,584	20,362.4	1.09	1.06	29,057	23,064.1	20,430	10,921.1

*not adjusted for DiabetesNZ dispensings

Table 11 Details of estimates of person-years using diabetes medications

	Data in sample (after adjustments for oh undercounts)					further adjustments				
group 1	Count of Encrypted HCU ID (records, unadjusted)	no. pts on regime at any time during yr	disp-based pye	no. SMBG pts	strip yrs (unadj)	no. SMBG patients, adjusted for DiabNZ disps	strip yrs, adjusted for DiabNZ disps	% pts using SMBG	% pye strip use	strip use/pt/day
rs+/-il-insln +/- oh	5642		2,628.9		2,442.0		3,255.3		93%	
il-insln	4897		2,369.0		1,795.1		2,003.1		76%	
il-insln + oh	3095		2,251.4		862.4		1,131.6		38%	
oh	21076		15,814.7		5,012.2		5,617.5		32%	
no diab Rx	7089		0.0		809.4		902.4			
Total in sample	41799	29,057	23,064.1	20,430	10,921.1	22,290	12,909.8	70%	47%	0.53
- pts using no diabetes Rx (SMBG alone)		2,040			809		902			
- pts using diabetes Rx		27,017			10,112		12,007			
extrapolated totals for NZ:										
total		101,943	80,917.2	71,677	38,315.0	78,203	45,292.3			
pts using diabetes Rx		94,786			35,475.5		42,126.5			

Use of ACE inhibitors and statins by patients using diabetes medications

An estimated 60539 patients in New Zealand using a diabetes medication also used an ACE inhibitor (63% of the above 94786), whilst 32% used both an ACE and a statin (30733/94786).

Rates of ACE inhibitor and statin use were highest in patients using oral hypoglycaemics with insulin and lowest in users of insulin alone. 46% of patients using an oral hypoglycaemic with insulin also used both an ACE inhibitor and statin (6400/14011), compared with 31% for patients using an oral hypoglycaemic (sulphonylurea or metformin) without insulin (13037/42603, 6565/20441). Of users of an oral hypoglycaemic alone, one fifth used neither an ACE inhibitor nor a statin (9425/42603, 4113/20441) (see following table and graphs):

Table 12

Rx use by patients with diabetes - estimates for New Zealand
- from encrypted NHI-annotated scripts for patients in October 2002 (PharmHouse data Oct'02-Sept'03)

Rx regime	no. pts		% of all diabetes pts	% of pts using diab Rx		% of diabetes pts using that diab Rx	
insulin alone	17,730		15%	18.7%		100%	
- using ACEs		9,175			9.7%		52%
- using ACEs + statins		4,731			5.0%		27%
- using ACEs (no statins)		4,444			4.7%		25%
- using statins (no ACEs)		1,684			1.8%		9%
- no ACE nor statin use		6,868			7.2%		39%
oral hypoglycaemics + insulin	14,011		12%	14.8%		100%	
- using ACEs		10,288			10.9%		73%
- using ACEs + statins		6,400			6.8%		46%
- using ACEs (no statins)		3,887			4.1%		28%
- using statins (no ACEs)		1,526			1.6%		11%
- no ACE nor statin use		2,195			2.3%		16%
sulphonylurea +/- metformin etc.	42,603		37%	44.9%		100%	
- using ACEs		27,810			29.3%		65%
- using ACEs + statins		13,037			13.8%		31%
- using ACEs (no statins)		14,774			15.6%		35%
- using statins (no ACEs)		5,368			5.7%		13%
- no ACE nor statin use		9,425			9.9%		22%
metformin alone	20,441		18%	21.6%		100%	
- using ACEs		13,266			14.0%		65%
- using ACEs + statins		6,565			6.9%		32%
- using ACEs (no statins)		6,701			7.1%		33%
- using statins (no ACEs)		3,053			3.2%		15%
- no ACE nor statin use		4,113			4.3%		20%
diet alone - no diabRx therapy	20,214		18%				
total, using diab Rx	94,786			100%			
total	115,000		100%				
total using diabetes Rx	94,786		82%	100%			
- using ACEs		60,539			63.9%		
- using ACEs + statins		30,733			32.4%		
- using ACEs (no statins)		29,806			31.4%		
- using statins (no ACEs)		11,630			12.3%		
- no ACE nor statin use		22,600			23.8%		

Figure 3

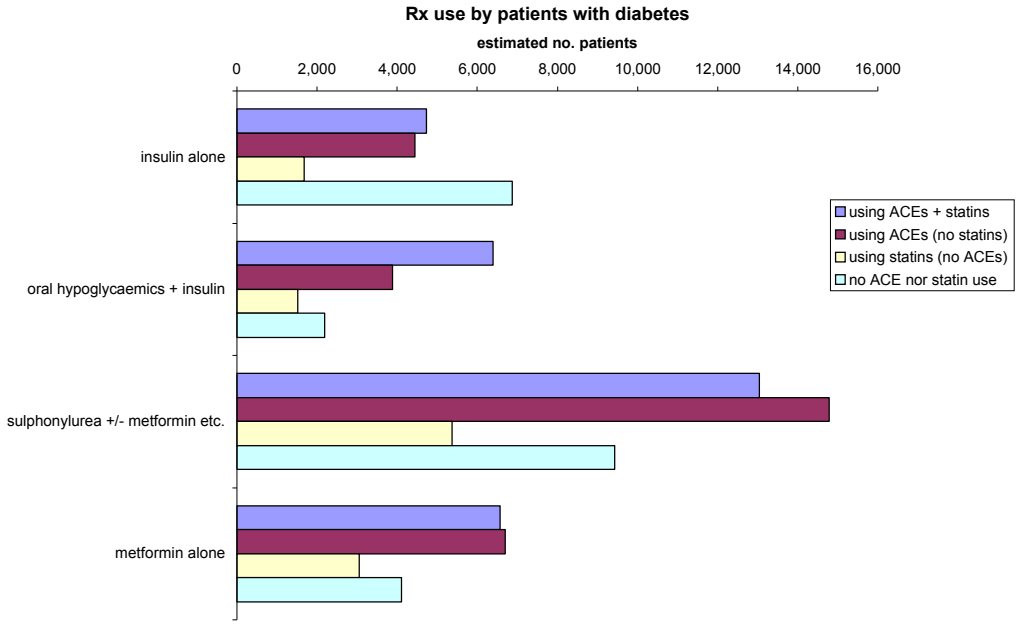
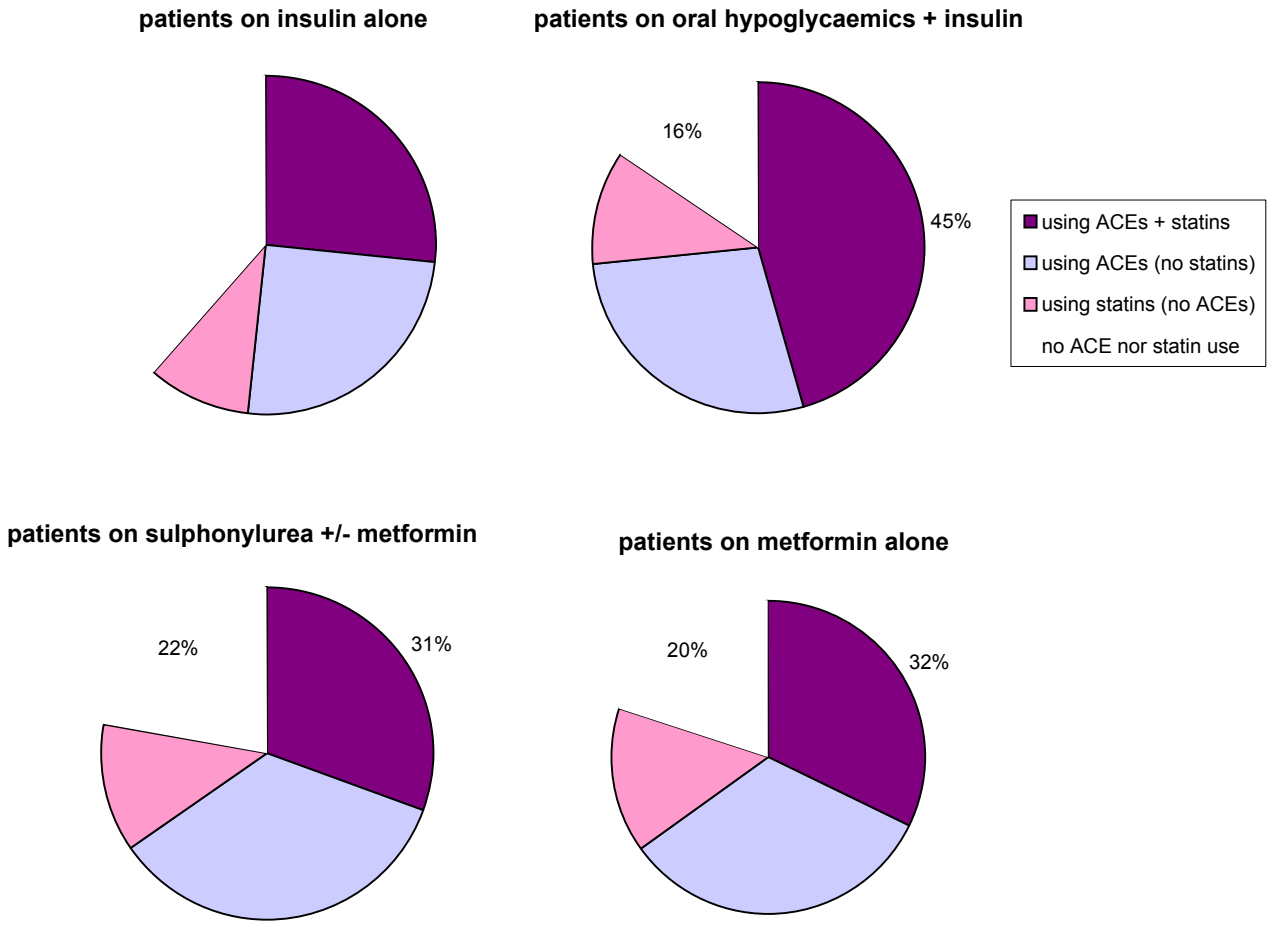

Rx use by patients with diabetes
estimated no. patients
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
insulin alone
oral hypoglycaemics + insulin
sulphonylurea +/- metformin etc.
metformin alone
using ACEs + statins
using ACEs (no statins)
using statins (no ACEs)
no ACE nor statin use

Figure 4

Patterns of ACE/statin use by patients with diabetes (as categorised by type of diabetes drugs)



Use of SMBG by patients using diabetes medications

The sample identified 19239 patients dispensed SMBG, captured in the encrypted NHI data (78432 dispensings). Over the same 12-month period, 47214 dispensings were of SMBG by Diabetes NZ, of 306485 total SMBG dispensings measured in PharmHouse – equating to an inflator of 18%. Further adjusting for undercounting of dispensings of oral hypoglycaemics increased the numbers of patients dispensed SMBG alongside oral hypoglycaemics, therefore eventually amending the numbers of patients dispensed SMBG to an estimate of 22290 overall.

These numbers equated to an estimated 78203 patients using SMBG in New Zealand. Of these, 7546 (10%) appeared to be on diet alone, that is they were using neither insulins nor oral hypoglycaemics; they accounted for 37% of the estimated number of patients on diet alone (7546/20214).

There were wide-ranging variations from ideal use of self-monitoring of blood glucose (SMBG), as evidenced by the use of blood glucose test strips by various patient groups compared with predicted need:

- Overall, SMBG was under-used at 44% of ideal, with 45292 actual total strip years (0.45 strips/user/day) when compared with 104039 strip years ideally (1.03 strips/user/day).

- There was marked under-use of SMBG by patients using insulins +/- oral hypoglycaemics. Patients needing >2 strips/day – viz those using a rapid/short-acting insulin, or Type 1 diabetes patients using inter-/long-acting insulin alone – had strip usage 27% of ideal (16574 actual/61827 ideal strip years, 1.07 strips/user/day). Patients needing 2 strips/day – viz using oral hypoglycaemics with inter/long-acting insulin, or Type 2 diabetes patients using inter-/long-acting insulin alone – had strip usage 29% of ideal (5688 actual/19953 idea strip years, 0.57 strips/user/day).

