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Effect of the quality and outcomes framework on diabetes care in the United Kingdom: retrospective cohort study

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ABSTRACT

Objectives To examine the management of diabetes between 2001 and 2007 in the United Kingdom and to assess whether changes in the quality of care reflect existing temporal trends or are a direct result of the implementation of the quality and outcomes framework.

Design Retrospective cohort study.

Setting 147 general practices (annual list size over 1 million) across the UK.

Patients People with type 1 or type 2 diabetes.

Main outcome measures Annual prevalence of diabetes and attainment of process and clinical outcomes over the three years before and the three years after the introduction of the quality and outcomes framework.

Results Significant improvements in process and intermediate outcome measures were observed during the six year period, with consecutive annual improvements observed before the introduction of incentives. However, the current diagnostic case definition for the quality and outcomes framework does not capture up to two thirds of people with type 1 diabetes and a third of people with type 2 diabetes. After the introduction of the quality and outcomes framework, existing trends of improvement in glycaemic control, cholesterol levels, and blood pressure were attenuated, particularly in people with diabetes who did not meet the case definition of the quality and outcomes framework. The introduction of the quality and outcomes framework did not lead to improvement in the management of patients with type 1 diabetes, nor to a reduction in the number of patients with type 2 diabetes who had HbA_{1c} levels greater than 10%. Introduction of the quality and outcomes framework may have increased the number of patients with type 2 diabetes with HbA_{1c} levels of ≤7.5%; odds ratio 1.05 (95% confidence interval 1.01 to 1.09; P=0.02).

Conclusions The management of people with diabetes has improved since the late 1990s, but the impact of the quality and outcomes framework on care is not straightforward; upper thresholds may need to be removed or targets made more challenging if people are to benefit. Many patients in whom care may be suboptimal may not be captured in the quality and outcomes framework assessment.

INTRODUCTION

Performance based payment incentives are now a routine part of many health economies.[1] In April 2004 the quality and outcomes framework was first introduced as part of the general practitioner contract in the United Kingdom.[2] This scheme offers financial rewards for achieving a series of process outcome measures (what is actually done in giving and receiving care) and intermediate outcome measures (changes in health status that affect subsequent health outcomes) that should improve the quality of patient care. The quality and outcomes framework comprises a range of criteria grouped into four domains: clinical, organisational, patient experience, and additional services.[3] For the period 2006-7 a total of 80 indicators were included in the clinical domain, with a maximum of 655 points achievable from an overall total of 1000 points. Indicators for diabetes account for 93 of these points, the largest single clinical area, and cover 18 separate indicators covering structure (maintaining a register of patients with diabetes), process (measurement), and intermediate outcomes such as blood pressure, cholesterol level, and glycaemic (HbA_{1c} level) control. Payments are staged, and to be eligible for maximum payment practices are required to achieve a minimum target before they are paid—that is, the lower threshold and a maximum or upper threshold.[4] Maximum thresholds for most clinical process indicators in diabetes are currently set at 90% but are lower for intermediate outcome indicators. Thus the upper threshold for the proportion of people with HbA_{1c} levels of 7.5% or less is 50%, for a blood pressure reading of 145/85 mm Hg or less is 60%, and for a cholesterol level of 5 mmol/l or less is 70%.[4] When a general practitioner (or the patient) judges that treatment to these targets is inappropriate—for example, terminal disease or patient choice—a patient may be "excepted" from the indicator denominator.[3] Within the diabetes domain the median exception reporting rate is 5.4%.[5]

Data on people with diabetes are identified for analysis in the quality and outcomes framework using primary care morbidity codes (Read codes). Read codes are a hierarchical coding system used to code clinical data, including signs, symptoms, procedures,

investigations, and diagnoses.[6] The current version of Read codes are five characters long, with the first character indicating the disease area and later characters providing more precise detail.[7] When the quality and outcomes framework was first introduced, people with diabetes were identified on the basis of the presence of any diabetes Read code (C10 and any codes below it in the hierarchy). In April 2006 the case definition for diabetes was changed to a narrower set of more specific Read codes; identifying type 1 diabetes mellitus (the C10E hierarchy: C10E0 to C10EP) and identifying type 2 diabetes mellitus (the C10F hierarchy: C10F0 to C10FQ).[8] Studies have shown that prevalence is underestimated if only these specific C10E and C10F Read codes are used, and interpretation of the change in the quality and outcomes framework indicators has proved difficult because of this change in case definition.[8 9] Furthermore, even the use of the less specific C10 Read codes may exclude some people with diabetes from evaluation through the quality and outcomes framework.

Since the introduction of the quality and outcomes framework a series of studies has suggested an improvement in the management of people with diabetes in primary care.[9-12] Notably, one study suggested "that the introduction of pay for performance was associated with a modest acceleration in improvement" in the management of diabetes.[10] However, this work assessed care at only three time points, one of which followed the introduction of the quality and outcomes framework and was based on relatively small numbers of selected patients and therefore may not be fully representative of care. Other studies have focused on specific regions in the UK and may not be generalisable.[11 12] It therefore remains unclear to what extent the introduction of incentives has impacted on existing temporal trends, reflecting, for example, the national quality improvement strategy.[10]

We examined the prevalence of diabetes and the proportion of people meeting targets for diabetes management annually from April 2002 to March 2007 (three years before and three years after the introduction of the quality and outcomes framework). We also assessed the impact of the quality and outcomes framework on clinical outcomes (glycaemic control, cholesterol levels, and blood pressure) in people with type 1 and type 2 diabetes.

