

Optimal diabetes care using the web-based Diabetes Manager software

Julian Brown

Article points

1. An automated report that highlights to the individual what they are at risk of, how they could reduce that risk, and why diet, exercise and medications are of benefit, could improve the overall care of people with diabetes.
2. The reports from Diabetes Manager give the person with diabetes an individual plan stating what their recent results are like for 12 outcome measures, what their medications are for, what they are doing well, what they are doing badly and what their goals are.
3. Diabetes Manager and a practice diabetes team that work closely together can achieve great results and reduce the need for insulin.

Key words

- HbA_{1c}
- Self-management
- Web-based database

Julian Brown is a GP in Litcham, Norfolk

Diabetes Manager, an online diabetes management database, was launched in early 2008 in a rural GP practice in West Norfolk, with the aim of optimising the glycaemic control of people with type 2 diabetes through the use of automated self-management plans. For each individual, this included results for 12 outcome measures, what their medications were for, what they were doing well, what they were doing badly and what their goals were. By the end of March 2009, Litcham had the best glycaemic control of the 92 surgeries within the PCT with the highest number of people with an HbA_{1c} level of <7.5 (58 mmol/mol; 81.2%). This article describes the development of the website and the results of a clinical audit.

Litcham Surgery is a rural Norfolk village GP practice. The population of 3300 is relatively elderly with a high rate of obesity and a particularly high rate of diabetes (in April 2008 there were 174 people with type 2 diabetes – a prevalence of 5.3%). As a GP, the author has always had a keen interest in diabetes and has run the practice diabetes clinic for the past 10 years. Because of the author's interest in the use of information technology in healthcare, he started the website www.prescribing.org in 2001 – a drug information and ordering system now used by many pharmaceutical companies. The growth of this initial project resulted in the need to employ several skilled full-time programmers, which enabled the development of www.diabetesmanager.org.uk, an online diabetes management database.

Running the diabetes clinics made it clear to the author that many people with diabetes

simply did not take their medications and did not listen to what was said to them. It was felt that having an automated report that highlighted to the individual what they are at risk of, how they could reduce that risk, and why diet, exercise and medications were of benefit, would do no harm, and could radically improve the overall care of people with diabetes.

Methods

Data extraction

The single most important part of any IT project is to get an accurate and complete database to allow appropriate analysis to be undertaken. The “Diabetes Manager” system obtains its data from three principal sources: the GP system, people with diabetes via healthcare assistants, and from people with diabetes through a direct online interface.

Page points

1. All people coming for their diabetes review were seen by a healthcare assistant, prior to seeing the diabetes nurse, for a 15-minute appointment. The healthcare assistant took details on exercise, weight and blood pressure and ensured that all blood and urine tests were up to date.
2. For the healthcare professional, the data are presented in five different sections: My Patients, Screening, Safe Prescribing, Performance and Education.

Data extraction from the GP system

The first objective was to develop an easy method of extracting data from the GP system (EMIS LV) to the online SQL database that would give the flexibility needed for data analysis. Information governance created several restraints but soon a system was developed that would allow the practice’s entire diabetes EMIS data to be extracted and uploaded within the 5-minute timeframe that was deemed acceptable. Each upload was undertaken on a weekly basis on the morning of the diabetes clinic.

Figure 1 outlines the main datasets that were extracted. In addition, both current and past medications were uploaded as well as other “significant” medical conditions. The system will now also work with Vision and should soon be available for all GP systems using the manual import system.

Data extraction from people with diabetes via healthcare assistants

All people coming for their diabetes review were seen by a healthcare assistant, prior to seeing the diabetes nurse, for a 15-minute appointment. The healthcare assistant took details on exercise, weight and blood pressure and ensured that all

blood and urine tests were up to date. Any missing data (such as that on alcohol, smoking or exercise) were input into Diabetes Manager to allow the self-management plan to be formulated.

Data extraction from people with diabetes through a direct online interface

Individuals were given online logins to www.diabetesmanager.org.uk, through which they could input data. The system marked this data as “patient input”, allowing it to be filtered out as needed.

Data analysis and presentation

Once the data have been imported, the “update patients” button is clicked and the SQL database automatically updates all the reports.

Data are then presented in different formats depending on whether the user is a healthcare professional or person with diabetes. For the healthcare professional, the data are presented in five different sections (Figure 2), discussed below.

My Patients

The *My Patients* section includes league tables of the surgery patients to be analysed to allow improved recall and vigilance. Individuals whose diabetes control has gradually declined can be quickly contacted and those who have stopped collecting their medications identified.

