Swiss Quality and Outcomes Framework: Quality Indicators for Diabetes Management in Swiss Primary Care Based on Electronic Medical Records

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Key Words
Primary health care · Electronic medical records · Diabetes mellitus · Quality and Outcomes Framework · Switzerland

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Introduction

Background

Chronic diseases and multimorbidity present the most common disease pattern and have significant medical and economic implications. As in many other modern industrial countries, the growing prevalence of chronic diseases such as diabetes challenges the health care financing system in Switzerland [1–6]. Since large diabetes studies provided evidence that the achievement of certain target values (e.g. for HbA1c and blood pressure) influ-

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ences the long-term outcome of patients with diabetes, many treatment guidelines and recommendations for disease management have been published with the intention of improving the quality of care and subsequently minimizing the long-term effects of disease and reducing health care costs [7–11]. However, in Switzerland there currently exists no monitoring system that documents the adherence of health care providers to the evidence-based standards of diabetes care or rather their related clinical outcomes and influences on health-related quality of life (HRQL). Today, the responsibility for ongoing management of patients with diabetes rests primarily with general practitioners (GPs) and the primary care team, who are traditionally working in single-handed private practices with a fee-for-service payment. Therefore, it is neither possible to assess the true epidemiology of diabetes and the current level of treatment outcomes in general nor to systematically evaluate the impact of new disease management programs and other changes in health care delivery such as the introduction of integrated care programs. Indeed, due to observations from previous studies, a large evidence-performance gap must be supposed [12, 13].

On the contrary, other nations successfully implemented measurement systems allowing monitoring of health care quality and the achievement of treatment targets. In 2004 the UK National Health Service (NHS) introduced the Quality and Outcomes Framework (QOF), a voluntary annual reward and incentive program for all general medical practices in England, Wales, Scotland and Northern Ireland and part of the General Medical Services contract for general practices [14]. The intention of this initiative is to encourage appropriate and high-quality clinical care for key long-term conditions by detailing and displaying the overall practice achievement through a points system. At the end of the financial year the total number of practice achievement points is converted into a payment amount, which can be seen as a reward for adherence to evidence-based care and implementing 'good practice'. In this context, the NHS QOF provides a range of clinical quality indicators, based on the best available evidence, against which practices score points according to their level of achievement in the care of different highly prevalent diseases such as diabetes [14, 15].

Aim of the Study

The main objective of this study was to investigate to what extent clinical data, extracted from electronic medical records (EMRs) of Swiss GPs, can be used as diabetes quality indicators in terms of a Swiss Quality and Outcomes Framework (SQOF) adopted from the NHS QOF. In the absence of an overall Swiss monitoring system collecting relevant EMR data needed to calculate the scoring of individual general medical practices, we reverted to the FIRE database (Family Medicine ICPC Research Using Electronic Medical Records), a standardized collection of clinical routine data extracted from EMRs of Swiss GPs [16].

First, we investigated to what extent clinical routine data based on the EMRs contain the information that is needed to apply the NHS QOF indicator set for diabetes care. Applicable indicators were adopted and used to construct the SQOF. Second, we measured the achievements of Swiss GPs against these quality indicators and compared the results with the average results of GPs in England – available online at the NHS Information Centre for Health and Social Care [17].

Methods

The QOF of the UK NHS has undergone several revisions since its introduction in 2004; the latest changes were made in April 2012 [18]. We based our analyses on the QOF 'online GP practice results database' of the year 2010/2011, as the latest evaluated year available online [19].

We listed the NHS QOF diabetes indicator set and reviewed to what extent these indicators were mirrored in clinical routine data extracted from the FIRE database. The FIRE database is the centerpiece of an ongoing research project at the Institute of General Practice and Health Services Research of the University of Zurich, Switzerland, started in 2009. Its establishment and data structure are reported elsewhere [16]. In brief, the database contents structured medical data that GPs routinely assess during patient encounters and enter in their EMR software. GPs extract these data from their EMR software monthly by the means of XML (an Extensible Markup Language export tool currently provided by the five leading EMR software companies of the Swiss market). Participation in the project is voluntary and not incentivized, and participants are recruited consecutively.