METHODS

We obtained data from the doctors' independent network (DIN)-LINK database, which contains anonymised computer records from primary care practices in the UK using iSOFT (previously TOREX) clinical systems including morbidity coding, biochemical test results, prescribing data, and ACORN geodemographic classification (a classification of residential neighbourhoods—a deprivation score).[13 14] The age-sex structure of the DIN-LINK database has been shown to be similar to the UK average, but practices in the south of England and higher socioeconomic groups are over-represented.[15] We identified people with a diagnosis of diabetes from practices with continuous data over a 10 year period, from 1 April 1997 to 31 March 2007. Analyses were done using SAS V9.1.

Identification of people with diabetes

We identified people with diabetes if they had a Read code for diabetes or one or more prescriptions for oral antidiabetic drugs, insulin, or glucose testing kits. MJC and AS identified relevant Read codes, which were verified by a clinician (RJM). Read codes included those in the C10 hierarchy and other diabetes related Read codes including diabetes monitoring, referrals, and diabetes related eye and foot complications. We excluded women with gestational diabetes unrelated to pre-existing diabetes. People were classified as having type 1 diabetes if they were prescribed insulin (or an insulin device), did not have a Read code for type 2 diabetes, or had any previous prescription for an oral antidiabetic drug. The remaining people were classified as having type 2 diabetes.

In addition, in order to be able to interpret the effect of the change in diagnostic case definition in the quality and outcomes framework which occurred from April 2006, we also identified the first occurrence of Read codes in the C10E (type 1 diabetes mellitus) or C10F (type 2 diabetes mellitus) hierarchies for people during the study period.[8]

Prevalence of diabetes

The prevalence of diabetes was estimated annually on the 31 March from 2002-7. We considered all people with a diagnosis of diabetes who were registered in each practice on each date.

Attainment of targets in quality and outcomes framework

We carried out analyses on attainment of diabetes and smoking outcomes using data between 1 January 2001 and 31 March 2007, as annual targets in the quality and outcomes framework are assessed over a 15 month period (Department of Health business rules).[16] These definitions were adhered to with the following exceptions: for our principal analyses we considered all people with diabetes (rather than only those with clinical Read codes). In the primary analyses we excluded diabetes exception reporting codes (9h4 hierarchy) that did not give the reason for exception. We did, however, include outcome specific exception codes such as contraindication codes and maximal therapy codes. We undertook a series of sensitivity analyses to assess attainment of outcomes in people with recorded Read codes in the C10E and C10F hierarchies and the impact of diabetes exception reporting (9h4 codes) on glycaemic control.

Impact of quality and outcomes framework on glycaemic control

We assessed the relation between attainment of glycaemic targets (HbA_{1c} levels $\leq$7.5% and $\leq$10%) and year of assessment, the introduction of the quality and

outcomes framework, and evidence of the new diagnostic coding definitions, using mixed models with a logit link and binomial error and a random effect term describing the effect of practice with a Gaussian error structure using the SAS nlmixed procedure (SAS V9.1). Four separate models were produced: response variable HbA_{1c} level ≤7.5% in people with type 1 diabetes; response variable HbA_{1c} level ≤10% in people with type 1 diabetes; response variable HbA_{1c} level ≤7.5% in people with type 2 diabetes; response variable HbA_{1c} level ≤10% in people with type 2 diabetes. For patients with multiple assessments of HbA_{1c} levels recorded during each year we used the latest assessment before the quality and outcomes framework reference date. We assessed linear and non-linear functional forms (natural logarithm and exponential functions) for year. To allow for a sudden shift in the rate of change as a result of the introduction of the quality and outcomes framework in addition to annual changes we used an additional variable to indicate whether the quality and outcomes framework was being implemented. The presence of the new quality and outcomes framework diagnostic coding (C10E or C10F hierarchies) were also coded variables to assess the impact of being included in the pay for performance review on glycaemic control. Interaction terms were assessed. We derived the denominator degrees of freedom from the number of practices. Akaike's information criterion was used to determine the best model fit and most appropriate functional form for annual changes.[17]

RESULTS

Overall, 147 of the 300 practices contributing to the DIN-LINK database had usable data over the study period, of which 34 (23%) provided pharmacy dispensing services in addition to primary medical care. The practices employed a mean number of 5.8 general practitioners (SD 2.9) and on 31 March 2007 had a mean list size of 8929 (SD 4147).

Prevalence of diabetes

During the six years of the study period (2002-7) the recorded prevalence of type 1 diabetes remained stable whereas the recorded prevalence of type 2 diabetes increased (fig 1). The use of specific morbidity codes for type 1 and type 2 diabetes increased over time but remained about two thirds of the total codes for diabetes at the end of the study period.

Changes in quality and outcomes framework indicators over time

Improvements in all diabetes indicators were observed over the study period (tables 1 and 2 and fig 2). The proportion of people with type 1 diabetes attaining process targets was greater than 70% in 2007, with the exception of testing for microalbuminuria. The proportion of people with type 2 diabetes attaining these targets was higher.