Screening

The *Screening* section allows identification of the most appropriate people to ask back to the diabetes clinic using a combination of:

- Time since last clinic assessment.
- Excess risk (risk calculations based on the UK Prospective Diabetes Study [UKPDS] risk calculator [Coleman et al, 2007]. Realising that reversible risk is the principal value that is of interest, this was separated from the absolute risk as “% over”).
- Rate of change of endpoint markers (i.e. if the individual is deteriorating they are more likely to be called in).

Safe Prescribing

The *Safe Prescribing* section allows continual monitoring of the safety of medications prescribed.

| Patient Summary | | | | | | | |
|-----------------|------------------------|----------------------------|------------------|------------|--------|---------|--|
| No | Test | Date | Result | Due | Target | Score | |
| 1 | HbA1c | 27/11/2009 (06/08/2008) | 6.6 (8.4) | 27/05/2010 | 7.0 | 19 / 20 | |
| 2 | BP Systolic | 27/11/2009 (02/08/2008) | 128.0 (100) | 27/05/2010 | 140 | 10 / 10 | |
| 3 | BP Diastolic | 27/11/2009 (02/08/2008) | 88.0 (70) | 27/05/2010 | 80 | 10 / 10 | |
| 4 | Total Cholesterol | 27/11/2009 (06/08/2008) | 3.6 (4.7) | 27/05/2010 | 4.0 | 10 / 10 | |
| 5 | Cholesterol Ratio | 27/11/2009 (06/08/2008) | 2.7 (3.4) | 27/05/2010 | 4.0 | 10 / 10 | |
| 6 | Triglycerides | 12/05/2009 (N/A) | 0.8 (N/A) | 12/11/2009 | 2.0 | 10 / 10 | |
| 7 | Weight | 27/11/2009 (02/08/2008) | 85.8 (84.8) | 27/05/2010 | 74.3 | 8 / 10 | |
| 8 | Exercise | 27/11/2009 (06/08/2008) | 1260.0 (2120) | 27/02/2010 | 175 | 20 / 20 | |
| 9 | Weight Flux | 27/11/2009 (02/08/2008) | -1.0 (+1.9) | 27/05/2010 | 2.0 | 4 / 10 | |
| 10 | Smoking | 27/08/2009 (06/08/2008) | 0.0 (0.0) | 27/08/2010 | 0.0 | 10 / 10 | |
| 11 | Alcohol | 06/08/2009 (13/08/2008) | 12.0 (13.0) | 06/08/2010 | 4.0 | 7 / 10 | |
| 12 | Microalbuminuria | 05/11/2008 (22/11/2007) | 0.3 (2.0) | 05/11/2009 | 2.0 | 6 / 10 | |
| 13 | Diabetic Annual Review | 07/12/2009 | ok | 07/12/2010 | | 5 / 5 | |
| 14 | Retinal Screening | 13/05/2009 | ok | 13/05/2010 | | 5 / 5 | |
| 15 | Foot Screen | 07/12/2009 | ok | 07/12/2010 | | 5 / 5 | |
| 16 | Medication Review | 07/12/2009 | ok | 07/12/2010 | | 5 / 5 | |

Figure 1. Patient data card formulating the basis of their diabetes report.

Table 1. Change in use of blood glucose-lowering agents during the audit period.

| Drug class | Generic name | April 2008 | April 2009 | January 2010 |
|---|---------------------------|------------|------------|--------------|
| <i>n</i> (% of patients) | | | | |
| Biguanide | Metformin | 97 (56%) | 137 (67%) | 163 (72%) |
| Thiazolidinedione | Pioglitazone | 39 (22%) | 48 (23%) | 50 (22%) |
| Sulphonylureas | Gliclazide, glibenclamide | 15 (9%) | 30 (15%) | 36 (16%) |
| Dipeptidyl-peptidase-4 inhibitor | Vildagliptin | 0 (0%) | 8 (4%) | 17 (8%) |
| Insulin | Various | 18 (10%) | 13 (6%) | 13 (6%) |
| Glucagon-like peptide-1 receptor agonists | Exenatide, liraglutide | 0 (0%) | 0 (0%) | 0 (0%) |

Alerts for individuals on metformin whose renal function has deteriorated, people taking thiazolidinediones (TZDs) who have been started on diuretics or have any Read code related to heart failure are immediately identified. In addition, people who fail to be monitored correctly (for example, liver function tests for people on dipeptidyl-peptidase-4 [DPP-4] inhibitors) will be highlighted. Adherence issues are also highlighted in this section.