- By contrast, there was marked over-use of SMBG by patients using metformin and/or acarbose alone (needing one strip/week) or diet alone (needing perhaps 0.1/day on average). Actuals were up to double ideal, being 196% for patients using metformin and/or acarbose alone (5264 actual/2687 ideal strip use, 0.28 strips/user/day) and 157% for patients on diet alone (3166 actual/2021 ideal strip years, 0.16 strips/user/day).

- SMBG use appeared to be less than ideal in patients using sulphonylureas (+/- metformin or acarbose), if ideally x4-8/week, at 83% (14600/17550, 0.40 strips/user/day) (see below table and graphs).

Table 13

Patterns of SMBG use in patients at October 2002
- encrpyted NHI-annotated scripts + Diabetes NZ dispensings vs. all PharmHouse data, Oct'02-Sept'03, adjusted for undercounting of oral hypoglycaemics, extrapolated to NZ populatio

SMBG users - diab Rx group	ideal pattern						estimated actuals*					variance ac
group	*subgroup*	no. pts (at any time during 12 mths)	pyes	recommended daily use	total strip years (pye)	ideal % of SMBG use	no. pts dispensed*	total strip years (pye)	usage rate (% pts using SMBG, of pts using diabetes Rx)	dispensed daily use in pt users (strips/pt/day)	actual % of SMBG use	difference total strip years
1. insulin +/- oh needing >2 SMBG/day[#]		19,047	15,457	4.00	61827	59%	18,795	16574	99%	1.07	37%	-45253
rapid/short-acting insulin +/- inter-/long-acting +/- oh		*13,831*	*9,223*	*4.00*	*36893*	*35%*	*13,645*	*10585*	*99%*	*1.15*	*23%*	*-26308*
inter-/long-acting insulin alone - est for Type 1 diabetes		*5,216*	*6,234*	*4.00*	*24934*	*24%*	*5,150*	*5990*	*99%*	*0.96*	*13%*	*-18945*
2. inter-/long-acting insulin +/- oh needing 2 SMBG/day[##]		12,694	9,977	2.00	19953	19%	11,553	5688	91%	0.57	13%	-14265
oral hypoglycaemics + inter-/long-acting insulin only		*10,955*	*7,899*	*2.00*	*15798*	*15%*	*9,966*	*3831*	*91%*	*0.48*	*8%*	*-11967*
inter-/long-acting insulin alone - est for Type 2 diabetes		*1,739*	*2,078*	*2.00*	*4156*	*4%*	*1,586*	*1857*	*91%*	*0.89*	*4%*	*-2299*
3. oral hypoglycaemics w/o insulin		63,045	55,484	0.36	20238	19%	40,309	19864	64%	0.36	44%	-373
sulphonylurea +/- metformin or acarbose[###]		*42,603*	*36,672*	*0.48*	*17550*	*17%*	*28,708*	*14600*	*67%*	*0.40*	*32%*	*-2950*
metformin and/or acarbose alone[####]		*20,441*	*18,812*	*0.14*	*2687*	*3%*	*11,602*	*5264*	*57%*	*0.28*	*12%*	*2577*
4. no diab Rx[#####]		20,214	20,214	0.10	2021	2%	7,546	3166	37%	0.16	7%	1144
total		115,000	101,131	1.03	104039	100%	78,203	45292	68%	0.45	100%	-58747
- subtotal, diab Rx		94,786	80,917		102018		70,657	42126	75%	0.52	93%	-59892

*includes adjustment for extra Diabetes NZ SMBG dispensings; assumes these extra disps are distributed as average of [preferentially according to need] and [proportionate to encrypted-NHI actuals]
in the absence of further information, this scenario assumes that patients receiving SMBG test strips through Diabetes NZ are on average just as likely to be distributed the same as:
1. ideal need, viz. % (strip years for regime/total strip years - where 63% of strip use is needed for the 17% of patients needing >2 SMBG/day), or
2. what actually occurs in those individual patients identifiable through PharmHouse (via encrypted NHIs)
For estimates of patient numbers, assumes the extra dispensings translate to proportionately half as many more patients

[#] using insulin, including oral hypoglycaemics with any rapid/short-acting insulin only, including inter-/long-acting insulin alone in patients with Type 1 diabetes, but excluding ohs with inter-/long-acting insulin only; ideally x4/day

[##] ideally x2/day

[###] ideally 4- to 8- per week (based on BNF 47 and NZGG diabetes guidelines) for patients with HbA1c >=7.0% (47% in UKPDS 35), perhaps once a week if HbA1c <7.0% (53%), = weighted average of 0.48 per day

[####] ideally perhaps once a week (broadly based on BNF 47, NZGG diabetes guidelines and PTAC subcommittee advice), = 1/7ths per day

[#####] ideally one per day in every tenth patient, whilst contemplating regime escalation (broadly based on BNF 47 and NZGG diabetes guidelines), = 0.1 per day

International Diabetes Center. Type 1 diabetes practice guidelines http://www.guidelines.gov/summary/summary.aspx?view_id=1&doc_id=4158

International Diabetes Center. Type 2 diabetes practice guidelines http://www.guidelines.gov/summary/summary.aspx?view_id=1&doc_id=4159

BNF 47 http://bnf.org/bnf/index.htm 6.1.2.1 Sulphonylureas "All [sulphonylureas] may cause hypoglycaemia but this is uncommon and usually indicates excessive dosage." 6.1.2.2 Biguanides "Hypoglycaemia does not usually occur with metformin"

Best Practice Evidence-based Guideline. Management of Type 2 diabetes. NZ Guideline Group, December 2003. P29

"Testing before meals and at bed time on one or two days a week is reasonable for people with stable type 2 diabetes, although for those with controlled diabetes on diet-only therapy, periodic HbA1c monitoring may be sufficient."

Figure 5

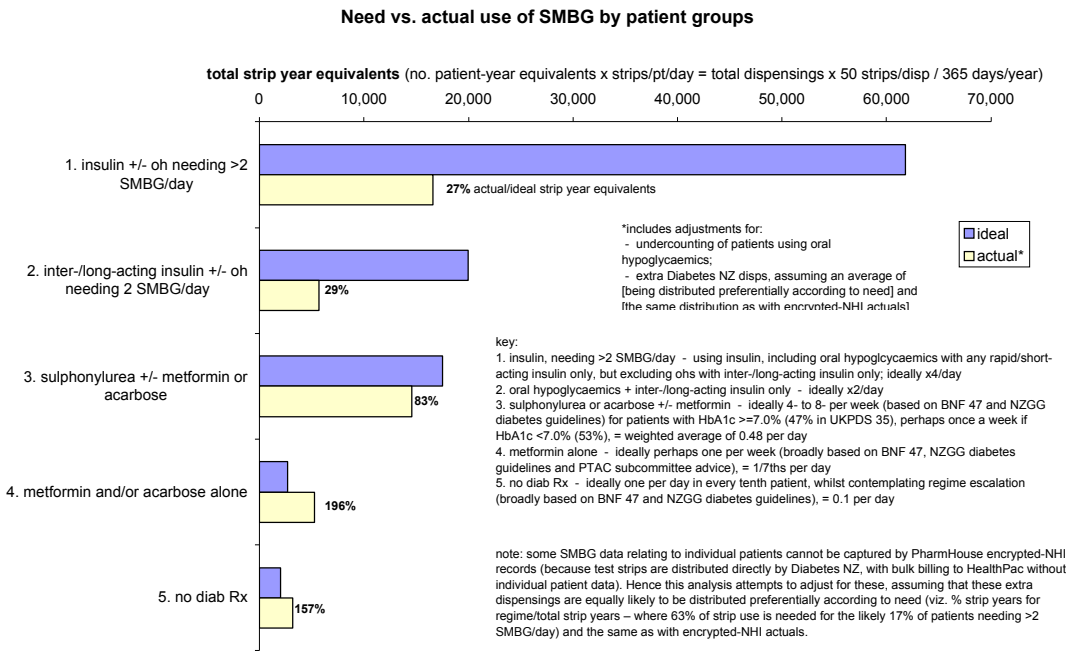
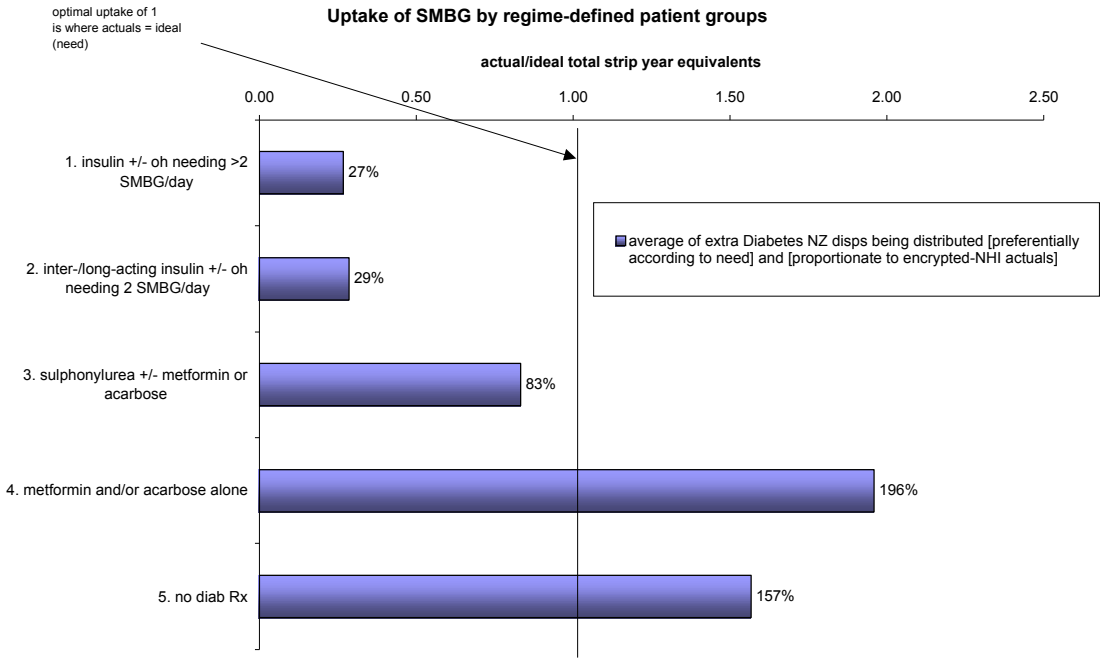


Figure 6



Discussion

- statement of principal findings
- strengths and weaknesses of the study
- strengths and weaknesses in relation to other studies, discussing important differences in results
- meaning of the study: possible explanations and implications for clinicians and policymakers
- unanswered questions and future research

The data indicate patterns of diabetes pharmaceutical use in New Zealand, with likely underuse of ACEs/statins in patients ostensibly with Type 2 diabetes and with high cardiovascular risk, and wide variations from "ideal" with the use of SMBG.

Strengths and limitations

The study's main strength is that it links patterns of use of diabetes medications with the related use of ACE inhibitors, statins and SMBG, at a national level. In addition the dataset is able to account for regime change in the year (retention rates) and proxy compliance rates (frequency of dispensings divided by 12 months/year).

The study has a number of limitations that affect its validity, which need to be taken into account when interpreting the results and assessing the robustness of its results:

1. Low NHI annotation rates (29% of October 2002 dispensings of diabetes medications had NHIs entered into PharmHouse) affect the validity of the results, with some variation from expected patterns (see Appendix One).

2. The above sampling therefore meant a need to apply a global scaler to obtain NZ estimates.

3. The need to adjust numbers of patients and pyes of oral hypoglycaemic users/use (by a factor of one-third for metformin), based on conjectural undercounts when comparing PharmHouse with IMS unit volumes.

4. Possible bias if users with NHIs have more severe disease (increasing the chance of hospital-acquired NHI).

5. Possible missing data if patients wholly captured in October 2002 data do not have some subsequent months' dispensings included. This would occur either when NHIs are not annotated these occasions – meaning that pyes and perhaps regime retention rates for the cohort are underestimated – or when NHIs are annotated incorrectly (meaning that some pyes are misascribed to other regimes – a non-differential bias). There is no requirement for NHIs to be coded onto dispensing claim data (even if x% annotation rate by prescribers on the scripts themselves – Dovey et al.)

6. The data are dispensing based, not prescription-at-doctor-visit based nor patient end-use based. The data do not measure end-use (whether medicines dispensed are actually taken by the patient – wastage and suboptimal treatment), or prescriber intent (since not all prescriptions are necessarily dispensed and captured in the data).