The proportion of people attaining intermediate outcomes also improved over time but was lower than that observed for process targets. The proportion of people with type 1 and type 2 diabetes attaining targets for glycaemic control (HbA_{1c} level ≤7.5% and ≤10%), cholesterol level, and blood pressure showed attenuation of annual trends in improvement after the introduction of the quality and outcomes framework (fig 2). This effect appeared greater for the proportion of people attaining glycaemic control.

Model results (table 3) showed significant annual increases in the proportion of people attaining targets for HbA_{1c} levels. Target attainment was significantly higher in those people with a quality and outcomes framework diagnostic Read code (with the exception of people with type 1 diabetes and HbA_{1c} target ≤10%). Introduction of the quality and outcomes framework was only significantly associated with an increase in the proportion of people attaining HbA_{1c} target ≤7.5% in people with type 2 diabetes, and this effect was relatively small.

Characterisation of people without quality and outcomes framework case definition Read codes

In light of the findings, the use of the quality and outcomes framework diagnostic Read codes was examined in the most recent (2007) cohort. A total of 3811 people with type 1 diabetes were in the 2007 cohort for HbA_{1c} levels, of whom 1228 had a specific C10E code and would be assessed in the quality and outcomes framework. Of the remaining 2583 people, none had a

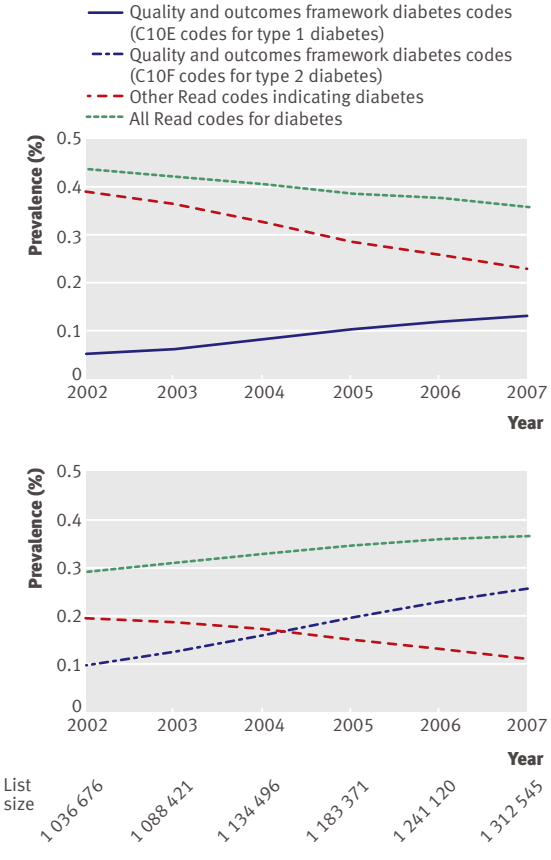

Fig 1 | Prevalence of type 1 and type 2 diabetes across study period

Read code indicating type 2 diabetes and all had a prescription for insulin but no oral antidiabetic drug before the quality and outcomes framework reference date. Exploratory analyses indicated that people with a C10E hierarchy Read code were younger than those without a C10E code (mean ages 40.6 *v* 50.4 years; P<0.001). They were also more likely to be men (61.4% *v* 55.3%, P<0.001).

A total of 42 032 people with type 2 diabetes in the 2007 cohort for HbA_{1c} levels were identified, of whom 29 674 had a specific C10F hierarchy Read code. Of the remaining 12 358 people without a C10F code, 8994 (72.8%) had either a prescription for an oral agent and insulin or insulin device before the reference date or a Read code indicating diabetic treatment. Overall, 2460 people (19.9%) had either the broader diabetes Read codes (C10 hierarchy) or the Read codes indicating screening for, or complications associated with, diabetes, such as eye and foot complications. Of the remaining people, 904 (7.3%) had Read codes indicating assessment or care of diabetes. People with a C10F code were older than those without a C10F code (mean ages 66.1 *v* 63.5 years; P<0.001). They were also more likely to be men (55.2% *v*

