Self-monitoring blood glucose test strip use with diabetes medicines in people with types 1 and 2 diabetes in New Zealand
Scott Metcalfe, Peter Moodie, Hew Norris, Dilky Rasiah

Abstract

Aims (1) To identify actual dispensings of publicly funded blood glucose test strips (SMBG) in New Zealand according to severity of disease, as proxied by the type of medicines prescribed; and (2) To compare these rates with published consensus guidelines on SMBG usage.

Method All dispensings of diabetes medicines and blood glucose test strips (SMBG) in 2011 were identified and matched to patients, using encrypted National Health Index numbers (NHIs).

Five hierarchical treatment groups were identified, as the use of:
- Insulins without oral hypoglycaemic agents (OHs);
- Insulins with OHs;
- Sulphonylurea-containing OH regimens without insulins (with or without other diabetes medicines);
- Metformin alone, with or without glitazones or acarbose; and
- No diabetes medication but accessing SMBGs.

The average SMBG dispensings to patients in each of these groups was then calculated. The calculation was performed only for ‘steady-state’ patients, i.e. patients assumed stabilised on the same medication regimen for at least one year. Differences between actual and expected dispensings were calculated from expected daily strip use for each group.

Results An estimated 183,000 patients were dispensed diabetes medicines and/or SMBG during 2011. Of these, 122,000 were identified as ‘steady-state’ patients. Patient numbers and median ages varied widely across treatment groups and by gender and ethnicity. Dispensing rates for SMBG varied by treatment group, with probable over-dispensing in some groups and under-dispensing in others when compared with published guidelines.

In particular there appeared to be relatively large under-dispensing of SMBG in patients requiring insulin (especially the 25–44 age-group or Māori and Pacific peoples) and a high over-dispensing in those using metformin alone or on no diabetic medication.

Conclusion There are appreciable variations in the use of SMBG between treatment groups. Adherence to published guidelines may improve efficacy and health outcomes for those using insulin and reduce pain, anxiety and disruption for those using metformin or diet alone for control of their diabetes.

Blood glucose testing for patients with type 1 diabetes, and those with type 2 diabetes using insulin, is a mainstay of clinical management. For those on treatment with sulphonylurea medicines but not using insulin, the main long-term benefit of self-monitoring blood glucose (SMBG) usage is to detect hypoglycaemia; however it is acknowledged that there will be greater usage in this group if they are transitioning to an insulin-based regimen.1–4

For patients with diabetes on metformin alone or other non-hypoglycaemia causing diabetes medication(s), or indeed on no diabetes medication at all, SMBG testing should not be a routine occurrence—as regular measurement of glycated haemoglobin (HbA1c) levels is the main means of
managing dosage changes.\textsuperscript{1–4} This is where clinical evidence\textsuperscript{5–8} and guidelines\textsuperscript{1–4} suggest that there is usually little need for patients maintained on diet and exercise or metformin alone to routinely self-monitor their blood glucose, but the intermittent use of SMBG may be encouraged as an educational and clinical management tool to detect patterns of glycaemia.\textsuperscript{1–4}

Despite national and international clinical guidelines on the optimal use of SMBG monitoring,\textsuperscript{1–4} to date there has been little information on how, at a national level, actual testing rates for different groups have compared with the guidance. Such information is useful, as under-testing can suggest suboptimal care (expected from first principles to contribute to poor diabetes outcomes); conversely, over-testing can be inconvenient, disruptive to patients, possibly harmful,\textsuperscript{9} and is an opportunity cost to public health system in New Zealand—where $23 million for test strips was publicly funded via the Pharmaceutical Schedule during the 2011/12 financial year\textsuperscript{10} (this spending predating PHARMAC’s funding decision in 2012 on strips and meters\textsuperscript{11}). Understanding real-world practice compared with optimal practice can therefore inform discussion and focus on the educational messages given to patients. It can also help ensure funding priorities in the health budget are appropriate.

Once a funded prescription is dispensed in New Zealand, information is collected in a national repository and available for analysis. In addition to prescriber details, the medication name, strength, quantity and dosage are recorded, along with an encrypted National Health Index (NHI) number where this is available.