Performance

“QOF league tables” identify obvious strengths and weaknesses in practice performance, while *Monthly Progress* allows the practice to monitor its month by month performance in relation to HbA_{1c} levels, blood pressure, cholesterol and weight.

Education

For people with diabetes and their carers there was initially an online interface only, within which they could access their diabetes reports. However, it quickly became apparent that this was not going to work as half of the author’s patients had not heard of the internet! Three forms of printable reports were developed that embraced the 80% of people uninterested in logging on themselves.

The reports give people with diabetes an individual plan stating what their recent results are for 12 outcome measures, what their medications are for, what they are doing well, what they are doing badly and what their goals are.

Clinical audit

The concept of giving individuals complete information on their diabetes control raised initial concerns that this would create increased anxiety and rebound workload; however, no evidence of this was found, although a problem did arise for those who had an excessive “natural” UKPDS risk (especially older men). Their comparative small benefit in “risk” by achieving their diabetes targets was a disincentive and thus the UKPDS risk calculation was removed from the patient interface and reports.



Figure 2. Healthcare professional menu in www.diabetesmanager.org.uk.

If Diabetes Manager was indeed going to improve diabetes lifestyle and medication adherence then improved HbA_{1c} levels and a reduced need to initiate insulin would be expected. Thus, glycaemic control became the primary focus of the clinical audit.

The primary parameters evaluated were related to glycaemic control:

- HbA_{1c} level.
- Need for insulin initiation in people with type 2 diabetes.
- Use of blood-glucose lowering agents over the 12-month period.
- Use of blood glucose testing strips.
- Number of episodes of hypoglycaemia.

Using EMIS reporting, the antidiabetes agents used in the people with type 2 diabetes were recorded in April 2008, April 2009 and again in April 2010 to see whether there would be a change in both the type and dose of the agents used (*Table 1*).

HbA_{1c} levels within the type 2 diabetes cohort were monitored using the Diabetes Manager monthly progress tool. QOF levels attained in the 2009 year would be utilised for analysis.

The use of blood glucose testing strips was also monitored as it could be argued that any improvements in glycaemic control could be related to increased monitoring.

Secondary parameters were also evaluated. These included blood pressure control, total cholesterol control and weight management. These were analysed through monthly uploads from EMIS to Diabetes Manager.

Results

Glycaemic control

During the 12-month period that the audit was undertaken there was a continual month on month improvement in the percentage of individuals with an HbA_{1c} level $\leq 7.0\%$ (≤ 53 mmol/mol; *Figure 3*).

When using the 2009 QOF data, Litcham had the best glycaemic control of the 90 surgeries within the PCT with the highest number of people with an HbA_{1c} level $\leq 7.5\%$ (≤ 53 mmol/mol; 81.2%) and second highest for people with an HbA_{1c} level $\leq 10\%$ (≤ 86 mmol/mol; 98.7%). (Please note that the glycaemic control levels were based on QOF outcome data DM20 and DM7 which combine both type 1 and 2 diabetes. Only one person was excluded from this data set.)

Use of blood glucose testing strips

The use of blood glucose testing strips in the fourth quarters of July 2008 and August 2009 were compared for

1. During the period from April 2008 to January 2010 there have been no new initiations of insulin for people with type 2 diabetes in Litcham despite a rise in the number of people with type 2 diabetes from 174 to 226.
2. Apart from the lack of insulin initiations, the most surprising statistic was the increase in the use of metformin with over 70% of people with type 2 diabetes now on it.
3. All individuals were routinely screened for hypoglycaemic symptoms on their diabetes reviews and encouraged to inform the practice staff if any symptoms develop.

both Litcham Surgery and then with the PCT. During this period, the number of prescriptions for glucose testing strips and the cost fell by 40% within Litcham Surgery while they continued to rise within the PCT.

Need for insulin initiation

During the period from April 2008 to January 2010 there have been no new initiations of insulin for people with type 2 diabetes in Litcham despite a rise in the number of people with type 2 diabetes from 174 to 226. In addition, no people were treated with injectable glucagon-like peptide-1 (GLP-1) receptor agonists during the audit period.

Change in use of blood glucose-lowering agents during the audit period

Apart from the lack of insulin initiations, the most surprising statistic was the increase in the use of metformin, with over 70% of people with type 2 diabetes now on it. The

surgery has a relatively high use of TZDs (pioglitazone), at 22%, and a steady increase in the use of DPP-4 inhibitors (vildagliptin). Insulin use has fallen from 10% to 6%, with the two people converted from insulin back to oral therapy achieving significantly better HbA_{1c} levels. There were also seven people on acarbose but this agent was not included in the analysis.