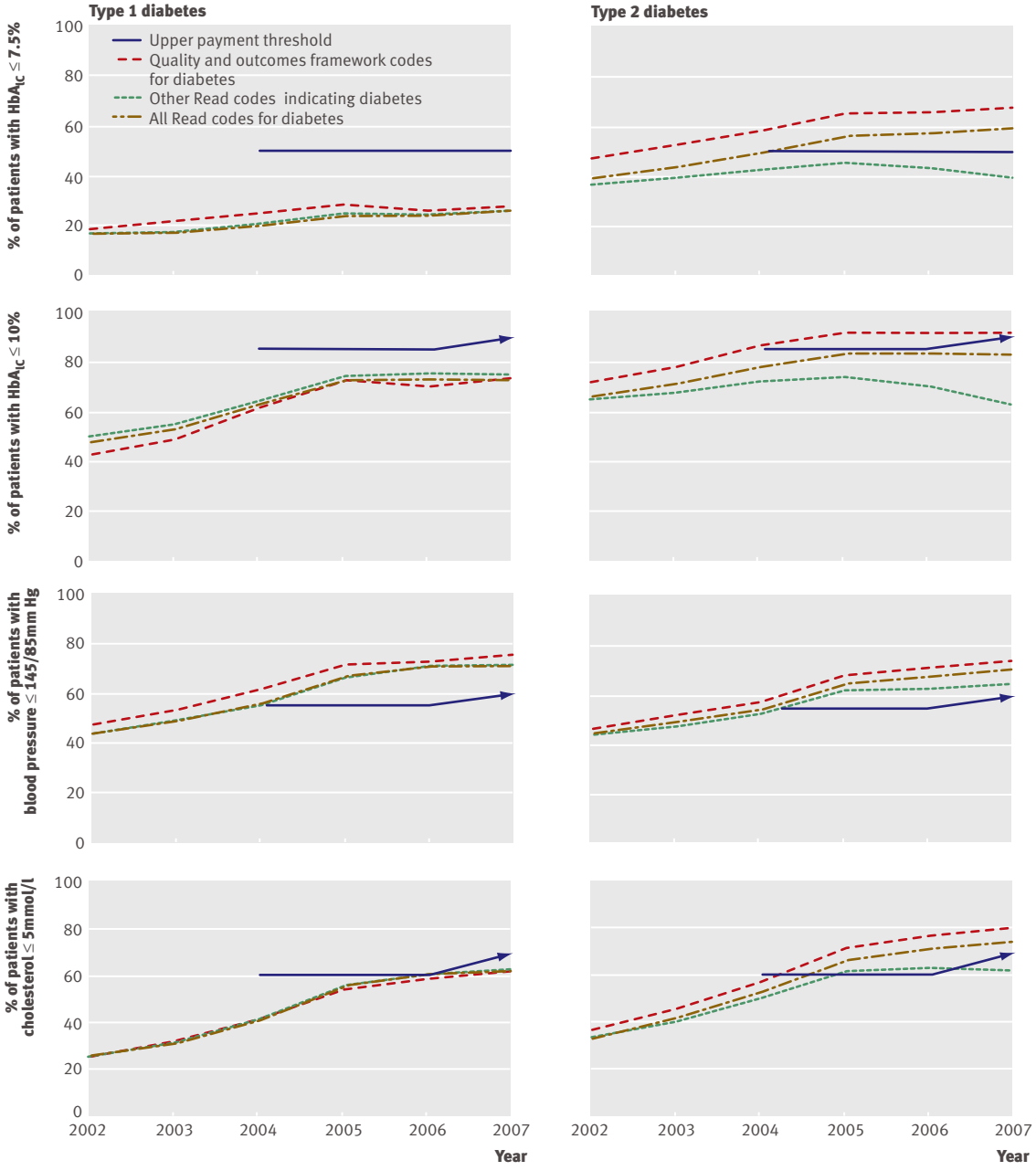

Fig 2 | Proportion of patients with diabetes meeting quality and outcomes framework targets for HbA_{1c} level, cholesterol level, and blood pressure. For patients with multiple assessments during each period the last measurement during the year was used

Table 1 | Number (percentage) of people with type 1 diabetes meeting quality and outcomes framework targets in previous 15 months from 1 April 2002-7