The NHI number is a unique identifier for nearly everybody in New Zealand who has ever had contact with the health service. This number can be linked anonymously to New Zealand census data and contains information about the individual’s date of birth, ethnicity and socio-economic status. Most general practices in New Zealand have computerised prescribing systems, and over 95% of all prescriptions recorded in the New Zealand Health Information Service (NZHIS) database now have an NHI number attached.

This brief analysis compares publicly funded blood glucose test strip uptake in New Zealand against published guidance on appropriate rates of usage. This helped inform the thinking behind PHARMAC’s 2012 funding decision for meters and strips.\textsuperscript{11}

**Methods**

This observational audit (see endnote *\textsuperscript{12})\textsuperscript{12} identified all patients who were prescribed diabetes medicines and/or blood glucose test strips between 1 January and 31 December 2011. These anonymised data\textsuperscript{12} were extracted from the Pharmaceuticals Collection (previously PharmHouse) administrative claims database,\textsuperscript{13} and were then categorised into five therapeutic-wide groupings (with categories within) consisting of patients using:

- **Insulins without oral hypoglycaemic agents (OHs) (which we divided into various subgroups, labelled as categories A, D and E).** These groups were regarded as surrogate markers for type 1 diabetes;
- **Insulins with OHs (category C),** being a surrogate marker type 2 diabetes on insulin;
- **Sulphonylurea-containing OH regimens without insulins, with or without other diabetes medicines (category F)—a surrogate for more severe type 2 diabetes;**
- **Metformin alone, with or without glitazones (thiazolidinediones) or acarbose (category G)—a surrogate for less severe type 2 diabetes;**
- **No diabetes medicines and presumably managed by diet alone but using SMBG (category H)—a surrogate for early type 2 diabetes.**

Note that the glucagon-like peptide-1 (GLP-1) agonist and dipeptidyl peptidase-4 (DPP-4) inhibitor classes of diabetes medicines (incretin mimetics, gliptins) are not funded in New Zealand.

Those patients who had received funded diabetes medicines or SMBG in 2011 were identified and then censored to comprise only those patients who had received the same script in the first and the last quarter of the year (‘steady-state’ patients); this was essentially a surrogate marker for those who had been on treatment for at least a year and likely to have been consistently accessing specific medicines and test combinations sustained
over 12 months (see endnote 1). After these steady-state patients were identified, they were further categorised according to type of medication regimen they were dispensed, alongside counts of test strips dispensed.

For these steady-state patients, we inferred current test strip usage (access) compared with expected, by comparing counts of dispensings to specific patient subgroups with expected use (i.e. clinical recommendations as to the number of times per day or week patients should be self-testing and therefore how many test strips should be dispensed to them). This analysis updated earlier analysis (2004)14—which had included epidemiological assumptions around patient mix and best-practice guidance for expected strip use—then in general applied those assumptions and methods14 to the recent data on steady-state patients.

These definitions of expected SMBG use, originally based on advice during the mid-2000s (international guidelines at the time regarding insulin use, the expert focus group on SMBG convened by PHARMAC in 2004, the Diabetes Subcommittee of the Pharmacology and Therapeutics Advisory Committee (PTAC), the 2003 NZGG diabetes guidelines, and the BNF),15-21 were since reiterated by the Canadian Agency for Drugs and Technologies in Health (CADTH) in 2009, the National Institute for Health and Clinical Excellence (NICE) and the Scottish Intercollegiate Guidelines Network (SIGN) in 2010, and the New Zealand Guidelines Group (NZGG) in 2011.1–4

Appendix 1, at the end of this article, summarises the workings and rationales for these groupings and provides expected test strip usage rates per patient/year for each group, where ideally in effect:

- At least 4 strips/day for patients stabilised on insulins without oral hypoglycaemic agents (OHs) (categories A,D,E);
- At least 2 strips/day for those on insulin with OHs (category C);
- 4 strips/week on average for those stabilised on sulphonylurea-containing OH regimens without insulins, with or without other diabetes medicines (category F);
- 3–4 strips/month on average for those stabilised on metformin alone, with or without glitazones (thiazolidinediones) or acarbose (category G); and
- 5 strips/month on average spread over the year for those stabilised on diet alone but using SMBG (category H).