7. Diagnosis by inference – use of regime type as de facto diagnosis, rather than more reliable clinical data sources.

8. Use of medication surrogates and epidemiological estimates for total numbers of patients with diabetes (differing methods) means that numbers of patients with diagnosed diabetes using diet alone may be inaccurate.

9. The inflator to adjust for under-counting of patients using SMBG not captured by Diabetes NZ dispensings applies globally across all diabetes medication groups.

10. Analysis is dated in that data were restricted to not going beyond September 2003, because of data anomalies and artefact due to the introduction of all-at-once dispensing from 1 October 2003.

11. The analysis has not attempted provide important contributory demographic and clinical information on patients – their age, gender, ethnicity, deprivation, region, type of diabetes, glycaemic control, renal function, other macrovascular and microvascular complications, neuropathies, etc. Such information is important to better elucidate key patterns and gaps in the treatment of patients with diabetes. Some of this information could be obtained by using NHI-identifiers to link with NZHIS NMDS morbidity (public hospital separations) and mortality data. However, this was not attempted for this analysis for a number of reasons: analysis would be very complex, with database software constraints; missing dispensings data for oral hypoglycaemic agents would mean unknown biases; data likely to be incomplete, absent or inaccurate for most clinical measures, with unknown biases. Hence the analysis must be regarded as preliminary, giving a partial (if important) picture.

Comparisons with usage rates elsewhere including SMBG

This analysis is the first we are aware of giving a nationwide perspective of diabetes medication and SMBG usage patterns in New Zealand. Usage rates and patterns appear to be largely comparable with that of recently published series overseas:

- We are aware[19] of one study from Australia showing similar distributions of diabetes type in insulin users, with 54% of respondents being classified as having probable Type 1 diabetes (c.f. 50% in this analysis – 15992 presumed Type 1 diabetes in New Zealand (r/s-acting ins +/- i/l-acting ins, or i/l-acting insulin alone in Type 1 diabetes) / 31,741 insulin users (+/ oral hypoglycaemics)).

- The Australian study (Tasmania) also showed similarly persistently high rates of SMBG usage amongst respondents with insulin-treated diabetes, with 98% reporting any self-monitoring[20] (c.f. 98% usage in this analysis – 17372/17730 estimates for New Zealand

[19] PubMed search 29 June 2004 keywords [diabetes] AND [Australia or New Zealand]; PubMed search 29 June 2004 keywords [*Blood Glucose Self-Monitoring/statistics & numerical data] OR [Blood Glucose Self-Monitoring/*economics]

[20] Sale MM, Hazelwood K, Zimmet PZ, Shaw JE, Stankovich JM, Greenaway TM, Dwyer T. Trends in diabetes management practices of patients from an Australian insulin-treated diabetes register. Diabet Med. 2004 Feb;21(2):165-70.

with adjustments), with previously 74% of respondents stating they self-monitored daily.[21]

- A postal survey in Scotland (60% response rate) showed 87% of patients using diabetes medications used SMBG (c.f. 75% in this analysis), with higher rates in insulin users.[22]

- A survey of adult diabetes patients in Texas suggested 52% SMBG adherence, defined as the frequency of self-reported testing when compared against recommended[23] (c.f. 44% overall in this analysis).

Use of ACEs inhibitors and statins

comment on usage rates, including comment on need for ACEs in diabetes is universal (cite Clinical Evidence on line and contributing RCTs (incl UKPDS)/meta-analyses) whilst need for statins is generally considered to relate to overall absolute cardiovascular risk.

Implications

[for further work]

comment on under-use of SMBG by insulin users - ? are the recommendations too strict? What to do if a real need?

The above seeming over-use of SMBG in patients treated with metformin alone or diet alone needs to be seen in the context of the paucity of clear outcomes data for SMBG. The evidence for tangible outcomes with SMBG appears to be largely inconclusive, with various size and methodological limitations. Note too the above recommendations for only sparse use of SMBG for patients requiring diet/ohs when diabetes is well controlled.

International guidance as to the role of SMBG varies, but overall the evidence for SMBG outcomes appears to be inconclusive:

- For instance, recent Canadian guidelines[24] recommend that SMBG be recommended to patients as an essential part of daily diabetes management for all people using insulin or oral antihyperglycemic agents, with x3 daily for insulin users. However, the empirical evidence cited for this recommendation appears to be that of largely one uncontrolled

[21] McCarty DJ, Greenaway TM, Kamp MC, Dwyer T, Zimmet PZ. Management of insulin-treated diabetes in Tasmania. Med J Aust. 1999 Apr 5;170(7):312-5.
[22] Stewart D, McCaig D, Davie A, Juroszek L, Blackwood L, et al. Glucose self-monitoring in primary care: a survey of current practice. J Clin Pharm Ther. 2004 Jun;29(3):273-7.

[23] Vincze G, Barner JC, Lopez D. Factors associated with adherence to self-monitoring of blood glucose among persons with diabetes. Diabetes Educ. 2004 Jan-Feb;30(1):112-25.
[24] Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2003 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. Can J Diabetes. 2003;27(suppl 2): S21-3 Monitoring Glycemic Control. http://www.diabetes.ca/cpg2003/downloads/cpgcomplete.pdf , http://www.diabetes.ca/cpg2003/downloads/monitoringgly.pdf

cross-sectional study[25], and the quality of these source data were commented on by the RCGP Working Group (see below).[26]

- However, guidance from the RCGP Working Group in the UK differs. Following what appears to be a comprehensive review of the literature available, the RCGP Working Group[27] has argued they could not give much credence to associations between blood glucose control and blood glucose self-monitoring in observational studies – expecting that patients and doctors who use and advocate self-monitoring will be the same people who are motivated to achieve better control. Their review of systematic reviews (Faas et al 1997[28], Coster et al 2000[29]) and the contributing 8 RCTs suggested that the evidence is largely inconclusive. For Type 2 patients, the Working Group considered there was no evidence to show that SMBG improves blood glucose control using HbA1c or fasting plasma glucose, but they noted that the studies reviewed were limited by low statistical power and were poorly conducted and reported, so that small but clinically relevant effects might not have been detectable. For Type 1 diabetes, the Working Group likewise considered the reviewed studies did not provide evidence to support the clinical effectiveness of SMBG, but again because the studies were generally neither well conducted, nor well reported, and had low statistical power, the results were inconclusive.

  A copy of the RCGP Working Group's full narrative of the evidence is attached as Appendix Two

The RCGP Working Group commented that professionals need to reconsider the almost automatic assumption by many that self-monitoring is beneficial. "[SMBG] needs to be seen in the context of packages of self-care for the individual. If self-care packages are not considered important for particular individuals for whatever reason, there is little point in advocating self-monitoring in isolation."[30]

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[25] Karter AJ, Ackerson LM, Darbinian JA, D'Agostino RB Jr, Ferrara A, Liu J, Selby JV. Self-monitoring of blood glucose levels and glycemic control: the Northern California Kaiser Permanente Diabetes registry. Am J Med. 2001 Jul;111(1):1-9

[26] Karter et al 2001 was a cross-sectional descriptive study relating SMBG to outcomes. This was the evidence cited by the Canadian guidelines as the Grade C Level 3(3) to support its recommendation that SMBG should be recommended as an essential part of daily diabetes management for all people using insulin or oral antihyperglycemic agents, with x3 daily for insulin users. The RCGP Working Group examined Karter et al. 2001, in addition to meta-analyses and component RCTs, and commented on the quality and relevance of the data reported in that study. The Working Group noted that Karter et al reported that patients who were categorised as more adherent to ADA recommendations regarding self-monitoring were statistically more likely to have better glycaemic control. However, the Working Group considered that the Karter study was selected (patients responding to a survey) with inadequately described controls (hence not really a cohort study), and the Working Group argued that no conclusions regarding causality could be drawn from it.

[27] McIntosh A, Hutchinson A, Home PD, Brown F, Bruce A, et al. Clinical guidelines and evidence review for Type 2 diabetes: management of blood glucose. ScHARR/Royal College of General Practitioners Effective Clinical Practice Unit, University of Sheffield, 2002. http://www.nelh.nhs.uk/guidelinesdb/html/fulltext-guidelines/Bloodglucose2.html, http://www.nelh.nhs.uk/guidelinesdb/html/downloads/NICE_full_blood_glucose.pdf

[28] Faas A Schellevis FG van Eijk JTM (1997) The efficacy of self monitoring of blood glucose in NIDDM subjects Diabetes Care 20: 1482-1486

[29] Coster S Gulliford MC Seed PT, et al Monitoring blood glucose control in diabetes mellitus: a systematic review Health Technology Assessment 2000; 4(12).

[30] The RCGP Working Group also commented that whilst self-monitoring per se cannot be considered an intervention with impact on outcomes such as HbA1c, decreased body weight, reduced incidence of hypoglycaemia or improved

Along these lines, the Scottish data (Stewart et al 2004) had 61% of responding insulin users who self-monitored reporting they altered their insulin dose if readings were beyond the target range. Conversely, 69% of responding patients who self monitored and were taking oral therapy took no action at all. We are not aware of any equivalent data for New Zealand.

Future directions

These data will inform the direction (in terms of responsible use of medicines, beyond simple cost-savings) and messages of the Diabetes testing campaign. Further analysis of patient-level data – including risk factors for SMBG under-use according to diabetes type, age, ethnicity, deprivation and region – may be attempted, depending on estimates of the extent and impact of bias due to the incomplete data for oral hypoglycaemic agents.

Conclusion

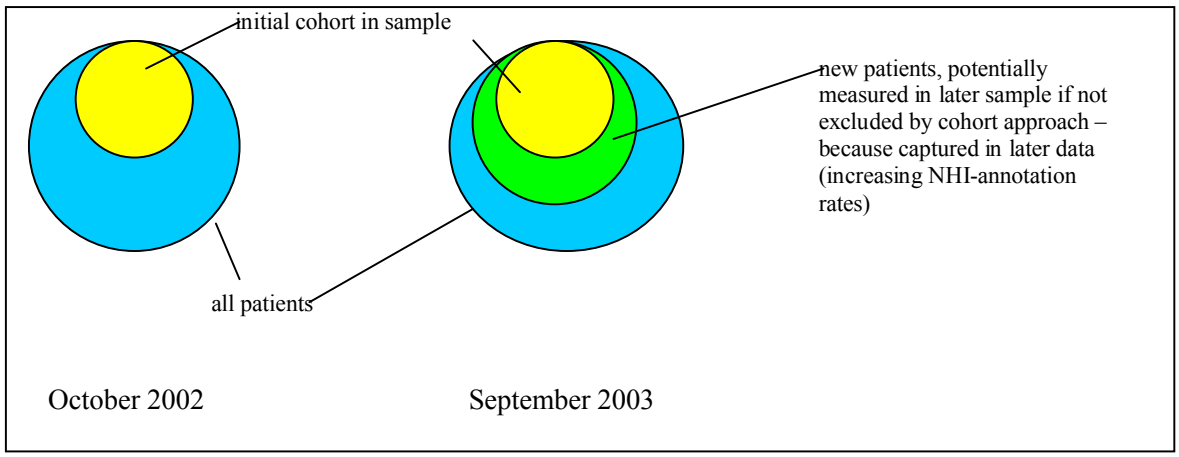
[for further work]

health-related quality of life, it may prove useful to people in their overall approach to self-care. "For example self-monitoring could be useful in allowing patients to see the impact of particular behaviours, such as dietary habits, on their blood glucose levels. This may help both in the process of identification of behaviours that prevent optimal control being achieved (and also those behaviours that improve control) and may also act as important triggers in behaviour change. This may be of particular importance in for example individuals who were considered to be moving in the direction of stepping up therapies, for example moving on to insulin therapy. The information gained through self-monitoring may be useful in reconsidering lifestyle behaviours and allowing a further attempt at behaviour modification."

Appendix One

Choice of cohort and measurement period

A cohort approach was chosen to prevent contamination caused by the effects of new patients being included in subsequent months. This was due to the differential (and increasing) annotation of NHI numbers on scripts, causing instability of estimates (see diagram below). This would otherwise cause mismatch in estimates of patient numbers and usage rates.



Note however that that longer period prevalence does increase the risk of bias from over-estimating the complexity of treatment regimes for some patients – whereby patients who switch from one regime to another during the longer treatment period are measured as being on the aggregate of both regimes.