Variables	2002	2003	2004	2005	2006	2007
DM2 with record of body mass index	1201/4028 (29.8)	1448/4074 (35.5)	2143/4086 (52.5)	3104/4042 (76.8)	3301/4117 (80.2)	3338/4146 (80.5)
DM3 with record of smoking status except never smokers, when smoking status should be recorded once	2571/4028 (63.8)	2763/4074 (67.8)	3197/4086 (78.2)	3687/4042 (91.2)	3737/4117 (90.8)	3827/4146 (92.3)
DM4 smokers with record that advice on smoking cessation has been offered	218/885 (24.6)	232/898 (25.8)	482/938 (51.4)	744/892 (83.4)	764/929 (82.3)	780/902 (86.5)
DM5 with record of HbA_{1c} or equivalent	2337/4028 (58.0)	2589/4074 (63.6)	3050/4086 (74.7)	3433/4042 (84.9)	3534/4117 (85.8)	3540/4146 (85.4)
DM5 with record of HbA_{1c} or equivalent (using diabetes exception reporting)	2337/4028 (58.0)	2589/4074 (63.6)	3036/4068 (74.6)	3249/3732 (87.1)	3168/3607 (87.8)	3220/3661 (88.0)
DM20 with last recorded HbA_{1c} (or equivalent) level of ≤7.5%*	613/3799 (16.1)	657/3858 (17.0)	793/3873 (20.5)	907/3639 (24.9)	912/3723 (24.5)	1003/3811 (26.3)
DM20 with C10E codes and last recorded HbA_{1c} (or equivalent) level of ≤7.5%*	53/289 (18.3)	83/394 (21.1)	146/587 (24.9)	221/782 (28.3)	262/1013 (25.9)	349/1228 (28.4)
DM7 with last recorded HbA_{1c} (or equivalent) level of ≤10%	1861/3799 (49.0)	2076/3858 (53.8)	2462/3873 (63.6)	2658/3639 (73.0)	2737/3723 (73.5)	2805/3811 (73.6)
DM7 with C10E codes and last recorded HbA_{1c} (or equivalent) level of ≤10	123/289 (42.6)	192/394 (48.7)	364/587 (62.0)	577/782 (73.8)	712/1013 (70.3)	901/1228 (73.4)
DM21 with record of retinal screening†	1113/4028 (27.6)	1350/4074 (33.1)	2150/4086 (52.6)	2939/4026 (73.0)	3038/4062 (74.8)	3186/4015 (79.4)
DM9 with record of presence or absence of peripheral pulses	339/4028 (8.4)	461/4074 (11.3)	1150/4084 (28.2)	2726/4024 (67.7)	2986/4082 (73.2)	2955/4100 (72.1)
DM10 with record of neuropathy testing	207/4028 (5.1)	318/4074 (7.8)	1002/4084 (24.5)	2677/4024 (66.5)	2967/4082 (72.7)	2945/4100 (71.8)
DM11 with record of blood pressure reading	2763/4028 (68.6)	3013/4074 (74.0)	3285/4086 (80.4)	3644/4042 (90.2)	3721/4117 (90.4)	3759/4143 (90.7)
DM12 with last recorded blood pressure of ≤145/85 mm Hg	1684/3799 (44.3)	1921/3858 (49.8)	2173/3887 (55.9)	2558/3794 (67.4)	2726/3850 (70.8)	2810/3893 (72.2)
DM13 with record of microalbuminuria testing	440/3934 (11.2)	600/3979 (15.1)	1053/3978 (26.5)	2202/3878 (56.8)	2450/3929 (62.4)	2553/3955 (64.6)
DM22 with record of estimated glomerular filtration rate or serum creatinine testing‡	1839/4028 (45.7)	2103/4074 (51.6)	2595/4086 (63.5)	3208/4042 (79.4)	3386/4117 (82.2)	3433/4146 (82.8)
DM15 with diagnosis of proteinuria or microalbuminuria and treated with ACE inhibitors (or A2 antagonists)	80/108 (74.1)	80/113 (70.8)	94/136 (69.1)	186/245 (75.9)	224/286 (78.3)	248/305 (81.3)
DM16 with record of total cholesterol level	1998/4028 (49.6)	2235/4074 (54.9)	2678/4086 (65.5)	3221/4042 (79.7)	3343/4117 (81.2)	3364/4146 (81.1)
DM17 with last measured total cholesterol level of ≤5mmol/l	989/3798 (26.0)	1215/3847 (31.6)	1581/3867 (40.9)	2069/3722 (55.6)	2262/3763 (60.1)	2370/3795 (62.5)
DM18 vaccinated against influenza in preceding 1 September to 31 March	2032/3986 (51.0)	1969/4030 (48.9)	2138/3950 (54.1)	2413/3475 (69.4)	2617/3585 (73.0)	2660/3637 (73.1)

DM identifies specific quality and outcomes framework diabetes indicator.
ACE=angiotensin converting enzyme.
*Formerly DM6 and used HbA_{1c} target of 7.4%.
†Formerly DM8 and changed as practices need to show that patients have received screening.
‡Formerly DM14 and included record of only serum creatinine level.

51.8%, P<0.001) and to belong to a higher socioeconomic class (66.8% *v* 58.3%; P<0.001).

DISCUSSION

Significant improvements were seen in all of the quality and outcomes framework clinical indicators over time for diabetes care in the UK. The results also highlight differences in the management of people with type 1 and type 2 diabetes, as those with type 2 diabetes generally underwent more testing for diabetes related complications than people with type 1 diabetes. This might reflect the fact that a higher proportion of people with type 1 diabetes receive specialist care that may not be as well recorded in primary care records.[18] By the end of the study in 2007, attainment of process measures was high. Whether this was a direct result of the quality and outcomes framework or reflects existing trends in improvement of care over time in response to clinical evidence, national guidelines, and other driving factors remains unclear.[10]

Significant improvements in clinical intermediate outcome measures (glycaemic control, cholesterol level, and blood pressure) were observed over the study period, with successive improvements being observed before the introduction of the quality and outcomes framework. This could in part be due to awareness among general practitioners of its impending introduction or the influence of national service frameworks in England and Wales and other clinical governance initiatives. After the introduction of the quality and outcomes framework, the trends appear to be attenuated. One study observed a modest acceleration in the improvement of care between 2003 and 2005 compared with 1998 to 2003, which the authors suggested might have been associated with the introduction of pay for performance.[10] In our study, outcomes appeared to improve consistently between 2002 and 2005, with attenuation in observed improvement between 2005 and 2007. This attenuation could reflect the increasing difficulty of target attainment in poorly controlled people because even in conditions of a clinical trial some people are unable to attain long term control.[19] However the attenuation of temporal trends might also reflect the lack of further incentive after attainment of the upper payment thresholds (the ceiling effect). This could suggest that upper thresholds need to be removed or targets made more challenging in line with the evidence base rather than the current alignment with lower audit targets. Both the lower and the upper thresholds were, however, shifted upwards for several intermediate outcomes in 2006, which does not appear to be reflected in subsequent target attainment, suggesting that further changes would require careful evaluation. If the observed ceiling effect does represent the natural equilibrium of current optimal management in primary care, this highlights the remaining gap in treatment and the need for new therapies, improved education, or management strategies.