Information included age, gender and ethnic group (see endnote §). We calculated median and mean dispensings and units for each patient group, both those dispensed SMBG and all (SMBG and no SMBG dispensings), with corresponding standard deviations and interquartile ranges across all strata. All remained anonymised.12

**Results**

A total of 2,624,405 dispensings of diabetes medicines and/or blood glucose test strips were recorded during the year 2011, in which 2,606,179 (99.3%) occurred for 181,342 known patients (i.e. dispensed to patients whose prescriptions contained their NHI number). With linear scaling (see endnote ‡), this means that approximately 183,000 patients were dispensed diabetes medicines and/or blood glucose test strips at some stage during the year 2011.

Of the 181,342 patients identified, about 122,000 received the same script combination in the first and fourth quarter of the 2011 year. Patients dispensed insulins and/or sulphonylureas (categories A-F) were likely to be such steady-state, but more than 2/5ths and 4/5ths of patients dispensed metformin (category G) or SMBG alone (category H), respectively, had different script combinations (endnote †).

Patient numbers and median ages varied widely across treatment groups. Of the 181,342 patients, 11% were dispensed category A (rapid/short-acting insulin ± inter-/long-acting insulin), compared with 33% dispensed category G (metformin and/or acarbose and/or glitazone alone), for example. Median ages varied between 48 years for category A (interquartile range 30–63 years) and 71 years for category E (intermediate-/long-acting insulin alone)(61–78 years).

Further details are provided in Figure 1 below, endnote § and in Supplementary results to this paper (at http://www.nzma.org.nz/__data/assets/pdf_file/0004/38290/SupplResults.pdf)
Figure 1. Numbers of censored steady-state patients accessing diabetes medicines and/or blood glucose test strips during 2011

For those steady-state patients dispensed test strips, we observed (amongst other things):

- Patients who had no identified diabetes medicines who were dispensed test strips (category H) received on average 18.8 test strips per patient per month (median 17, interquartile range 13-21);
- Those on metformin alone (category G) who were dispensed test strips received 12.7 test strips per patient-month (median 8 [4–17])—where nearly half (19164/40325) of steady-state metformin alone patients were dispensed test strips (see Table 1).

Table 1. Dispensings of blood glucose test strips in 2011 to steady-state patients

<table>
<thead>
<tr>
<th>SMBG users, steady state:</th>
<th>patients no.</th>
<th>% SMBG</th>
<th>strips/month mean (interquartile range)</th>
<th>mean (+/- 1 SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[A] rapid/short-acting insulin +/- inter-/long-acting</td>
<td>12,780</td>
<td>97%</td>
<td>100.0 (54-150)</td>
<td>112.0 (77.0)</td>
</tr>
<tr>
<td>[C] rapid/short-acting insulin +/- inter-/long-acting + oh</td>
<td>4,861</td>
<td>98%</td>
<td>58.3 (33-100)</td>
<td>72.0 (50.5)</td>
</tr>
<tr>
<td>[D] oral hypoglycaemics + inter-/long-acting insulin only</td>
<td>15,642</td>
<td>95%</td>
<td>37.5 (25-63)</td>
<td>45.5 (31.5)</td>
</tr>
<tr>
<td>[E] inter-/long-acting insulin alone</td>
<td>5,260</td>
<td>94%</td>
<td>50.0 (25-75)</td>
<td>55.1 (40.0)</td>
</tr>
<tr>
<td>[F] sulphonylurea +/- metformin or acarbose or glitazone</td>
<td>27,394</td>
<td>72%</td>
<td>16.7 (8-29)</td>
<td>21.9 (19.1)</td>
</tr>
<tr>
<td>[G] metformin and/or acarbose and/or glitazone alone</td>
<td>19,164</td>
<td>48%</td>
<td>8.3 (4-17)</td>
<td>12.7 (10.1)</td>
</tr>
<tr>
<td>[H] no diab Rx</td>
<td>3,018</td>
<td>91%</td>
<td>16.7 (13-21)</td>
<td>18.8 (13.0)</td>
</tr>
<tr>
<td>subtotal, SMBG users</td>
<td>88,119</td>
<td>72%</td>
<td>34.9</td>
<td>41.8</td>
</tr>
<tr>
<td>no SMBG</td>
<td>33,761</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>121,879</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- For those on rapid/short-acting insulin, with or without intermediate/long-acting insulins (category A) there were 19.3 million strips dispensed, being 2.1 million strips (-11%) less than expected from 4 strips/day ideal (where 3.3% (438/13218) of these patients were not dispensed test strips)(see Table 2).
Overall test strip dispensing in steady-state patients was ostensibly 8% less than what it should have been (see Figures 1 and 2 and Table 2 below):