Note that initially one-month data were used, being in effect a cohort dispensed during September 2003 alone ("September 2003 cohort" measuring one-month's dispensings). This was done with the belief that such one-month point-prevalence data would provide a sufficiently accurate picture of diabetes medication use patterns, yet be relatively feasible to extract and then compute data. September 2003 also was the most recent month available before implementation of all-at-once dispensing, and hence maximised chances of getting the most representative data – where inclusion of NHI umbers on scripts entered into PharmHouse had been progressively increasing, and had reached 50.5% of possible dispensings by that month. The sample measured 69032 dispensings of diabetes medications or diabetes management in patients with NHI-annotated scripts during that one-month period; total PharmHouse dispensings for diabetes medications/Management numbered 136831 that same month. This translated to 31349 patients using diabetes medications (with or without Diabetes Management)

However, examination of the one-month data indicated they strongly underestimated the extent of SMBG use, whereby less than half of patients dispensed insulin alone during that month were also dispensed blood glucose test strips (3208/7865 = 42%). This unrealistically low result was even after adjusting for some SMBG dispensings differentially not being able to be captured by PharmHouse data because of bulk dispensing by Diabetes Supplies Limited (without individual patient identifiers). Of the 31349 patients prescribed any diabetes medication (NHI-annotated scripts), 8740 were also dispensed SMBG (28%).

The low underestimate with the one-month data may have been due to potential long duration of test strip treatment. This is where each dispensing typically has 50-100 strips, potentially lasting well beyond one month. Hence this would undercount SMBG co-dispensing if measured during just one month.

The above underestimate necessitated the downloading of more extensive datasets and then re-analysis, in order to achieve credible SMBG use. Three-month measurement appreciably improved SMBG usage in insulin-only recipients, with 59% of these patients being dispensing SMBG[31] (July 2003 cohort measured over the 3 months July-September 2003, 32197 total diabetes Rx NHI-annotated patients). Six-month measurement increased the proportion of patients receiving insulin alone being dispensed SMBG[32] to 82% (April 2003 cohort measured over the 6 months April-September 2003, 32168 total diabetes Rx NHI-annotated patients).

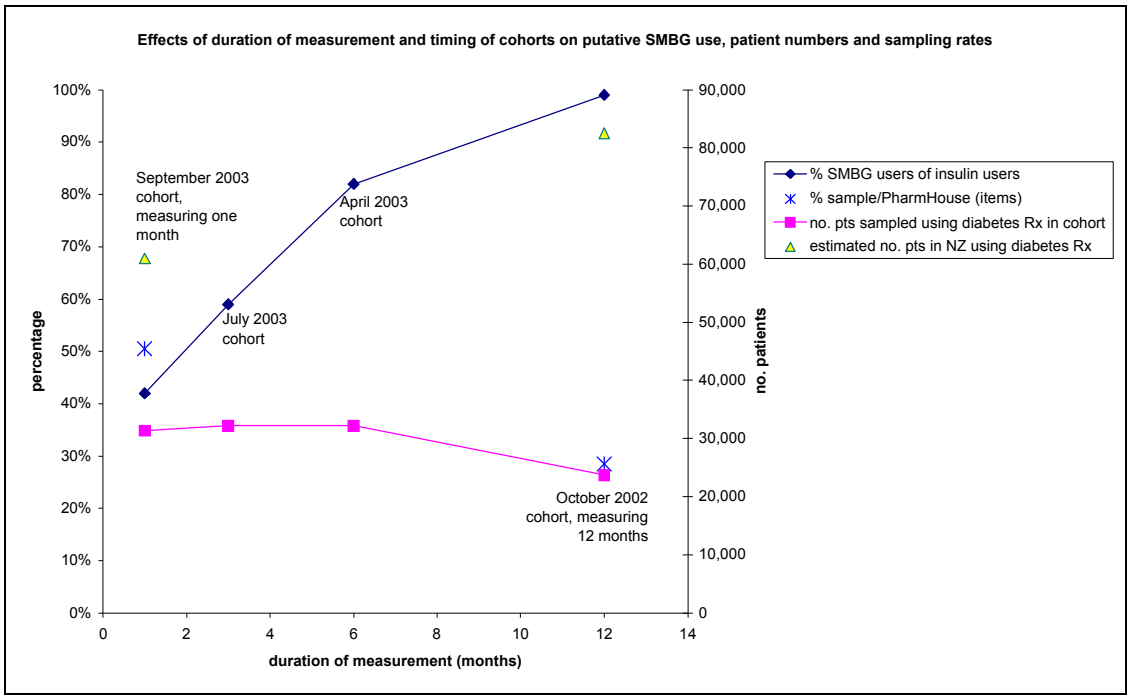
The longer 12-month period prevalence measurement (October 2002 cohort, 23688 total diabetes Rx/management NHI-annotated patients), with 98% of insulin-only patients also receiving SMBG, was hence considered to be steady state, in circumstances where data-handling capabilities were stretched. In view of the increasing putative usage rates of SMBG as measurement period increased, with appreciable differences between the 3-, 6- and 12-month periods, it was therefore decided necessary to use the full 12-month data.

The use of 12-month data also maximised estimates of patient numbers, presumably by increasing the chances of detection for those items typically dispensed less frequently than every 30 days (a problem if measuring during just one month). After scaling, the 12-month data estimated some 94,786 patients using diabetes medications, more than half again than the 60,987 patients estimated from one-month data. (The corollary to this is that there were fewer patients estimated to be on diet alone without diabetes Rx therapy, where these were estimated from a constant 115000 total patients and then the numbers of patents using diabetes medications – being 20214 with 12-month data, 60% less than the 54013 estimated from one-month data.)

The October 2002 cohort did have the downside of lower NHI-annotation rates, hence likely representing just 29% of patients. However it was considered the (small) decrements in validity (when comparing distributions against PharmHouse totals for the same period) did not outweigh the clear advantages of higher estimates of patient numbers and SMBG uptake results. These features can be seen in the following graph.

The other limitation of the October 2002 12-month cohort period-prevalence approach (rather than September 2003 one-month data) is the non-recognition of regimes change in the year. Some pharmaceutical combinations would have included patients changing from one medication combination to another during the twelve-month period. This would not be captured in the data, which uses period-prevalence (i.e. a block-period cohort approach). Hence the data may overstate, to an unknown extent, the breadth of regimes, when the data simply reflect a patient being on one regime and then changing to another.

[31] includes adjustment for SMBG undercounting in sample due to Diabetes NZ bulk dispensing
[32] includes adjustment for SMBG undercounting in sample due to Diabetes NZ bulk dispensing

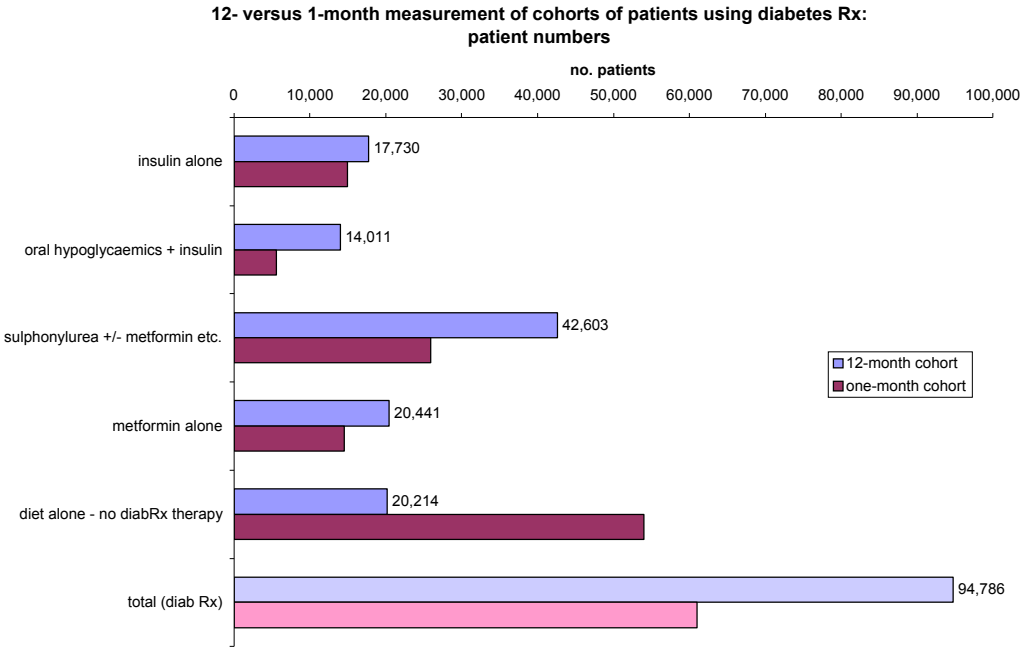


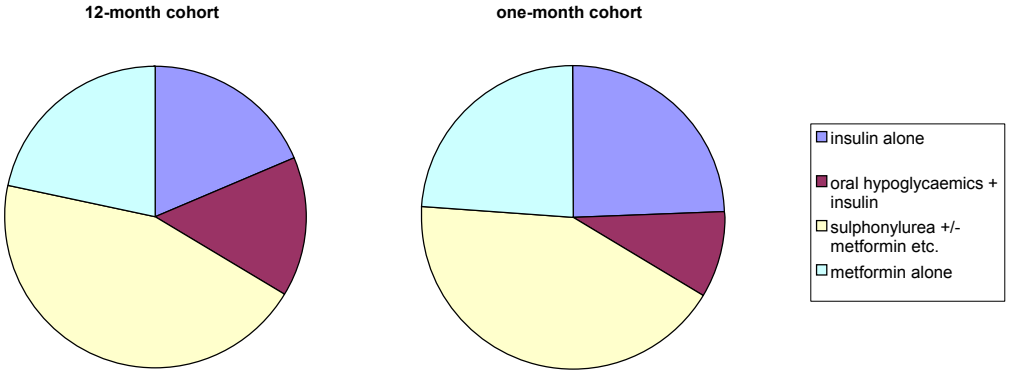
As can be seen in the following table and graphs, there are important differences between the 12-month and one-month measurements cohorts:

- There were higher numbers of patients estimated by the 12-month measurement (e.g. 94786 patients using diabetes medications, being 55% more than the 60987 estimated by one-month measurement)
- The 12-month measurement gave proportionately more patients using oral hypoglycaemics + insulin than one-month measurement, but proportionately fewer using metformin alone (although still more numerically).
- The increase in patients numbers was more pronounced for those using SMBG, with 70656 patients using diabetes medications also using SMBG when measuring 12-month data, compared with 17004 for the one-month measure.
- Higher proportions of patients used SMBG in the 12-month measurement than the one-month measure, with patients nearly three times as likely to use SMBG (75% of patients used SMBG when measuring 12-month data (October 2002 cohort), vs. 28% for one-month measure (September 2003 cohort):

patient numbers

	12-month cohort				one-month cohort			RR 12-month/one-month cohorts		
all pts with diabetes	115,000				115,000			1.00		
using diabetes Rx*	94,786				60,987			1.55		
	total pts	pyes	no. pts using SMBG with diabetes Rx*	**% SMBG users**	**total pts**	no. pts using SMBG with diabetes Rx*	**% SMBG users**	total pts	no. pts using SMBG with diabetes Rx*	% of all pts using diabetes Rx who are using SMBG
insulin alone	**17,730**	5,064	14,805	**84%**	**14,950**	6,242	**42%**	1.19	2.37	2.00
oral hypoglycaemics + insulin	**14,011**	2,143	11,768	**84%**	**5,566**	2,430	**44%**	2.52	4.84	1.92
sulphonylurea +/- metformin etc.	**42,603**	9,019	26,931	**63%**	**25,936**	5,792	**22%**	1.64	4.65	2.83
metformin alone	**20,441**	4,137	11,016	**54%**	**14,534**	2,540	**17%**	1.41	4.34	3.08
diet alone - no diabRx therapy	**20,214**				**54,013**			0.37		
total (diab Rx)	**94,786**	20,362	64,520	**68%**	**60,987**	17,004	**28%**	1.55	3.79	2.44


12- versus 1-month measurement of cohorts of patients using diabetes Rx: patient numbers
no. patients
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
insulin alone
17,730
oral hypoglycaemics + insulin
14,011
sulphonylurea +/- metformin etc.
42,603
metformin alone
20,441
diet alone - no diabRx therapy
20,214
total (diab Rx)
94,786
12-month cohort
one-month cohort