The NHS QOF diabetes indicators are based on patient data collected within 15 months since the last annual NHS QOF evaluation. Therefore, we focused our analysis on data extracted from the FIRE database covering at least 15 months of treatment. Eligible extracted data from the EMRs were adopted and built the SQOF. We measured the achievements of FIRE practices against the SQOF diabetes indicators. Both the overall achievement of FIRE practices and the achievement of each single practice were statistically evaluated. Subsequently, the SQOF data were compared with the average results of the general medical practices in England. To accomplish this task we used the QOF 2010/2011 practice level data tables and the QOF 2010/2011 prevalence data tables, respectively – both available online at the NHS Information Centre for Health and Social Care [19].

Furthermore, we calculated whether FIRE practices would have gained an achievement reward according to the NHS QOF

reimbursement policy by applying the NHS QOF calculation of points of the diabetes indicator set [20]. The applicable NHS QOF diabetes indicators have designated achievement thresholds also called payment stages. If a practice has achieved a percentage score in relation to a particular indicator that is the minimum set for that indicator (or below), it achieves no points. If a practice has achieved a percentage score that is between the minimum and the maximum set for that indicator, it achieves a proportion of the points which is rewarded with a certain amount [20]. We also calculated the mean points achieved per NHS QOF practice by using the QOF 2010/2011 practice level data tables and compared those outcomes with the outcome of FIRE practices [19].

Data Extraction from FIRE Database

Consultation data recorded in the FIRE database between January 2009 and June 2012 were used for the study. These data included 776,679 consultations derived from 136,132 patients and 937,858 medical problems according to the ICPC-2 classification (International Classification of Primary Care 2) [21]. The FIRE data further cover patient demographics, vital signs, laboratory data and type and dosage of prescribed medication at the level of individual consultations. Prescription drugs are classified according to ATC/DDD (anatomical therapeutic chemical/defined daily dose classification) coding established by the WHO [22].

Case histories of patients in the database were established by sorting individual physician-patient encounters by patient and date.

Inclusion criteria were patients with type 1 or type 2 diabetes and a case history of at least two encounters with an interval of at least 15 months. Patients with diabetes type 1 or type 2 were identified either by ICPC-2 codes or by type of prescribed medication classified according to ATC/DDD within their case history.

Comorbid conditions were determined by calculating the average number of conditions per patient, identified either by ICPC-2 codes or by type of prescribed medication. A set of specific ICPC-2 codes was applied to define chronicity from a diagnostic perspective [23] and the concept of pharmaceutical cost groups (PCGs) to define chronicity from a therapeutic perspective [24].

Results

Study Population Characteristics

Data of 4,832 patients with diabetes type 1 or type 2 derived from 136,132 patients were extracted from the FIRE database in June 2012; 3,148 patients were identified by type of prescribed medication classified according to ATC/DDD coding, 537 patients were identified by respective ICPC-2 codes and 1,147 patients by both coding schemes. The average age of all patients with diabetes was 67.7 years (69.8 years for the 2,097 female patients and 66.1 years for the 2,735 male patients). The average number of comorbid conditions per patient was 1.6 for ICPC-2 codes and 1.3 for PCGs.

Of all patients with diabetes, 1,781 had clinical data measurements covering at least 15 months of treatment and thus fulfilled the inclusion criteria. Thereof, 1,038 patients were identified by ATC/DDD coding, 190 by ICPC-2 codes and 553 by both coding schemes. The mean age was 69.3 years; 779 patients were female with an average age of 71.3 years and 1,002 were male with an average age of 67.7 years. On average, 14 consultations per patient were documented within the previous 15 months of treatment. The average number of comorbid conditions at patient level was 2.6 for ICPC-2 codes and 3.7 for PCGs. Comorbid conditions could be assigned to all ICPC-2 chapters, except chapters W and Z (W, pregnancy, family planning; Z, social). The most frequent chapters were K, L and T (K, circulatory; L, musculoskeletal; T, metabolic, endocrine, nutritional; online suppl. table 1; see www.karger.com/doi/10.1159/000357370 for all online suppl. material). The three most frequent comorbid conditions according to PCGs were hypertension, coronary and peripheral vascular disease and hyperlipidemia, with 17.8, 15.1 and 12.4%, respectively. Cardiac disease was stated in 6.6% and renal disease in 0.02% (1 patient).