- Stabilised patients using insulin ± oral hypoglycaemics (categories A–E) ostensibly under-used test strips, dispensings being 14% less than expected;
- Likewise dispensings were 9% less than expected for sulphonylurea ± metformin or acarbose or glitazone (category F);
- At the same time, steady-state actual test strip use was three times that expected for metformin and/or acarbose and/or glitazone alone (category G); and possibly up to two to five times higher for diet alone (category H).

Table 2. Actual vs expected use of blood glucose test strips in 2011 in steady-state patients, based on clinical recommendations

<table>
<thead>
<tr>
<th>Category</th>
<th>Units</th>
<th>No. patients</th>
<th>Actual test strips</th>
<th>Expected test strips</th>
<th>Actual v/s expected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>test strips</td>
<td>no. strips</td>
<td>strips</td>
<td>total</td>
<td>avg, all pts/month</td>
</tr>
<tr>
<td>1. insulin needing &gt;2 SMBG/day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rapid/short-acting insulin +/- inter-/long-acting</td>
<td>A</td>
<td>17,180,892</td>
<td>438</td>
<td>12,780</td>
<td>13,218</td>
</tr>
<tr>
<td>2. inter-/long-acting insulin +/- oh needing 2 SMBG/day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rapid/short-acting insulin +/- inter-/long-acting + oh oral hypoglycaemics + inter-/long-acting insulin only</td>
<td>C</td>
<td>4,199,276</td>
<td>123</td>
<td>4,861</td>
<td>4,984</td>
</tr>
<tr>
<td>inter-/long-acting insulin alone</td>
<td>D</td>
<td>8,539,838</td>
<td>799</td>
<td>15,642</td>
<td>16,441</td>
</tr>
<tr>
<td>E</td>
<td>3,478,962</td>
<td>339</td>
<td>5,260</td>
<td>5,599</td>
<td>55.1</td>
</tr>
<tr>
<td>3. oral hypoglycaemics w/o insulin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sulphonylurea +/- metformin or acarbose or glitazone</td>
<td>F</td>
<td>7,213,167</td>
<td>10,897</td>
<td>27,393</td>
<td>38,290</td>
</tr>
<tr>
<td>metformin and/or acarbose and/or glitazone alone</td>
<td>G</td>
<td>2,918,271</td>
<td>21,161</td>
<td>19,164</td>
<td>40,325</td>
</tr>
<tr>
<td>4. no diabetes Rx</td>
<td>H</td>
<td>679,285</td>
<td>3,018</td>
<td>3,018</td>
<td>18.8</td>
</tr>
<tr>
<td>subtotal, diabetes Rx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. insulin needing &gt;2 SMBG/day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rapid/short-acting insulin +/- inter-/long-acting</td>
<td>A</td>
<td>4.0</td>
<td>122.0</td>
<td>19,298,591</td>
<td>-11%</td>
</tr>
<tr>
<td>2. inter-/long-acting insulin +/- oh needing 2 SMBG/day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rapid/short-acting insulin +/- inter-/long-acting + oh oral hypoglycaemics + inter-/long-acting insulin only</td>
<td>C</td>
<td>2.0</td>
<td>61.0</td>
<td>3,638,440</td>
<td>-15%</td>
</tr>
<tr>
<td>inter-/long-acting insulin alone</td>
<td>D</td>
<td>2.0</td>
<td>61.0</td>
<td>12,001,849</td>
<td>-29%</td>
</tr>
<tr>
<td>E</td>
<td>2.0</td>
<td>61.0</td>
<td>4,087,176</td>
<td>-15%</td>
<td>-608,214</td>
</tr>
<tr>
<td>3. oral hypoglycaemics w/o insulin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sulphonylurea +/- metformin or acarbose or glitazone</td>
<td>F</td>
<td>0.56</td>
<td>17.2</td>
<td>7,886,412</td>
<td>-9%</td>
</tr>
<tr>
<td>metformin and/or acarbose and/or glitazone alone</td>
<td>G</td>
<td>0.07</td>
<td>2.2</td>
<td>1,051,324</td>
<td>170%</td>
</tr>
<tr>
<td>4. no diabetes Rx</td>
<td>H</td>
<td>0.12</td>
<td>3.7</td>
<td>133,027</td>
<td>411%</td>
</tr>
<tr>
<td>subtotal, diabetes Rx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table continued (below):
Beyond these overall patterns by group (categories A-H), Māori and Pacific peoples in the 25-44 age-group were appreciably under-dispersed in some insulin-containing regimens (categories A, D).