12-month cohort
one-month cohort
insulin alone
oral hypoglycaemics + insulin
sulphonylurea +/- metformin etc.
metformin alone

DRAFT

SMBG use

	12-month cohort					one-month cohort				
	no. patient	recommen	total strip months			no. patient	recommen	total strip months		
			ideal	actual*	**% use**			ideal	actual*	**% use**
1. insulin, needing >2 SMBG/day	19,047	4.00	61,827	16,574	**27%**	15,824	4.00	63,296	12,787	**20%**
2. oral hypoglycaemics + inter-/long-acting ins	12,694	2.00	19,953	5,688	**29%**	4,692	2.00	9,385	3,767	**40%**
3. sulphonylurea or acarbose +/- metformin	42,603	0.48	17,550	14,600	**83%**	25,936	0.48	12,412	10,434	**84%**
4. metformin alone	20,441	0.14	2,687	5,264	**196%**	14,534	0.14	2,076	4,633	**223%**
5. no diab Rx	20,214	0.10	2,021	3,166	**157%**	54,013	0.10	5,401	6,244	**116%**
total	115,000	1.03	104,039	45,292	**44%**	115,000	0.80	92,571	37,865	**41%**
all pts using diabetes Rx	94,786		102,018	42,126	**41%**	60,987		87,169	31,621	**36%**

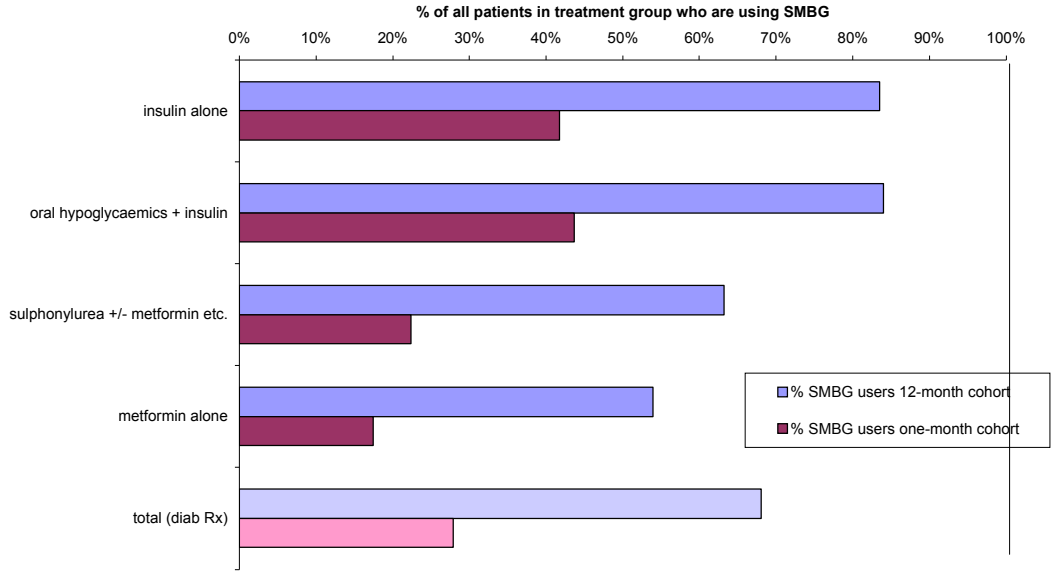
	RR 12-month/one-month cohorts				
	no. patient	recommen	total strip months		
			ideal	actual*	% use
1. insulin, needing >2 SMBG/day	1.20	1.00	0.98	1.30	1.33
2. oral hypoglycaemics + inter-/long-acting insulin only	2.71	1.00	2.13	1.51	0.71
3. sulphonylurea or acarbose +/- metformin	1.64	1.00	1.41	1.40	0.99
4. metformin alone	1.41	1.00	1.29	1.14	0.88
5. no diab Rx	0.37	1.00	0.37	0.51	1.35
total	1.00	1.28	1.12	1.20	1.06

*extra Diabetes NZ disps distributed proportionate to encrypted-NHI actuals

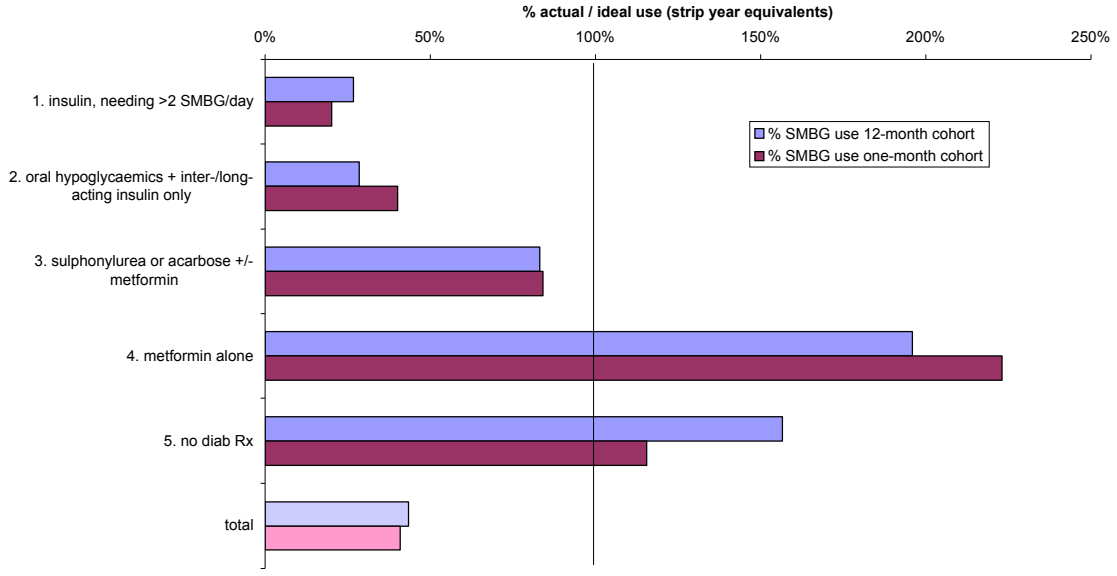
key:

1. insulin, needing >2 SMBG/day; using insulin, including oral hypoglycaemics with any rapid/short-acting insulin only, but excluding ohs with inter-/long-acting insulin only; ideally x4/day
2. oral hypoglycaemics + inter-/long-acting insulin only - ideally x2/day
3. sulphonylurea or acarbose +/- metformin - ideally 4- to 8- per week (based on BNF 47 and NZGG diabetes guidelines), = 6/7ths per day
4. metformin alone - ideally perhaps one per week (broadly based on BNF 47, NZGG diabetes guidelines and PTAC subcommittee advice), = 1/7ths per day
5. no diab Rx - ideally one per day in every tenth patient, whilst contemplating regime escalation (broadly based on BNF 47 and NZGG diabetes guidelines), = 0.1 per day

12- versus 1-month measurement of cohorts of patients using diabetes Rx: extent of SMBG use (patients)



12- versus 1-month measurement of cohorts of patients using diabetes Rx: extent of SMBG under-/over-use (total strip patient-year equivalents)



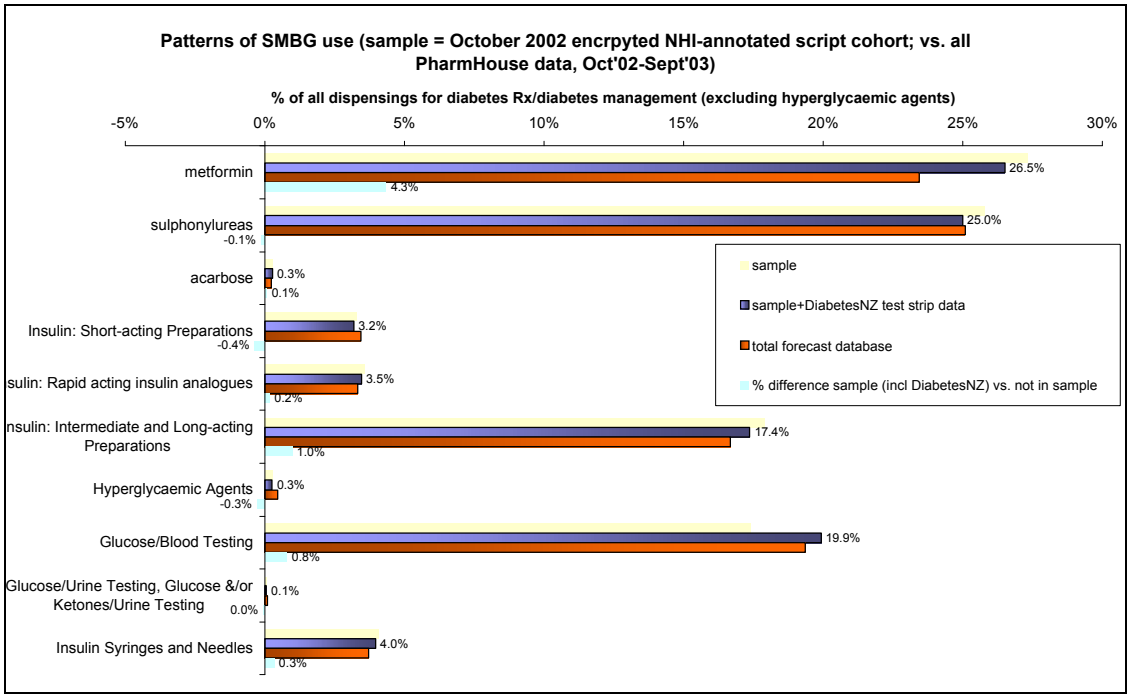
Validity of encrypted NHI sampling

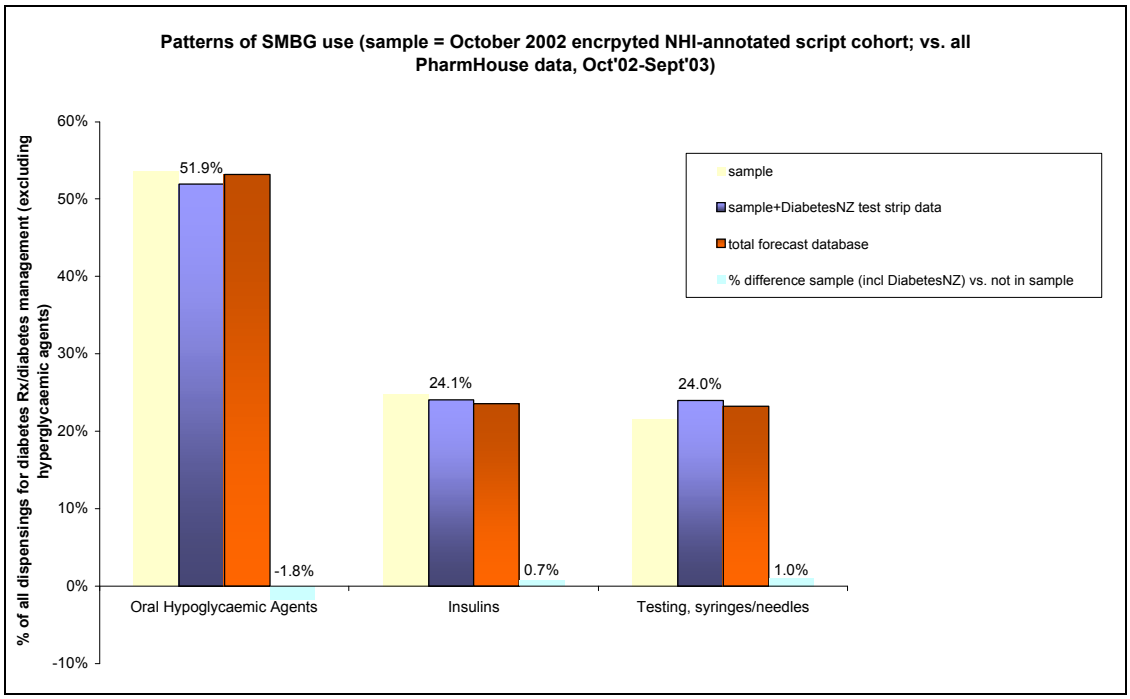
Comment on problems with validity – smaller sample means greater discrepancies c.f. PharmHouse actuals distributions than previously. Describe results. Describe IMS data, which appears to give patterns consistent with this sample.