Number of hypoglycaemic episodes

All individuals were routinely screened for hypoglycaemic symptoms on their diabetes reviews and encouraged to inform the practice staff if any symptoms develop. During the period, nine people with type 2 diabetes reported hypoglycaemic symptoms. Interestingly, four of these were just on metformin, two were on insulin, one on just a sulphonylurea, one on pioglitazone plus metformin, and one on metformin plus a sulphonylurea. None of the hypoglycaemic episodes were serious and most were exercise

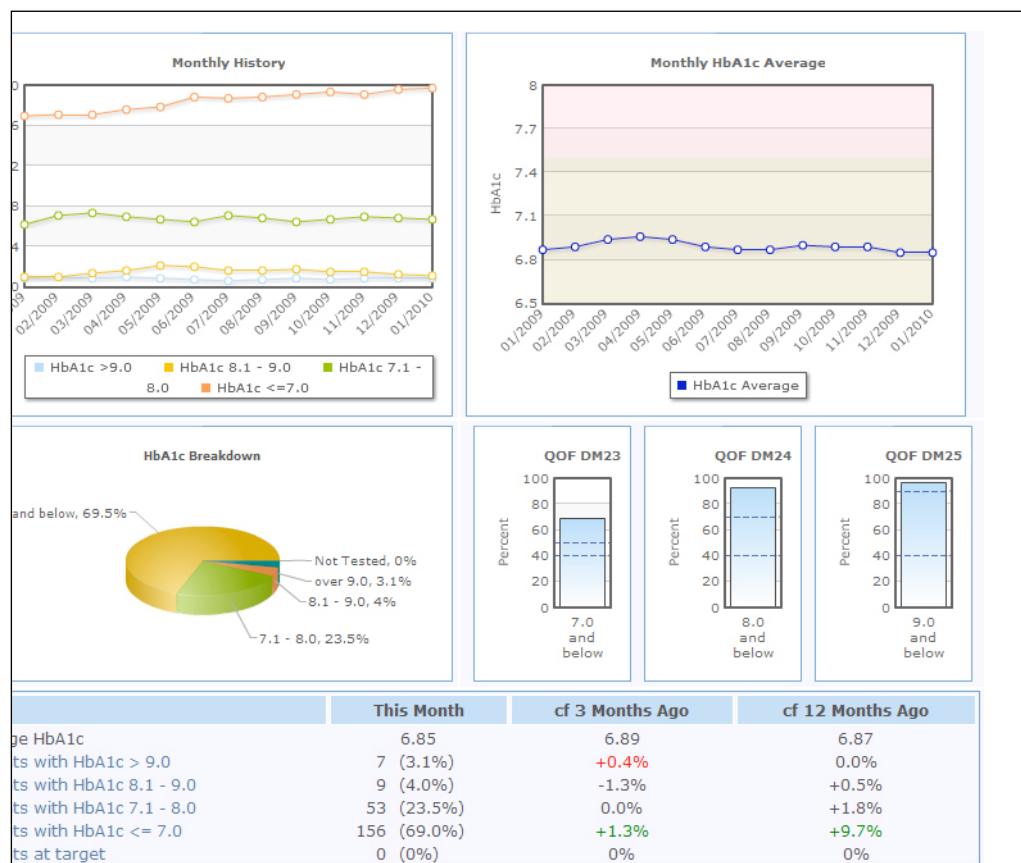


Figure 3. A screenshot of Diabetes Manager showing the performance-tracking system.

induced. It is of interest that none of the people on triple therapy (metformin, pioglitazone and sulphonylurea) had any problems.

Results for secondary parameters

Blood pressure

There was a significant improvement in blood pressure control across all blood pressure ranges.

Optimal blood pressure remains the single most important target for people with type 2 diabetes to attain and thus it was imperative that overall blood pressure outcome data were monitored during the audit period. During the 12-month period there was a significant and sustained improvement in the overall blood pressure control within the patient group.

In QOF (British Medical Association and NHS Employers, 2009), DM12 reports the number of people with diabetes with blood pressure $\leq 145/85$ mmHg. For Litcham Surgery

in 2008/9, 89.2% of people with diabetes achieved this indicator compared with 82.3% the previous year. This is an increase from 40th best in the PCT to 8th best. Since then, there have been further improvements with a 15% increase in the number of people with blood pressure $\leq 140/80$ mmHg compared with 12 months earlier.

Cholesterol and BMI

There was a small increase in the number of people with cholesterol ≤ 5 mmol/L (DM17). This rose from 87.7% (17th in the PCT) to 88.2% (16th in the PCT). It should be noted that this was achieved while remaining in the top ten surgeries for generic statin use and with just one person on ezetimibe. The rates of people with cholesterol below 4 mmol/L and 5 mmol/L have continued to rise. The average monthly BMI has fallen steadily since March.