Further information is available in Supplementary results to this paper.

Discussion

This study was designed to examine which patient groups actually received SMBGs and whether this ostensible usage was consistent with guidelines, such as they are.

During 2011 there appeared to be both under-dispensing of test strips among some patient groups as well as over-dispensing in other groups.

New Zealand is fortunate to have its pharmaceutical databases reliably providing dispensing information at a national level. National and international clinical guidelines and advice indicate that there is usually little need for patients maintained on diet/exercise or metformin alone to be routinely self-monitoring their blood glucose,1–8,22–24 however, the expenditure on test strips in these two patient groups has been at approximately $2.6 million per year. Unfortunately it is not possible to estimate from the dispensing data what proportion of non-medicated people with diabetes use test strips.

Limitations—The study’s main strength is that it links patterns of dispensing of diabetes medicines with the related use of SMBG, at a national level.

Limitations that affect validity include:

- The study is confined to patients with diabetes identified from diabetes medicines and/or blood glucose test strip dispensings. This method omits diabetes patients who are not currently treated with diabetes medicines or dispensed test strips, treated instead by diet alone and clinically monitored by periodic HbA1c testing (not SMBG).
The data are dispensing-based, not based on prescription-at-doctor-visit nor patient end-use (see endnote **).

Diagnoses are by inference and will include other conditions where diabetes medicines are used, including polycystic ovary syndrome;\textsuperscript{25} however the numbers of these cases are likely to be relatively small.

The steady-state grouping reflects patients being dispensed any diabetes medication and/or test strips in the first three and last three months of the year; this omits where patients’ medication regimens may have changed during the year.

Patients were grouped hierarchically according to all medicines received over the year, rather than their specific regimen at any one point in time (or their weighted average regimen over the entire 12 months).

The analysis has not attempted to link SMBG usage with laboratory data such as HbA1c measurements of glycaemic control, nor has it considered the full range of demographic and clinical information—socioeconomic deprivation, region, type of diabetes, renal function, other macrovascular and microvascular complications, neuropathies, use of other medicines (e.g. ACE inhibitors, statins), etc.—to better elucidate key patterns and gaps in the treatment of patients with diabetes.

Note that the audit period (2011) was when conceivably patients may have been aware of oncoming changes in the meter/strip supplier,\textsuperscript{11} with potential stockpiling of strips and thus seemingly higher SMBG dispensings. Most patients however would have been unaware of the possible changes until early 2012 (i.e. after the audit period), when consultation began.\textsuperscript{26}

Comparisons with usage rates elsewhere including for SMBG—This analysis provides a nationwide perspective of diabetes medication and SMBG dispensing patterns in New Zealand. Dispensing rates and patterns appear to be largely comparable with that of recently published series overseas:

- Reports of Tasmanian data (1995–97, 2001) indicate similarly persistently high rates of SMBG usage amongst respondents with insulin-treated diabetes, with 98% reporting any self-monitoring (c.f. 95% usage in this analysis—40230/46816 for insulin alone in New Zealand 2011) and 74% of respondents stating they self-monitored daily.\textsuperscript{27,28}

- A postal survey in Scotland (60% response rate) reported 87% of patients using diabetes medications used SMBG (c.f. 64% in NZ 2011), with higher rates in insulin users.\textsuperscript{29}

- Western Australia data (1993-96) reported 71% of patients with type 2 diabetes using SMBG (c.f. NZ 2011 68% for patients with possible type 2 diabetes).\textsuperscript{30,31}

- Canadian data from Ontario (for all ages\textsuperscript{32,33} and for those aged 65+ \textsuperscript{34}) and the elderly in Nova Scotia\textsuperscript{35} suggest similar proportions of diabetes medicines use as occurs in New Zealand (Ontario\textsuperscript{32,33}), increasing use of SMG over time (Ontario elderly\textsuperscript{34}) and more marked variation from expected for oral hypoglycaemics and diet alone than occurs in New Zealand; endnote \textsuperscript{11} provides further information.