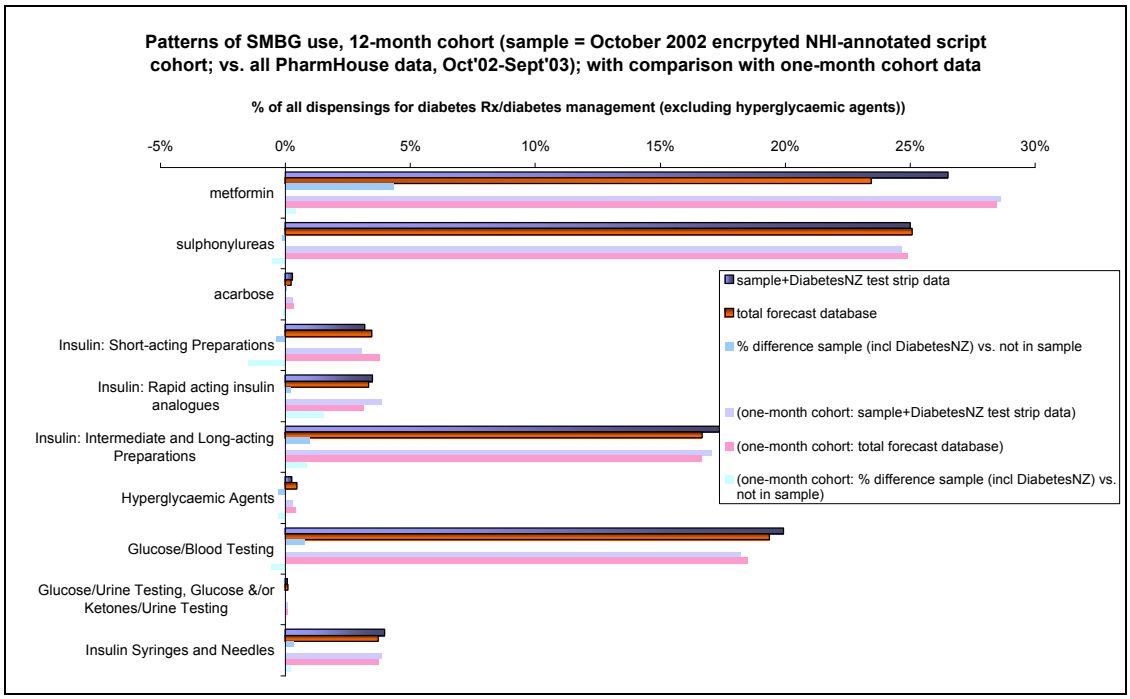
Validation of encryrpted NHI-annotated sample September 2003 (representativeness c.f. PharmHouse actuals)

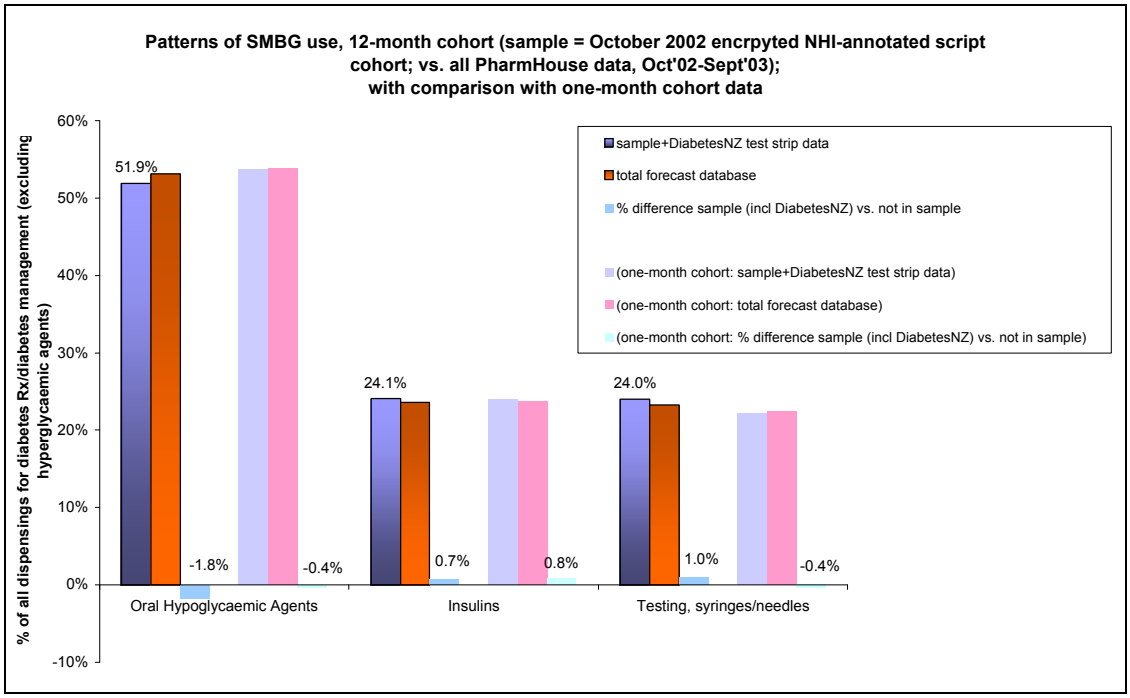
Tg Levle3 Name	Chemical Name	sample		sample+DiabetesNZ test strip data		not in sample		(total forecast db)		sample (incl Diabetes NZ data) vs non-sample			[one-month cohort]
		no. items	% items	no. items	% items, all SMBG	no. items	% items	no. items	% items	diff% of Rx	RR	diff% of all	% items, all SMBG
Insulin: Rapid acting insulin analogues	Insulin Aspart	2871	0.6%	2871	0.6%	8,113	0.7%	10,984	0.7%	-15.0%	0.85	-0.1%	1.2%
	Insulin Lispro	13286	2.9%	13286	2.9%	30,371	2.7%	43,657	2.8%	5.0%	1.05	0.1%	2.6%
Insulin: Short-acting Preparations	Insulin Neutral	14825	3.3%	14825	3.2%	38,044	3.4%	52,869	3.3%	-6.4%	0.94	-0.2%	3.1%
Insulin: Intermediate and Long-acting Preparations	Insulin Isophane	37641	8.3%	37641	8.1%	92,694	8.3%	130,335	8.2%	-2.5%	0.97	-0.2%	8.5%
	Insulin Isophane with Insulin Neutral	39464	8.7%	39464	8.5%	82,492	7.4%	121,956	7.7%	14.9%	1.15	1.1%	7.8%
	Insulin Zinc Suspension	3739	0.8%	3739	0.8%	7,838	0.7%	11,577	0.7%	14.5%	1.15	0.1%	0.7%
Oral Hypoglycaemic Agents	Acarbose	1314	0.3%	1314	0.3%	3,419	0.3%	4,733	0.3%	-7.7%	0.92	0.0%	0.3%
	Glibenclamide	9679	2.1%	9679	2.1%	24,597	2.2%	34276	2.2%	-5.5%	0.94	-0.1%	2.0%
	Gliclazide	63402	14.0%	63402	13.6%	158,936	14.2%	222338	14.0%	-4.2%	0.96	-0.6%	13.7%
	Glipizide	42356	9.4%	42356	9.1%	98,916	8.8%	141272	8.9%	2.8%	1.03	0.2%	8.8%
	Metformin Hydrochloride	123388	27.3%	123388	26.5%	308,362	27.6%	431750	27.3%	-3.9%	0.96	-1.1%	28.6%
	Tolbutamide	886	0.2%	886	0.2%	2,517	0.2%	3403	0.2%	-15.5%	0.85	0.0%	0.1%
Hyperglycaemic Agents	Glucagon Hydrochloride	1232	0.3%	1232	0.3%	6,104	0.5%	7336	0.5%	-51.5%	0.48	-0.3%	0.3%
Glucose/Blood Testing	Glucose Oxidase	78432	17.4%	**92715**	19.9%	213,770	19.1%	***306485***	19.4%	4.1%	1.04	0.8%	18.2%
Glucose &/or Ketones/Urine Testing	Glucose Oxidase	74	0.0%	74	0.0%	44	0.0%	118	0.0%	303.8%	4.04	0.0%	0.0%
	Sodium Nitroprusside	190	0.0%	190	0.0%	199	0.0%	389	0.0%	129.2%	2.29	0.0%	0.0%
Glucose/Urine Testing	Glucose Oxidase	20	0.0%	20	0.0%	870	0.1%	890	0.1%	-94.5%	0.06	-0.1%	0.0%
Insulin Syringes and Needles	Insulin Pen Needles	13750	3.0%	13750	3.0%	28,546	2.6%	42296	2.7%	15.6%	1.16	0.4%	2.8%
	Insulin Syringes, disposable with attached needle	4720	1.0%	4720	1.0%	11,923	1.1%	16,643	1.1%	-5.0%	0.95	-0.1%	1.0%
total diab Rx		451269	100.0%	465552	100.0%	1,117,755	100.0%	1,583,307	100.0%			5.6%	100.0%
% sample+DiabetesNZ test strip data/total forecast db				29%									52%
diff% of all				5.6%									3.7%

total SMBG dispensings in PharmHouse (NHI-encrypted and non-NHI patients)	306,485
no. SMBG dispensings by Diabetes NZ (to both NHI-encrypted and non-NHI pts)*	47,214
no. extra SMBG NHI-encrypted dispensings likely from Diabetes NZ dispensings	14,283


Patterns of SMBG use (sample = October 2002 encrpyted NHI-annotated script cohort; vs. all PharmHouse data, Oct'02-Sept'03)
% of all dispensings for diabetes Rx/diabetes management (excluding hyperglycaemic agents)
-5%
0%
5%
10%
15%
20%
25%
30%
metformin
26.5%
4.3%
sulphonylureas
-0.1%
25.0%
acarbose
0.3%
0.1%
Insulin: Short-acting Preparations
-0.4%
3.2%
sulin: Rapid acting insulin analogues
3.5%
0.2%
nsulin: Intermediate and Long-acting Preparations
17.4%
1.0%
Hyperglycaemic Agents
-0.3%
0.3%
Glucose/Blood Testing
19.9%
0.8%
Glucose/Urine Testing, Glucose &/or Ketones/Urine Testing
0.1%
0.0%
Insulin Syringes and Needles
4.0%
0.3%
sample
sample+DiabetesNZ test strip data
total forecast database
% difference sample (incl DiabetesNZ) vs. not in sample


Patterns of SMBG use (sample = October 2002 encrpyted NHI-annotated script cohort; vs. all PharmHouse data, Oct'02-Sept'03)
% of all dispensings for diabetes Rx/diabetes management (excluding hyperglycaemic agents)
60%
50%
40%
30%
20%
10%
0%
-10%
51.9%
-1.8%
24.1%
0.7%
24.0%
1.0%
Oral Hypoglycaemic Agents
Insulins
Testing, syringes/needles
sample
sample+DiabetesNZ test strip data
total forecast database
% difference sample (incl DiabetesNZ) vs. not in sample


Patterns of SMBG use, 12-month cohort (sample = October 2002 encrpyted NHI-annotated script cohort; vs. all PharmHouse data, Oct'02-Sept'03); with comparison with one-month cohort data
% of all dispensings for diabetes Rx/diabetes management (excluding hyperglycaemic agents))
-5%
0%
5%
10%
15%
20%
25%
30%
metformin
sulphonylureas
acarbose
Insulin: Short-acting Preparations
Insulin: Rapid acting insulin analogues
Insulin: Intermediate and Long-acting Preparations
Hyperglycaemic Agents
Glucose/Blood Testing
Glucose/Urine Testing, Glucose &/or Ketones/Urine Testing
Insulin Syringes and Needles
sample+DiabetesNZ test strip data
total forecast database
% difference sample (incl DiabetesNZ) vs. not in sample
(one-month cohort: sample+DiabetesNZ test strip data)
(one-month cohort: total forecast database)
(one-month cohort: % difference sample (incl DiabetesNZ) vs. not in sample)


Patterns of SMBG use, 12-month cohort (sample = October 2002 encrpyted NHI-annotated script cohort; vs. all PharmHouse data, Oct'02-Sept'03); with comparison with one-month cohort data
% of all dispensings for diabetes Rx/diabetes management (excluding hyperglycaemic agents)
60%
50%
40%
30%
20%
10%
0%
-10%
51.9%
-1.8%
-0.4%
24.1%
0.7%
0.8%
24.0%
1.0%
-0.4%
Oral Hypoglycaemic Agents
Insulins
Testing, syringes/needles
sample+DiabetesNZ test strip data
total forecast database
% difference sample (incl DiabetesNZ) vs. not in sample
(one-month cohort: sample+DiabetesNZ test strip data)
(one-month cohort: total forecast database)
(one-month cohort: % difference sample (incl DiabetesNZ) vs. not in sample)