Application of NHS QOF Indicators

The QOF diabetes indicators for the year 2010/2011 published by the UK NHS consist of a set of 17 indicators against which practices score points according to their level of achievement [15, 25]. On this basis, we focused on 11 indicators which we were able to extract from the FIRE database and thus defined 11 SQOF diabetes indicators as shown in table 1. Considering the SQOF indicator 11 in comparison with the corresponding NHS QOF indicator, the FIRE database only provides records of serum creatinine testing and not of estimated glomerular filtration rate. Thus, we adapted the SQOF indicator accordingly. Further, we did not include the NHS QOF indicator stating whether a practice can produce a register of all patients aged 17 years and over with diabetes by specifying diabetes type 1 or type 2, since the FIRE database itself represents a register from which such data can be extracted. The following NHS QOF diabetes indicators were not applicable to the FIRE database and therefore excluded from the analysis: (1) the percentage of patients with diabetes with a record of the presence or absence of peripheral pulses in the previous 15 months; (2) the percentage of patients with diabetes with a record of neuropathy testing in the previous 15 months; (3) the percentage of patients with diabetes who have a record of microalbuminuria testing in the previous 15 months (exception: reporting for patients with proteinuria); (4) the percentage of patients with diabetes with proteinuria or microalbumin-

Table 1. SQOF compared with NHS QOF

Indicator No.	SQOF diabetes indicators	Corresponding NHS QOF diabetes indicators	Percentage of patients with diabetes from FIRE database in whom the indicator was fulfilled (n = 1,781)	Percentage of practices from FIRE database fulfilling indicator (n = 46)
Ind_01	Percentage of patients with diabetes whose notes record BMI in the previous 15 months since last consultation	Percentage of patients with diabetes whose notes record BMI in the previous 15 months	41.9	89.1
Ind_02	Percentage of patients with diabetes who have a record of HbA1c in the previous 15 months since last consultation	Percentage of patients with diabetes who have a record of HbA1c or equivalent in the previous 15 months	75.6	95.7
Ind_03	Percentage of patients with diabetes in whom the last HbA1c is 7% or less in the previous 15 months	Percentage of patients with diabetes in whom the last HbA1c is 7% or less (or equivalent test/reference range depending on local laboratory) in the previous 15 months	41.4	89.1
Ind_04	Percentage of patients with diabetes in whom the last HbA1c is 8% or less in the previous 15 months	Percentage of patients with diabetes in whom the last HbA1c is 8% or less (or equivalent test/reference range depending on local laboratory) in the previous 15 months	62.1	95.7
Ind_05	Percentage of patients with diabetes in whom the last HbA1c is 9% or less in the previous 15 months	Percentage of patients with diabetes in whom the last HbA1c is 9% or less (or equivalent test/reference range depending on local laboratory) in the previous 15 months	70.3	95.7
Ind_06	Percentage of patients with diabetes who have a record of blood pressure in the previous 15 months since last consultation	Percentage of patients with diabetes who have a record of the blood pressure in the previous 15 months	82.0	97.8
Ind_07	Percentage of patients with diabetes in whom the last blood pressure is 145/85 mm Hg or less, measured within the previous 15 months	Percentage of patients with diabetes in whom the last blood pressure is 145/85 mm Hg or less, measured within the previous 15 months	48.8	95.7
Ind_08	Percentage of patients with diabetes who have a record of total cholesterol in the previous 15 months since last consultation	Percentage of patients with diabetes who have a record of total cholesterol in the previous 15 months	37.2	71.7
Ind_09	Percentage of patients with diabetes whose last measured total cholesterol within the previous 15 months is 5 mmol/l or less	Percentage of patients with diabetes whose last measured total cholesterol within the previous 15 month is 5 mmol/l or less	22.0	67.4
Ind_10	Percentage of patients with diabetes who have had influenza immunization (ATC J07BB) in the preceding September 1 to March 31	Percentage of patients with diabetes who have had influenza immunization in the preceding September 1 to March 31	15.6	45.7
Ind_11	Percentage of patients with diabetes who have a record of serum creatinine testing in the previous 15 months since last consultation	Percentage of patients with diabetes who have a record of estimated glomerular filtration rate or serum creatinine testing in the previous 15 months	49.3	71.7

uria who are treated with ACE inhibitors (or A2 antagonists), and (5) the percentage of patients with diabetes who have a record of retinal screening in the previous 15 months.