In 2007 the monitoring and control of glycaemia still seemed suboptimal in some people, with over 10% of people having no record of an HbA_{1c} level or equivalent in the previous 15 months. Twenty six per cent of people with type 1 diabetes and 17% with type 2 diabetes had an HbA_{1c} level of more than 10%, and 41% of people with type 2 diabetes and 74% with type 1 diabetes had an HbA_{1c} level of more than 7.5%. Similarly, nearly a third of patients had evidence of raised blood pressure and over a quarter of patients had raised serum cholesterol levels. The introduction of the quality and outcomes framework seems to be significantly associated with better glycaemic control in people with type 2 diabetes for the more stringent target (HbA_{1c} level ≤7.5%), although the quality and outcomes framework did not seem to significantly predict attainment of the higher target (HbA_{1c} level ≤10%), and attenuation in trends was observed for both targets. Since the maximum payment threshold for payment for an HbA_{1c} target of 7.5% or less is 50%, the quality and outcomes framework seems to offer no further incentive for optimal glycaemic control for many people. However, since attainment was over 60% on average, perhaps greater thought is needed for additional targeting of poorly performing practices as opposed to general interventions or developing and implementing more nuanced indicators. It may be, for example, that introducing a system of tightly linked process measures into the diabetes domain, similar to the system used by the Veterans Administration,[20] could improve care further, although this would require some modification to the information technology infrastructure underpinning the quality and outcomes framework.

We observed substantial variation in the level of glycaemic control attained across practices. For example, the median proportion of people with type 1 diabetes achieving the HbA_{1c} target of 7.5% or less in 2007 was 25.8% (interquartile range 20.0-32.5%), with one practice reporting that all patients had HbA_{1c} levels less than or equal to 7.5% and for people with type 2 diabetes the median was 60.1% (55.4-65.5%), with 14 practices reporting that less than half of patients achieved the target and only three practices reporting that over three quarters of patients achieved the target. Characteristics of the patient population in each practice, including prevalence of disease, case mix, and list size have been shown to influence attainment of targets.[21,22] Management may also be affected by the views of patients and healthcare providers.[23]

Subgroup analyses of attainment of intermediate outcomes (glycaemic control, cholesterol level, and blood pressure) by patients with or without a Read code meeting the quality and outcomes framework case definition (C10E and C10F) indicate that people included in the quality and outcomes framework denominator, and particularly those with type 2 diabetes, were in general more likely to attain the targets. Our finding that older people, men, and those from affluent backgrounds seem more likely to have a specific C10F hierarchy code and therefore be assessed within the quality and outcomes framework is consistent with others' work on the relation between patients' personal characteristics and attainment of targets, and

Table 2 | Number (percentage) of people with type 2 diabetes meeting quality and outcomes framework targets in previous 15 months from 1 April 2002-7