Page points

1. In QOF, DM12 reports the number of people with diabetes with blood pressure $\leq 145/85$ mmHg. For Litcham Surgery in 2008/9, 89.2% of people with diabetes achieved this indicator compared with 82.3% the previous year.
2. There was a small increase in the number of people with cholesterol ≤ 5 mmol/L (DM17). This rose from 87.7% (17th in the PCT) to 88.2% (16th in the PCT).

Page points

1. It appears that motivating people to improve their lifestyle, weight and medication adherence through a self-management plan delayed the need for insulin as an add-on therapy.
2. By using Diabetes Manager and a focused team approach, the best diabetes glycaemic control in the PCT was achieved without initiating any people with type 2 diabetes on injectable drugs and using 40% fewer blood glucose monitoring strips over a 12-month period.

Use of secondary care services

The use of secondary care services was also significantly reduced during the period analysed. Using the NHS comparator analysis the surgery had minimal admissions activity during the 2008/09 analysis, costing over 54% less than that anticipated. The data were analysed on a ratio per 1000 population and surgeries with a higher diabetes population (like Litcham) may have been expected to perform worse.

Discussion of results

The excellent glycaemic control was clearly of interest especially with the lack of need for insulin. It appears that motivating people to improve their lifestyle, weight and medication adherence through a self-management plan delayed the need for insulin as an add-on therapy. In addition, the low number of hypoglycaemic episodes, reduced need for blood screening and substantial cost savings through insulin avoidance cannot be ignored.

Metformin

The high use of metformin is of interest. In keeping with the NICE (2009) guideline, the use of metformin is avoided if the creatinine level is $>150 \mu\text{mol/L}$ or estimated glomerular filtration rate (eGFR) is $<30 \text{ mL/min/1.73m}^2$ and the daily dose is reviewed if the eGFR level is $<45 \text{ mL/min/1.73m}^2$. However, the majority of other people with type 2 diabetes are encouraged to take it. If they did not tolerate it in the past it is reintroduced in the slow-release format and taken immediately after food. Those who appeared to have stopped using it were gently encouraged to restart.

Insulin

The low use of insulin and lack of need for any insulin initiations over a 20-month period could have several significant benefits:

- There is reduced need for specialist support.
- There is reduced need for blood glucose monitoring.
- There are fewer complications of weight gain and hypoglycaemic episodes.
- There are significant reductions in the overall cost associated with insulin avoidance.

In the author's opinion, the reasons for such improved glycaemic control were:

- Easy identification of struggling individuals through Diabetes Manager.
- Improved medications adherence. This occurred due to easy identification of non-adherent individuals and positive reinforcement of adherence through the patient summary report.
- Intensive monitoring of activity and lifestyle input into Diabetes Manager by the enthusiastic healthcare assistants.
- Positive effect of feeding back improved outcome data to the diabetes team through the *Performance Tracking* guide on Diabetes Manager. This inspires the team to continually try to outperform themselves month on month.
- Having a forward-thinking PCT, which allows use of slow-release metformin and pioglitazone and gives the flexibility to use DPP-4 inhibitors where appropriate.

Conclusion

If you were asked to get the best diabetes glycaemic control in your PCT without initiating any people with type 2 diabetes on injectable drugs and using 40% fewer blood glucose monitoring strips over a 12-month period you would probably smile. However, by using Diabetes Manager and a focused team approach, this has been achieved. What is even more exciting is that the number of people with an HbA_{1c} level of $\leq 7.0\%$ ($\leq 53 \text{ mmol/mol}$) has continued to improve each month since April 2009 (*Figure 3*).

Automated analysis of data for people with type 2 diabetes, the generation of structured management plans for people with the condition, and a practice diabetes team that work closely together can achieve great results and significantly reduce the need for insulin. ■

BMA and NHS Employers (2009) *Quality and Outcomes Framework Guidance for GMS contract 2009/10. Delivering Investment in General Practice*. DH, London

Coleman R, Stevens R, Holman R (2007) Estimating cardiovascular disease risk for individuals with type 2 diabetes: the new UKPDS Risk Engine. *Diabet Med* 24(Suppl 1): 56

NICE (2009) *Type 2 Diabetes: The Management of Type 2 Diabetes*. NICE, London

If any surgeries or PCTs are interested in trying Diabetes Manager please do contact me (this is a free interface and is in no way funded or sponsored by a third party): julian.brown@nhs.net