Implications—This analysis provides population level commentary that will not necessarily reflect individual clinical or personal circumstances. Advice from clinicians in the field is that patients may over- or under-use due to their personal preference with respect to their diabetes.\textsuperscript{36} In addition clinicians often initiate newly diagnosed type 2 patients on test strips so that patients can see what effect diet and exercise have on their blood glucose.\textsuperscript{36} Our calculations have taken this into account, allowing 3 months of daily use in the 62% of patients expected to dose-escalate in any year; however dispensings were still at least double expected despite this adjustment. Numbers can be substantial when converting daily use (strip counts) to bottles per year.
Clinicians have also noted that patients currently have ample opportunity to access test strips and that it is up to the clinician and patient to agree to the appropriate level of testing; however long-term testing may be damaging, as increased testing may lead to increased anxiety, unnecessarily. Information on prescriber and patient consumer perspectives would be helpful (see endnote ‡‡).

Given the view that those people on insulin have appropriate information and access to test strips, it may be that there is no need to have specific targeting campaigns. General education on the appropriateness of ongoing testing is being undertaken, for instance by the Best Practice Advocacy Centre (bpacnz) and such information can reinforce these education messages. One such message for patients with type 2 diabetes could be only to test if they are then likely to change what they do, this advice being consistent with that of CADTH, NICE, SIGN, NZGG, and the American Diabetes Association.1–4,38

**Conclusions**

This study compared publicly funded blood glucose test strip uptake in steady-state (stabilised) patients against published guidance on appropriate rates of usage. There was continuing both under-accessing of test strips among some patient groups and over-accessing in other groups.

While some of the ‘under-use’ may be appropriate to patients’ circumstances, persisting patterns of ostensible under-use (especially in younger Māori and Pacific peoples on insulin) are cause for concern and require further research, in the context of measures of diabetes control and long-term clinical outcomes.

Conversely, while again some ‘over-use’ may prove clinically acceptable, the continued accessing of expensive testing regimens with little evidence of benefit but good evidence of cost represents possible unintended harm.9,24

**Competing interests:** Scott Metcalfe is a member of the NZMA Services Board.

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**Endnotes**

* The study was an observational study (being an audit observing outcomes without controlling study variables nor having an intervention) with the secondary use of data for quality assurance/outcome analysis/resource review undertaken by people employed by the service provider holding the information (PHARMAC) and where participants remain anonymous. It did not meet criteria for requiring ethics committee review.12

† Patients were groupable into two groups. These comprised:

1. stable treatment (steady-state) patients, being those patients who likely consistently accessed the same specific medicines and test combinations sustained over 12 months (proxied by the same combination in the first and last quarters of the year), and

2. changing treatment (dynamic) patients, being those who started, stopped or changed specific medicines and test combinations during the year (death; medication changes; adherence; etc.) or who otherwise were not dispensed the same specific medicines and test combinations during both the first and last 3 months of the 12 month period.
This analysis was confined to censored stable treatment (steady-state) patients. There were some 122,000 steady-state patients and 61,000 changing treatment (dynamic) patients. Of 16,200 total patients on diet & exercise alone, 3,000 of whom accessed test strips throughout the year (steady-state), the other 14,000 (dynamic) accessing test strips for just part of the year (consistent with use when establishing new regimens or starting late or ending before the year’s end); some patients on diet & exercise alone (of indeterminate number) would have been monitored alone by HbA1c, not using SMBG.

**Steady-state (stabilised) vs dynamic patients accessing diabetes medicines and/or blood glucose test strips 2011**

\[\text{Scaling occurred to adjust patient numbers to account for scripts with missing NHI numbers, based on total units dispensed / units dispensed on scripts with known NHIs. Scaling therefore used linear interpolation, where the scaled no. scripts for a medicine for an age/sex/ethnic group = no. scripts with NHI numbers for that medicine for an age/sex/ethnic group × total scripts for medicine ÷ total scripts for medicine with NHI numbers.}\]

\[\text{Patient numbers and median ages of treatment groups varied widely by ethnicity. By prioritised ethnicity, Europeans comprised 52 to 82% of all patients (category D vs category A; median ages 49-74 years). This compared with Māori whose range was 6-19% (category H vs. D, median 41-67 years). Pacific peoples ranged 3-18% (category A vs D, median 45-64 years), and Asian patients ranged 3-14% (A vs H, median 49-61 years).}\]