Variables	2002	2003	2004	2005	2006	2007
DM2 with record of body mass index	12 810/28 451 (45.0)	16 559/32 037 (51.7)	24 093/35 599 (67.7)	33 131/39 175 (84.6)	36 824/42 816 (86.0)	40 153/46 189 (86.9)
DM3 with record of smoking status except never smokers, where smoking status should be recorded once	20 640/28 451 (72.6)	24 535/32 037 (76.6)	30 320/35 599 (85.2)	37 107/39 175 (94.7)	40 327/42 816 (94.2)	43 824/46 189 (94.9)
DM4 smokers with record that advice on smoking cessation has been offered	1274/4629 (27.5)	1793/5196 (34.5)	3336/5620 (59.4)	5243/5978 (87.7)	5467/6317 (86.5)	6115/6878 (88.9)
DM5 with record of HbA_{1c} or equivalent level	20 573/28 451 (72.3)	24 554/32 037 (76.6)	29 750/35 599 (83.6)	34 627/39 175 (88.4)	37 752/42 816 (88.2)	40 311/46 189 (87.3)
DM5 with record of HbA_{1c} level or equivalent (using diabetes exception reporting)	20 573/28 451 (72.3)	24 553/32 035 (76.6)	29 658/35 465 (83.6)	33 176/37 197 (89.2)	35 615/39 906 (89.3)	38 116/43 172 (88.3)
DM20 with last recorded HbA_{1c} (or equivalent) level of ≤7.5%*	10 292/26 082 (39.5)	12 997/29 413 (44.2)	16 193/32 658 (49.6)	19 756/35 271 (56.0)	22 043/38 621 (57.1)	24 940/42 032 (59.3)
DM20 with C10F codes and last recorded HbA_{1c} (or equivalent) level of ≤7.5%*	3841/8103 (47.4)	5879/11 198 (52.5)	8858/15 250 (58.1)	12 750/19 698 (64.7)	15 979/24 448 (65.4)	20 068/29 674 (67.6)
DM7 with last recorded HbA_{1c} (or equivalent) level of ≤10%	17 327/26 082 (66.4)	20 933/29 413 (71.2)	25 562/32 658 (78.3)	29 412/35 271 (83.4)	32 191/38 621 (83.4)	34 756/42 032 (82.7)
DM7 with C10F codes and last recorded HbA_{1c} (or equivalent) level of ≤10%	5779/8103 (71.3)	8652/11 198 (77.3)	13 074/15 250 (85.7)	17 950/19 698 (91.1)	22 332/24 448 (91.3)	27 090/29 674 (91.3)
DM21 with record of retinal screening†	11 523/28 451 (40.5)	14 976/32 037 (46.8)	21 131/35 595 (59.4)	28 985/39 004 (74.3)	31 804/42 429 (75.0)	35 608/45 265 (78.7)
DM9 with record of presence or absence of peripheral pulses†	5197/28 451 (18.3)	7195/32 037 (22.5)	14 626/35 594 (41.1)	29 613/39 059 (75.8)	34 144/42 554 (80.2)	36 556/45 807 (79.8)
DM10 with record of neuropathy testing	3474/28 451 (12.2)	5282/32 037 (16.5)	12 954/35 594 (36.4)	29 419/39 059 (75.3)	34 031/42 554 (80.0)	36 339/45 807 (79.3)
DM11 with record of blood pressure reading	24 287/28 451 (85.4)	28 334/32 037 (88.4)	32 337/35 599 (90.8)	37 037/39 174 (94.5)	40 475/42 810 (94.6)	43 566/46 146 (94.4)
DM12 with last recorded blood pressure of ≤145/85 mm Hg	11 557/26 081 (44.3)	14 481/29 413 (49.2)	17 846/32 661 (54.6)	23 020/35 457 (64.9)	26 203/38 759 (67.6)	29 764/42 110 (70.7)
DM13 with record of microalbuminuria testing	4186/28 107 (14.9)	7447/31 658 (23.5)	12 715/35 072 (36.3)	25 686/38 053 (67.5)	30 540/41 210 (74.1)	33 291/44 234 (75.3)
DM22 with record of estimated glomerular filtration rate or serum creatinine testing‡	18 053/28 451 (63.5)	22 225/32 037 (69.4)	28 374/35 599 (79.7)	35 414/39 175 (90.4)	39 124/42 816 (91.4)	42 181/46 189 (91.3)
DM15 with diagnosis of proteinuria or microalbuminuria and treated with ACE inhibitors (or A2 antagonists)	266/429 (62.0)	356/507 (70.2)	623/821 (75.9)	1942/2360 (82.3)	2272/3329 (83.3)	3480/4026 (86.4)
DM16 with record of total cholesterol level	19 298/28 451 (67.8)	23 438/32 037 (73.2)	28 821/35 599 (81.0)	34 832/39 175 (88.9)	38 392/42 816 (89.7)	41 431/46 189 (89.7)
DM17 with last measured total cholesterol level of ≤5 mmol/l	8761/26 071 (33.6)	12 213/29 275 (41.7)	16 984/32 261 (52.7)	23 055/34 562 (66.7)	26 823/37 704 (71.1)	30 305/40 860 (74.2)
DM18 vaccinated against influenza in preceding 1 September to 31 March	17 527/27 888 (62.9)	19 458/31 341 (62.1)	23 427/33 952 (69.0)	28 260/34 435 (82.1)	31 435/37 978 (82.8)	34 189/40 897 (83.6)

DM identifies specific quality and outcomes framework diabetes indicator.
ACE=angiotensin converting enzyme.
*Formerly DM6 and used target HbA_{1c} of 7.4%.
†Formerly DM8 and changed as practices need to show that patients have received screening.
‡Formerly DM14 and included record of only serum creatinine level.

Table 3 | Relation between glycaemic control with time, introduction of quality and outcomes framework, and meeting diagnostic case definition of quality and outcomes framework

Variables	HbA_{1c} target ≤7.5%		HbA_{1c} target ≤10%	
	Odds ratio (95% CI)	P value	Odds ratio (95% CI)	P value
Type 1 diabetes:				
Year	1.02 (1.01 to 1.04)†	0.003	1.06 (1.03 to 1.08)	<0.001
Quality and outcomes framework	*	*	*	*
Presence of C10E Read code	1.41 (1.24 to 1.59)	<0.001	0.72 (0.64 to 0.80)	<0.001
Year and presence of C10E Read code	0.97 (0.90 to 1.0)†	0.04	*	*
Type 2 diabetes:				
Year	1.06 (1.05 to 1.08)	<0.001	+2.51 (2.13 to 2.95)	0.001
Quality and outcomes framework	1.05 (1.01 to 1.09)	0.02	*	*
Presence of C10F Read code	1.67 (1.64 to 1.71)	<0.001	1.68 (1.61 to 1.75)	<0.001

Years were coded in model as −3 to 2 to indicate their relation to introduction of quality and outcomes framework unless otherwise stated.
*Variable not included in final model as non-significant (P>0.05).
†Year with an exponential transformation.
+Year with log transformation (rescaled years as 1 to 6). Although this rescaled log transformed model had best model fit as judged by Akaike's information criterion, this metric is difficult to interpret practically.