DRAFT

IMS data Oct-Dec 2001, 2001

	E10-E14 diabetes		E10 IDDM		E11 NIDDM		non-IDDM (E11, E14)		% use NIDDM/ (IDDM+NIDDM)		% use non-IDDM/all	
	3m	12m	3m	12m	3m	12m	3m	12m	3m	12m	3m	12m
all drugs prescribed	159000	634000	14000	71000	51000	189000	145000	563000	78%	73%	91%	89%
diabetes drugs	102000	404000	9000	45000	33000	129000	93000	359000	79%	74%	91%	89%
oral antidiabetics	72000	293000	1000	4000	28000	118000	71000	289000	97%	97%	99%	99%
human insulin+analogues	29000	110000	8000	41000	5000	11000	21000	69000	38%	21%	72%	63%
				91%		9%		19%				
% human insulin+analogues				9%		91%		81%				
% oral antidiabetics												
biguanides	40000	154000	0	3000	14000	62000	40000	151000	100%	95%	100%	98%
sulphonylureas	32000	134000	0	1000	12000	56000	32000	133000	100%	98%	100%	99%
blood glucose tests	32000	136000	4000	17000	11000	40000	28000	119000	73%	70%	88%	**88%**
ACE inhibitors	8000	28000	0	3000	3000	6000	8000	25000	100%	67%	100%	89%
% prescriptions oral antidiabetics/all diab Rx	70.6%	72.5%	11%	9%	85%	91%	76%	**81%**				
% prescriptions insulins/all diab Rx	28.4%	27.2%										
% prescriptions biguanides/oral antidiabetics	55.6%	53.5%		75%	54%	53%	56%	**53%**				
possible % unnecessary blood glucose testing by Type 2 pts												**37%**
no. patients	95000	386000	8000	37000	31000	122000	87000	349000	79%	77%	92%	90%
items/pt	1.67	1.64	1.75	1.92								
%Type 1/all			8.4%	9.6%								

distribution of Rx prescribed by diagnosis:

	E10 IDDM	non-IDDM (E11, E14)	total
human insulin+analogues	10%	17%	27%
oral antidiabetics	1%	72%	73%
total	11%	89%	100%

Comparisons between IMS data and other datasets:

	1m	3m	12m	IMS 12m data	RR IMS vs PharmHouse, 12m data
Sample of PharmHouse data (NHI-annotated scripts):					
estimated no. patients using diabates Rx			82,562	96,500	1.169
% pts using oral antidiabetics +/- insulin / all diab Rx	75.5%	75.8%	76.9%		
% disp oral antidiabetics / all diab Rx	69.1%		68.2%		
% disp insulins / all diab Rx	30.9%		31.8%		
All PharmHouse data:					
no. diabetes drugs dispensed (PharmHouse) or prescribed (IMS)		280,786	1,035,986	1,212,000	1.170
% disp using oral antidiabetics / all diab Rx - 2002/03	69.5%	69.2%	69.3%		
% disp using oral antidiabetics / all diab Rx		69.3%	68.9%	72.5%	1.05
% disp using insulins / all diab Rx		30.7%	31.1%	27.2%	0.88
% disp biguanides / oral hypoglycaemics		47.6%	46.3%	53.5%	1.15

NZ estimates:	
diabetes pts	114712
Type 1 pts	10254
Type 2 pts	104458
%Type 1/all	8.9%
RR IMS/estimate	1.072

distribution of Rx prescribed by diagnosis, 12 month data, IMS vs. PharmHouse sample of NHI-annotated scripts

	IMS	sample	RR
human insulin+analogues	27%	31%	0.88
oral antidiabetics	73%	69%	1.06
biguanides	53%	46%	1.15

Source data from item-based NHI-encrypted data (#81294), October 2002 cohort, data Oct'02-Sept'03

No. patients in sample x drug category – unadjusted for undercounting of oral hypoglycaemic agents etc.

no. pts	
category	Total
diab Rx only	5402
ACE+diab Rx	7404
statin+diab Rx	2861
residual LMA+diab Rx	456
ACE+statin+diab Rx	7565
SMBG w/o diabetes Rx	2903
(urine testing only)	21
Total	26612

No. patients in sample x drug class combination (unadjusted)

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Count of Encrypted HCU ID						ACE inhibitors and statins:				
						ACE inhibitors +		no ACEs		Total
Insulin - rapid- or short-acting	Insulin: Intermediate and Long-acting Preparations	Sulphonylureas	Metformin	Acarbose	SMBG	statins +	no statins	statins +	no statins	
yes	yes	yes	yes	yes	yes	2	0	0	0	2
				no	yes	43	34	10	21	108
					no	5	1	0	3	9
			no	yes	yes	2	0	0	0	2
				no	yes	25	12	4	19	60
					no	3	1	2	3	9
		no	yes	yes	yes	4	2	1	2	9
				no	yes	206	85	43	68	402
					no	25	12	6	10	53
			no	yes	yes	5	3	1	1	10
					no	1	1	0	0	2
				no	yes	593	534	261	1273	2661
					no	72	79	40	249	440
	no	yes	yes	no	yes	6	3	0	2	11
					no	1	0	1	0	2
			no	no	yes	2	1	0	5	8
					no	0	1	0	0	1
		no	yes	no	yes	2	1	2	1	6
					no	0	0	0	3	3
			no	no	yes	11	12	2	35	60
					no	1	3	4	4	12
no	yes	yes	yes	yes	yes	5	8	0	0	13
					no	1	0	0	1	2
				no	yes	350	211	94	100	755
					no	66	49	21	23	159
			no	yes	yes	4	6	2	0	12
				no	yes	137	90	27	54	308
					no	23	18	10	9	60
		no	yes	yes	yes	7	1	1	3	12
					no	2	0	1	0	3
				no	yes	451	276	103	149	979
					no	86	74	20	30	210
			no	yes	yes	6	7	2	0	15
					no	2	1	0	0	3
				no	yes	670	608	171	381	1830
					no	126	149	39	132	446
	no	yes	yes	yes	yes	14	9	6	6	35
					no	8	3	2	1	14
				no	yes	1371	1331	531	754	3987
					no	677	753	241	439	2110
			no	yes	yes	2	4	1	4	11
					no	2	0	0	3	5
				no	yes	661	864	340	701	2566
					no	438	676	198	438	1750
		no	yes	yes	yes	2	1	1	0	4
					no	2	1	1	0	4
				no	yes	802	799	386	430	2417
					no	637	672	283	474	2066
			no	yes	no	0	1	1	2	4
				no	yes	906	1018	583	426	2933
					no	0	0	0	1	1
Total						8467	8415	3442	6260	26584

No. dispensings in sample x drug (unadjusted)

	scripts	**items**
diab Rx/Management	189662	451338
other	67439	190921
total	257101	642259

				Data	
Tg Level2 Name	Tg Levle3 Name	ATCLevel4	Chemical Name	no. records	no. dispensings
Diabetes	Insulin: Rapid acting insulin analogues		Insulin Aspart	584	2,871
			Insulin Lispro	1,632	13,286
	Insulin: Short-acting Preparations		Insulin Neutral	2,099	14,825
	Insulin: Intermediate and Long-acting		Insulin Isophane	4,702	37,641
			Insulin Isophane with Insulin Neutral	4,113	39,464
			Insulin Zinc Suspension	503	3,739
	Oral Hypoglycaemics	sulphonylureas	Glibenclamide	1,104	9,679
			Gliclazide	6,587	63,402
			Glipizide	4,509	42,356
			Tolbutamide	85	886
		biguanides	Metformin Hydrochloride	13,376	123,388
		other	Acarbose	162	1,314
	Hyperglycaemic Agents		Glucagon Hydrochloride	812	1,232
Diabetes Management	Glucose/Blood Testing		Glucose Oxidase	19,210	78,432
	Glucose &/or Ketones/Urine Testing		Glucose Oxidase	64	74
			Sodium Nitroprusside	142	190
	Glucose/Urine Testing		Glucose Oxidase	12	20
	Insulin Syringes and Needles		Insulin Pen Needles	4,508	13,750
			Insulin Syringes	1,203	4,720
[Renin-Angiotensin Rxs]	ACE Inhibitors		Captopril	579	6,114
			Cilazapril	5,615	52,693
			Enalapril	1,301	12,353
			Lisinopril	210	2,361
			Perindopril	33	449
			Quinapril	7,232	71,585
			Trandolapril	35	440
	ACE Inhibitors with Diuretics		Cilazapril with Hydrochlorothiazide	1,542	13,955
			Enalapril With Hydrochlorothiazide	31	239
			Quinapril with Hydrochlorothiazide	469	3,748
	Angiotension II Antagonists		Candesartan	1,157	10,949
			Losartan	235	2,374
Lipid Modifying Agents	Statins		Atorvastatin	2,977	32,634
			Fluvastatin	28	36
			Simvastatin	9,177	78,960
	Fibrates		Bezafibrate	2,710	23,294
			Gemfibrozil	196	896
	Resins		Cholestyramine with Aspartame	22	91
			Colestipol Hydrochloride	11	52
	Other lipid modifying agents		Acipimox	37	303
			Nicotinic Acid	75	591
Total				99,079	765,386

Appendix Two

Extracts from:
http://www.nelh.nhs.uk/guidelinesdb/html/downloads/NICE_full_blood_glucose.pdf
The Royal College of General Practitioners Effective Clinical Practice Unit, University of Sheffield. **Clinical Guidelines for Type 2 Diabetes** Management of blood glucose.
A Collaborative Programme between: The Royal College of General Practitioners Diabetes UK; The Royal College of Physicians; The Royal College of Nursing
Publication Date: September 2002
Review Date: September 2005

Measurement

Self-monitoring

Recommendations
Self-monitoring should not be considered as a stand-alone intervention. (D)
Self-monitoring should be taught if the need/purpose is clear and agreed with the patient. (D)
Self-monitoring can be used in conjunction with appropriate therapy as part of integrated selfcare. (D)

Evidence statements
1a Using blood or urine testing as a stand alone intervention does not appear to improve HbA1c, decrease body weight, reduce incidence of hypoglycaemia or improve health related quality of life.

III Self-monitoring may have a role to play as part of an integrated self-care package for people with Type 2 diabetes.

1a There is no evidence that blood glucose monitoring is more effective than urine testing as part of an integrated self-care package in improving blood glucose control.

1a Urine testing is cheaper than blood glucose testing.

III Urine testing is preferred by some patients and blood testing by others.

IV Insulin doses can only be adjusted appropriately on the basis of self-monitored blood glucose levels at different times of day.

Evidence: narrative

Self-monitoring in Type 2 diabetes was considered in a systematic review undertaken by Faas et al (1997). This included two Medline searches for 1976-96, resulting in 77 and 813 articles respectively. However all of those identified in the second search were eliminated. Additionally a search through the reference lists was also undertaken.

- Twelve studies met the inclusion criteria, but only 4 met all qualitative criteria (all RCTs):
- one was excluded as patients were mainly using insulin
- four were descriptive, prospective
- one was comparative, retrospective
- six were RCTs.

These six RCTs formed the basis for the review. Three of the trials showed no significant difference between self-monitoring of blood glucose (SMBG) and urine testing. One trial showed no efficacy of SMBG over no SMBG, one trial showed a significantly positive result of SMBG compared with no SMBG (HbA1c and weight), while two studies showed slightly but not significantly positive results (mean HbA1c in one and weight loss in the other). One study showed improved compliance with therapy but not blood glucose control.

An HTA review (Coster et al 2000) has looked at monitoring of blood glucose in people with diabetes. This included a section concerned with self-monitoring. This was a systematic review, and involved data synthesised using meta-analysis where possible. The review included eight RCTs. Of the RCTs, one included only patients who were on oral glucose-lowering agents or insulin, while another trial included only those on oral medications. The remaining trials included only patients who were not insulin users. No trial included enough subjects to detect a difference in HbA1c of □0.5%. Interventions were not standardised, while patient training and compliance were not addressed:

- three studies compared urine and blood monitoring
- four studies compared blood monitoring to no monitoring
- one three-armed trial compared urine and blood, and blood and no monitoring.