In common with many analyses undertaken within the health sector, this analysis used prioritised ethnicity. With this 'prioritised output' system, adopted in earlier years by Statistics New Zealand, each person is identified as belong to just one ethnic group, prioritised in a hierarchy by Māori first, etc. (i.e. all individuals identifying as Māori (including those also identifying with other ethnic groups) are coded as Māori; all those identifying as Pacific peoples, other than those also identifying as Māori, are coded as Pacific peoples; etc.), and so on. Problems with prioritised ethnicity, which Statistics NZ no longer supports (recommending since 2004 against its use) nor provides publicly, have been summarised previously in the Journal. Alternatives include the use of sole ethnic groups.

** Dispensing based data (rather than prescription-at-doctor-visit or patient end-use) do not capture end-use (i.e. whether medicines dispensed are actually taken by the patient—wastage and suboptimal treatment), nor prescriber intent (since not all prescriptions are necessarily dispensed and captured in the data).

\[\text{Table and figures comparing diabetes medicines and SMBG use in New Zealand 2011 with Ontario2006.}^{33}\]
<table>
<thead>
<tr>
<th>Category</th>
<th>Patients no. NZ 2011</th>
<th>Patients no. Ontario 2006</th>
<th>Patients per 1000 NZ 2011</th>
<th>Patients per 1000 Ontario 2006</th>
<th>Distribution NZ 2011</th>
<th>Distribution Ontario 2006</th>
<th>Strips per million NZ 2011</th>
<th>Strips per million Ontario 2006</th>
<th>Strips per day expected (guideline) NZ 2011</th>
<th>Strips per day actual NZ 2011</th>
<th>Strips per day actual Ontario 2006</th>
<th>% Variation from ideal NZ 2011</th>
<th>% Variation from ideal Ontario 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin alone</td>
<td>22,467</td>
<td>30,999</td>
<td>5.1</td>
<td>2.5</td>
<td>12%</td>
<td>7%</td>
<td>11%</td>
<td>2.8</td>
<td>3.0</td>
<td>2.7</td>
<td>2.8</td>
<td>-6%</td>
<td>-7%</td>
</tr>
<tr>
<td>Insulin + OHs</td>
<td>24,360</td>
<td>30,214</td>
<td>5.5</td>
<td>2.5</td>
<td>13%</td>
<td>11%</td>
<td>11%</td>
<td>2.1</td>
<td>1.8</td>
<td>1.6</td>
<td>2.3</td>
<td>-13%</td>
<td>30%</td>
</tr>
<tr>
<td>OHs alone</td>
<td>119,786</td>
<td>160,938</td>
<td>27.2</td>
<td>13.2</td>
<td>66%</td>
<td>60%</td>
<td>13,329,643</td>
<td>79,151,388</td>
<td>2.8</td>
<td>6.5</td>
<td>0.2</td>
<td>0.3</td>
<td>1.3</td>
</tr>
<tr>
<td>No diabetes Rx; diet alone</td>
<td>16,139</td>
<td>47,124</td>
<td>3.7</td>
<td>3.9</td>
<td>9%</td>
<td>9%</td>
<td>2.0</td>
<td>1.4</td>
<td>0.1</td>
<td>0.3</td>
<td>1.0</td>
<td>182%</td>
<td>70%</td>
</tr>
<tr>
<td>Total</td>
<td>182,741</td>
<td>269,235</td>
<td>41.5</td>
<td>22.1</td>
<td>100%</td>
<td>100%</td>
<td>50,706,600</td>
<td>153,018,907</td>
<td>11.5</td>
<td>12.6</td>
<td>0.7</td>
<td>0.8</td>
<td>1.6</td>
</tr>
</tbody>
</table>

### Diagrams

#### No. Patients per 1000 Population

- **Insulins**
- **Insulins + OHs**
- **Oral Hypoglycaemic Agents (OHs)**
- **No Diabetes Rx; SMBG & Diet Alone**

#### Proportion of Patients Using Diabetes Rx and/or SMBG

- **Insulins**
- **Insulins + OHs**
- **Oral Hypoglycaemic Agents (OHs)**
- **No Diabetes Rx; SMBG & Diet Alone**
‡‡ Patients on metformin or diet alone, part of the group that is arguably over-testing, did not have funded access to blood glucose meters, so they would have been receiving meters from their doctor (who would in turn have received them from the pharmaceutical supplier) or by paying for them privately.