raises concerns that the quality and outcomes framework may not have been as efficient in reducing inequalities in health in diabetes as was hoped.[22 24] Detailed assessment of Read codes and prescriptions for patients that did not meet the current case definition for the quality and outcomes framework indicates that an important group of people that seem to have diabetes are no longer included within the quality and outcomes framework. Some of these (<7%) may purely have been included in the study definition on the basis of monitoring for suspected diabetes and therefore reasonably not received comprehensive diabetes care, which may contribute to the apparent reduced care in people not meeting the diagnostic case definition of the quality and outcomes framework. An alternative explanation for the apparent reduced level of care in people without C10F codes is the selective exclusion of poorly managed patients by clinicians that might lead to increased income. However such "gaming" was not seen on a wide scale in a recent evaluation of exception reporting in the quality and outcomes framework.[5]

Our results indicate that identification of patients using the diagnostic case definition for the quality and outcomes framework (C10E and C10F hierarchy Read codes) artificially decreases the observed prevalence of diabetes, as observed by others.[9] Although standardised coding has increased over time, we observed substantial variation in the use of Read codes across practices. For example, in 2007 the median proportion of people within a practice with type 2 diabetes who had a C10F code was 72.1% (interquartile range 67.1-79.3%). Only three practices had over 90% of people meeting the type 2 case definition of the quality and outcomes framework and four practices had less than 20% of people defined in this manner. In 2007 nearly two thirds of people with type 1 diabetes and a third of people with type 2 diabetes would not be identified using the diagnostic case definition in the quality and outcomes framework. Other studies have also reported similar underestimates of prevalence when only specific diabetes codes are considered.[9] Further standardisation of coding is required if quality of care is to be monitored in an unbiased and effective way.[6] This may require widespread education within primary care before the introduction of new indicators.

Strengths and limitations of the study

The mean prevalence in our study based on the quality and outcomes framework case definition (2.7%, range 0.2-5.1%) was lower than reported nationally by Department of Health systems (3.7%, range 0.0-14.4%),[25] although over 90% of practices included in the quality and outcomes framework reported a prevalence within our observed range. This may in part reflect the under-representation of practices in deprived areas, which tend to have higher proportions of people from ethnic minority groups and hence diabetes, in the database used in this study.[26-28] The practices included in the (DIN)-LINK database have a similar age-sex structure to that of the UK population but have been shown to over-represent practices in the south of England and higher socioeconomic groups.[15] In addition the practices included in this study (just under 50% of those contributing to the DIN-LINK database) were selected because they had high quality data available over a 10 year period, which allowed us to identify and assess the management of patients over time. These selected practices were spread throughout Great Britain but included a relatively high proportion of dispensing practices. We may anticipate that such practices with capture of higher quality data provide a different level of care, possibly higher, than those that do not meet such criteria. Furthermore, ease of accessibility to dispensing services may mean that some patients seen in our practices might have increased uptake and possibly compliance with therapy.

The prevalence of type 1 diabetes may be viewed as decreasing marginally over time, which could result from more accurate coding in general practitioners' notes, particularly in the case of people with type 2

WHAT IS ALREADY KNOWN ON THIS TOPIC

Since the introduction of the quality and outcomes framework in the United Kingdom, a series of studies has suggested an improvement in the management of people with diabetes in primary care

It remains unclear to what extent the introduction of incentives has had an impact on existing temporal trends

WHAT THIS STUDY ADDS

Significant improvements in diabetes care were observed from 2002-7, although this does not seem to be a direct result of the quality and outcomes framework

Many people in whom care may be suboptimal do not seem to be captured in the quality and outcomes framework assessment owing to the current diagnostic case definition

diabetes treated with insulin being more accurately coded as such.

Our sensitivity analyses on patients who had C10E and C10F Read codes and met the current case definition for the quality and outcomes framework was based on identification of these Read codes in the study period. Some people with earlier recorded morbidity Read codes may have been missed, but it is standard practice to include a Read code in the electronic record each time a patient is seen. Although the inclusion of people without C10 or the more specific C10E and C10F codes in the analysis might be criticised, other Read codes were more commonly in use in the period before April 2006. Other studies have also used codes such as the diabetes care codes (66A) and prescription information to identify patient cohorts[29] and have noted the inconsistent use of diabetes specific Read codes.[6] As we aimed to assess the management of people with diabetes over time and the impact of the quality and outcomes framework, it was important to avoid spurious trends as a result of changes in diagnostic case definition.[9] We also included people with codes for exception reporting (9h4 codes) as these codes were not in use before April 2005 and so their use would have led to an inaccurate assessment of change in care over the study period. A more inclusive approach considering the entire population of people with diabetes provides a clearer picture of care both before and after the implementation of the quality and outcomes framework.

Conclusions

The management of people with diabetes in the UK has improved since the late 1990s. The relation between incentives and attainment of targets may not, however, be as straightforward as initial reports suggest. Pay for performance may have contributed to the improvement in diabetes care but the relative importance of the quality and outcomes framework to other national quality improvement strategies is unclear. Our work and that of others highlights the potential unintended consequences of the scheme, which include selective inclusion of patients in the scheme through the removal[30] or addition of Read codes, exclusion of patients through exception reporting,[22] and potential threshold effects, all of which require further evaluation. The scheme in its present form fails to capture almost one third of people in whom care may be suboptimal and may even lead to reduced levels of care for some groups of patients.

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