In three out of four RCTs comparing blood / urine monitoring to no monitoring no difference in blood glucose control or body weight was found between subjects who monitored & those who did not. A meta-analysis on four RCTs showed no effect on HbA1c or body weight. The studies were poorly conducted and reported and had low statistical power; the small differences found, for example in glycated haemoglobin of up to 0.6 % or in body weight of up to 1.5 kg could be clinically significant. In conclusion,

- there was no difference in the effect on glycaemic control between urine and blood
- monitoring (Fontbonne, Allen, Gallichan, Miles)
- the three studies measuring well-being/quality of life (QoL)/mood showed no difference between blood monitoring and no monitoring (Muchmore et al & Wing et al) or between blood and urine testing (Miles et al)
- in two RCTs (Miles et al and Gallichan) 70 and 71 % of patients preferred urine to blood testing.

The main conclusion of the review in terms of self-monitoring in Type 2 diabetes, was:

- no evidence to show that self-monitoring of blood or urine glucose improves blood glucose control using HbA1c or fasting plasma glucose
- no evidence that blood glucose monitoring is more effective than urine glucose monitoring in improving blood glucose control
- the studies reviewed had low statistical power and were poorly conducted and reported, small but clinically relevant effects might not have been detectable
- patients' perceptions of monitoring were neither completely nor rigorously studied and further work is needed in this area
- urine testing is less costly than blood testing
- urine testing is preferred by some patients.

The review by Coster et al also considered the role of self-monitoring in people with Type 1 diabetes, and thus people using insulin. Extrapolation of these findings may be useful in people with Type 2 diabetes requiring insulin therapy. Eight trials were also included in this review looking at self-monitoring in people with Type 1 diabetes. Four studies included children (age <18 yr), six studies included people using twice daily insulin injections, one study included people using a mixture of twice and one daily dosing. In concluding, for people with Type 1 diabetes, Coster et al argued that the reviewed studies did not provide evidence to support the clinical effectiveness of self-monitoring in Type 1 diabetes. However, because the studies were generally neither well conducted, nor well reported, and because they had low statistical power, the review must be considered to give inconclusive results.

A recent study looked at the relationship between self monitoring of blood glucose and glycaemic control. Karter et al (2001) looked at the relationship between patients with diabetes, their practise of self-monitoring (determined by redemption of test strip prescriptions although redemption does not of course mean use and this is not discussed anywhere in the paper) and level of glycaemic control. The study was based on 24 312 responders to a survey (from 48 614 adults on their Register for a continuous 2 year period from January 1996 to December 1997). They found that patients who were categorised as more adherent to ADA recommendations regarding self monitoring were more likely to have better glycaemic control, at the level of statistical significance. It included a so called control group but no primary data is given for this group in the paper, rather a statement that by use of models comparing this group with the analysis group it appears that selection bias was not an issue. This study was described as a cohort study, although it more closely resembled a cross sectional study, and thus the major limitation is that no conclusions regarding causality can be made.

Franciosi et al (2001) had data available on nearly 3000 patients with Type 2 diabetes, the conclusions of this study were that; self monitoring of blood glucose can have an important role in improving metabolic control if it is an integral part of a wider educational strategy devoted to the promotion of patient autonomy. In patients not treated with insulin, self monitoring is associated with higher HbA1c levels and psychological burden. They argued therefore that their data did not support the extension of SMBG to this group.

Overall, we would argue that we can not give much credence to associations between blood glucose control and blood glucose self-monitoring in observational studies, as indeed it might be expected that patients and doctors who use and advocate self-monitoring will be the same people who are motivated to achieve better control.

Working group commentary

Whilst self-monitoring per se cannot be considered an intervention with impact on outcomes such as HbA1c, decreased body weight, reduced incidence of hypoglycaemia or improved health-related quality of life, it may prove useful to people in their overall approach to self-care. For example self-monitoring could be useful in allowing patients to see the impact of particular behaviours, such as dietary habits, on their blood glucose levels. This may help both in the process of identification of behaviours that prevent optimal control being achieved (and also those behaviours that improve control) and may also act as important triggers in behaviour change. This may be of particular importance in for example individuals who were considered to be moving in the direction of stepping up therapies, for example moving on to insulin therapy. The information gained through self-monitoring may be useful in reconsidering lifestyle behaviours and allowing a further attempt at behaviour modification.

Professionals need to reconsider the almost automatic assumption by many that self-monitoring is beneficial. It needs to be seen in the context of packages of self-care for the individual. If self-care packages are not considered important for particular individuals for whatever reason, there is little point in advocating self-monitoring in isolation.

The Working group concurred with the many guidelines recommending the need for blood glucose monitoring for insulin dose adjustment (such as the IDF Europe guidelines (1999)).

Evidence tables: Measurement (including self-monitoring):

Self-monitoring

RCTs for Type 2 diabetes self-monitoring reviewed in HTA report (Coster et al 2000)

Study	Setting	No. of patients	Inclusion criteria	Intervention	Monitoring Comparison B = blood U= urine N = no monitoring	Main measures	Results ND= no difference	Duration Dropouts
Allen, 1990	USA, medical centre	61	fpg 8.8-<22mmols/l No history of DKA Not using insulin No previous monitoring	SMBG & urine testing as part of standard treatment programme	B vs. U	fpg Weight GH_b	ND ND ND Cost of blood 12 times more in year 1 (8 times in later years)	6 months *7 dropouts*
Estey, 1989	Canada, medical centre	60	Referred for education Not on insulin Prepared to monitor blood Complete 3 day programme Access to telephone for follow-up	Study group received 3 day education + tel. follow-up to reinforce SMBG	B vs. B + tel. follow-up	HbA1c Weight Frequency of SMBG	ND ND	4 months *7 dropouts*
Fontbonne, 1989	France, diabetes clinics	208	Poor control (fpg 8.8mmol/l or more or post-prandial =/> 11mmol/l 3 times in a year Diabetes > 3 years Clinic attender	Urine monitoring or SMBG compared with GHb results	B vs. U vs. N	HbA1c Body weight	ND ND	6 months *44 dropouts*
Gallichan, 1994	UK, diabetes centre	27	On oral hypoglycaemic agents	Randomisation to a programme of blood or urine testing	B vs. U	Fructosamine	ND	24 weeks *10 dropouts*
Miles, 1997	UK, diabetes centre	150	Newly diagnosed	SMBG + education or urine monitoring + education	B vs. U	GHb BMI QOL	ND ND ND	6 months *36 dropouts*
Muchmore, 1994	USA, medical centre	29	Obese, elevated HbA1c No recent SMBG No diet programme in last 3 months	Randomisation to diet or diet + SMBG programme	B + diet vs. N	HbA1c Body weight QOL (DCCT)	ND ND ND	44 weeks *6 dropouts*
Rutten, 1990	Netherlands, general practices	149	40-75yrs Not treated with insulin Not receiving treatment for other diseases	Patients in study practices used SMBG as part of diabetes management protocol	B + GP protocol vs. N control (conventional GP care and no SMBG protocol)	fpg Weight HbA1c	ND Decrease in intervention group, increase in control group	12 months *10 dropouts*
Wing, 1986	USA, medical school	50	35-65yrs 120% or more IBW On oral hypoglycaemic drugs or insulin Developed diabetes > 30 years ago	Weight control programme including self-monitoring	Weight control + B vs. weight control + N.	Weight GHb & fpg Serum lipid Medication /lifestyle/mood changes	ND ND &ND ND ND	12 months *5 dropouts*

Self-monitoring

Author	Study details	Setting & Location Type 1 and/or 2 Diabetes duration, mean (range) years Inclusion/Exclusion	Numbers randomised Male: Female Age mean ±SD (range) years	Follow-up period Power calculation	Main outcome measures (other outcomes)	Results Metabolic factors	Results Other	Adverse effects
Schiel et al, 1999	NOT AN RCT, but a cross-sectional study to assess blood glucose self-monitoring. All patients in the study had received insulin treatment for at least 12 months.	Hospital clinic and out-patient department in Thuringia, Germany Type 2 diabetes 12.6 ± 7.6 (1-57) Inclusion/exclusion criteria not reported.	842 patients total, from whom 33 took part in a five-day structured treatment and teaching programme on self-monitoring and diabetes education. Sex not reported 60.1 ± 10.9 (20-87)	33 patients re-examined 1 year after participation in treatment programme Not reported	Correlation between blood glucose self tests and HbA1c, age and frequency of insulin-dose self adjustments of the patients Parameters associated with HbA1c Subgroup analysis of patients >60 years Subgroup analysis of patients who had not participated in the five day programme Change in relative HbA1c after treatment programme	Correlation between blood glucose self tests and HbA1c, age and frequency of insulin-dose self adjustments of the patients There were negative correlations between the frequency of blood glucose self tests and HbA1c (r=-0.17, p<0.001) and age (r=-0.16, p<0.001). There was a positive correlation between the frequency of blood glucose self tests and the frequency of insulin dose self adjustments of the patients (r=0.42, p<0.001). Parameters associated with HbA1c The important parameters associated with HbA1c (R-square=0.10), using multivariate analysis were: frequency of blood glucose self tests/week (c=-0.005, p<0.001), the insulin dosage/kg body weight (c=0.001, p=0.0032) and participation in treatment programme (c=0.085, p<0.0001). Age, diabetes duration, number of insulin injections/day and sex showed no associations. Subgroup analysis of patients > 60 years (n=396) Parameters associated with HbA1c (R-square=0.16) were participation in treatment programme (c=0.09, p=0.002), frequency of blood glucose self-tests/week (c=-0.006, p=0.0018), insulin dosage/kg body weight (c=0.004, p= 0.0002) and body mass index (c= 0.008, p= 0.0012). Subgroup analysis of patients who did not participate in treatment programme (n=249) No correlations or associations between frequency of blood glucose self-monitoring and HbA1c. Changes in relative HbA1c after treatment programme Relative HbA1c decreased from 1.84 ± 0.38% to 1.61 ± 0.30% (p=0.007) and there was a strong association between the frequency of blood glucose self-tests/week and HbA1c (c=-0.016, p=0.0032, R-square=0.25). *Conclusions:* Daily blood glucose self-monitoring was associated with better quality of metabolic control.	Not reported	Not reported

Self-monitoring

Meta-analysis/systematic review extraction table

Author (s)	Research question	Review type Databases used Time period covered Data analysis	Study design Interventions Follow-up period	Numbers randomised	Total sample number Diabetes status and duration Age (mean/SD/range) Male/female Ethnicity	Outcomes
Faas A., Schellevis F.G., van Eijk J.T.M. Diabetes Care 1997; 20 (9): 1482–1486	to clarify the efficacy of SMBG in NIDDM patients using diet or diet with oral antidiabetic medication as determined in published studies	systematic review: 6 RCTs (from 77 + 813 from searches) Medline on CD-ROM 1976–February 1996 not stated	RCTs self-monitoring of blood glucose (SMBG) urine testing 12-62 weeks	range 12 – 100 in each arm approx	smbg = 260 smbg + compliance: 28 urine testing: 111 no testing: 193 only those using exclusively insulin were excluded not stated not stated not stated	primary: HbA_{1c}, weight.

Results

The efficacy of SMBG in six RCTs:

Study No	Interventions	Mean HBA_{1c} (%) or fructosamine (µmol/l) Before	After	Overall conclusion
1	SMBG Non-SMBG	10.19 10.86	10.19 10.44	No difference
2	SMBG Urine testing Non-SMBG	8.2 8.6 8.2	7.84 8.47 7.7	No difference
3	SMBG Urine testing	12.4 11.7	10.4 9.7	No difference
4	SMBG Non-SMBG	9.7 8.9	9.32 9.36	Mean change of HBA_{1c} was -0.4% in the SMBG group versus +0.5% in the control group (p<0.05), mean weight loss 0.4kg in the SMBG group and mean weight gain 0.1kg in the control group (NS)
5	SMBG SMBG + compliance intervention	6.1 6.3	5.8 5.7	No difference for HBA_{1c} and weight, SMBG compliance was higher in the group with compliance intervention (p<0.0001)
6	SMBG Urine testing	324* 343*	333* 322*	No difference

* *Fructosamine level used instead of HBA_{1c}*

Conclusions:

- the efficacy of SMBG in NIDDM is still questionable

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