References


   http://www.bmj.com/content/344/bmj.e486

   http://www.bmj.com/content/336/7654/1139


17. Meeting of focus group on self-monitoring of blood glucose, 2 March 2004 at PHARMAC, Wellington. #78136


20. BNF 47 http://bnf.org/bnf/index.htm 6.1.2.1 Sulphonylureas, 6.1.2.2 Biguanides


Appendix 1. Expected SMBG usage for medicines-related groups

To examine actual versus expected use of SMBG, five mutually-exclusive hierarchical groups of steady-state (stabilised) patients were defined according to the following treatment-based hierarchy, with associated assumptions and calculations for average SMBG test strip use per patient-year:

Groups:
1. rapid/short-acting insulin ± intermediate-/long-acting insulin (categories A,D,E);*1
2. oral hypoglycaemics (OHs) with insulin and intermediate-/long-acting insulin (± rapid/short-acting insulin) (category C);*2
3. sulphonylurea-containing oral hypoglycaemic regimens without insulin—i.e. sulphonylurea ± metformin or acarbose or a glitzone (category F);*3
4. residual non-sulphonylurea oral hypoglycaemics w/o insulin—i.e metformin and/or acarbose alone and/or glitzones (category G);*4 and
5. no diabetes Rx (diet/exercise alone) (category H).*5

* note there is no category ‘B’.

Assumptions/calculations for average SMBG test strip use in steady-state (stabilised) patients per patient-year:

*1. rapid/short-acting insulin ± intermediate-/long-acting insulin (categories A,D,E)
   = using rapid/short-acting insulin ± intermediate-/long-acting insulin but not when combined with oral hypoglycaemics (suggesting less brittle control):
   ideally x4/day

*2. oral hypoglycaemics (OHs) with insulin and intermediate-/long-acting insulin (+/- rapid/short-acting insulin) (category C):
   ideally x2/day

*3. sulphonylurea-containing oral hypoglycaemic regimens without insulin (category F):
   ideally 4-8 per week (based on BNF 47 and NZGG diabetes guidelines) for patients with HbA1c >7.0% (59% in “Get Checked” for 2003),
   perhaps once a week if HbA1c < 7.0% (41%) (higher if HbA1c > 8.0%, contemplating insulins),
   = weighted average of 0.56 per day

*4. residual non-sulphonylurea oral hypoglycaemics w/o insulin (category G):
   ideally this would be perhaps once a fortnight (broadly based on SIGN, NZGG diabetes guidelines and PTAC subcommittee advice);
   however, perhaps 15% of patients need to escalate their treatment regimens, hence for these patients ideally one per day
   (in 15% of patients) whilst contemplating regimen escalation (broadly based on BNF 47 and NZGG diabetes guidelines and previous PHARMAC analysis), occurring over a 3-month period;
   hence overall weighted average of 0.11 per day (15% * 3/12 * daily + [85%+(15%*9/12)] * every 14th day), i.e.
   ~0.8/week on average

*5. no diabetes Rx (diet/exercise alone) (category H):
   for patients well controlled on diet alone, nil strips (i.e. HbA1c monitoring alone) aside from perhaps daily testing for 3 months following diagnosis (awareness raising);
   for patients with poorer control contemplating regimen escalation, ~25% of all diet alone, ideally daily testing for the 3 months (broadly based NZGG diabetes guidelines),
   hence = ~1.2/week on average

Sources for expected SMBG usage for medicines-related group calculations:


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


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

Clinical Practice Unit, University of Sheffield, 2002.


http://www.bmj.com/content/344/bmj.e486

http://www.cadth.ca/media/pdf/compus_BGTS_OT_Rec_e.pdf

National Institute for Health and Clinical Excellence. Type 2 diabetes; the management of type 2 diabetes. NICE clinical guideline 87. Developed by the National Collaborating Centre for Chronic Conditions and the Centre for Clinical Practice at NICE, May 2009.