SQOF Diabetes Indicators

The first SQOF indicator assesses the proportion of patients with diabetes whose notes record a body mass index (BMI) in the previous 15 months since last consultation (table 1). Of the 1,781 patients in our study, 747

(41.9%) had respective measurements with 1 record on average (min. 0, max. 28); 258 patients (14.5%) had at least 1 BMI entry in their case history, though not within the preceding 15 months and 776 patients (43.6%) had no BMI measured at all. Of the 747 patients with a BMI measurement, 7.8% had a BMI of <25, 32.0% had a BMI of 25–35 and 10.3% had a BMI of >35.

The quality indicators 2–5 include the percentage of patients with diabetes with a record of HbA1c in the previous 15 months since last consultation and the degrees of attainment of defined target values (online suppl. table 2). Of the 1,781 patients with diabetes with at least 15 months of treatment, 1,346 (75.6%) had an HbA1c record during the respective period of time, 188 (10.6%) had at least 1 HbA1c record, though not within the preceding 15 months since last consultation, and 247 (13.9%) had no HbA1c measured at all. HbA1c was measured 2.4 times (min. 0, max. 13) on average per patient. The proportion with recorded last HbA1c of ≤7% was 41.4 and 34.1% with recorded last HbA1c of >7%. We assessed 62.1% of patients in whom the last HbA1c was ≤8 and 13.5% with an HbA1c of >8%. The percentage with recorded last HbA1c of ≤9 was 70.3 and 5.3% with a last HbA1c of >9%. Related to the 1,346 patients with an HbA1c record, 54.8% had a last HbA1c of ≤7 and 45.2% had a last HbA1c of >7%. Considering a last HbA1c of ≤8% and of >8, 82.2% were below and 17.8% above the threshold. The proportion of the 1,346 patients for recorded last HbA1c of ≤9% was 93 and 7% for last HbA1c of >9%.

The quality indicators 6 and 7 quantify the blood pressure measurement and the defined target value. Overall, 1,460 patients (82%) of the study population had a measurement of blood pressure in the previous 15 months since last consultation, with an average of 4 records (min. 0, max. 47), 316 patients (17.7%) had at least 1 blood pressure entry in their case history, but not within the preceding 15 months, and 5 patients (0.3%) had no blood pressure measurement at all. The percentage of patients with diabetes in whom the last blood pressure was ≤145/85 mm Hg corresponds to 48.8 and 33.2% for a last blood pressure measurement of >145/85 mm Hg. Of the 1,460 patients with a measurement of blood pressure, 59.5% had a last blood pressure of ≤145/85 mm Hg and 40.5% one of >145/85 mm Hg.

The quality indicators 8 and 9 include the total cholesterol measurement and the defined total cholesterol target value. Of the 1,781 patients with diabetes covering at least 15 months of treatment, 662 (37.2%) had a record of total cholesterol in the previous 15 months since last consultation, 198 (11.1%) had at least 1 total cholesterol record, although not during the respective time period, and 921 (51.7%) had no such record at all. On average total cholesterol was recorded 0.5 times (min. 0, max. 20) per patient; 22% of the study population had a last measured total cholesterol of ≤5 mmol/l and 15.2% one of >5 mmol/l. In relation to the 662 patients with total cholesterol record, 59.2% of them had a last measured total cholesterol of ≤5 mmol/l and 40.9% one of >5 mmol/l.

The quality indicator 10 assesses the proportion of patients with diabetes who have had influenza immunization (ATC code J07BB) in the preceding period from September 1 to March 31 within the previous 15 months since last consultation and corresponds to 278 patients (15.6%).

The last quality indicator includes the serum creatinine testing with an average of 1 record (min. 0, max. 19) at patient level. Of the 1,781 patients in our study, 878 (49.3%) had a record of serum creatinine testing in the respective time period since last consultation, 200 (11.2%) had at least 1 serum creatinine testing, though not within the previous 15 months since last consultation, and 703 (39.5%) had no such testing at all.

SQOF Diabetes Indicators at Practice Level

A total of 46 Swiss general medical practices participating as of June 2012 in the FIRE project showed EMRs for patients with diabetes with the respective clinical data within a timeline of at least 15 months of treatment. On average 39 patients per practice were recorded (min. 1, max. 110). A crosscheck against the original FIRE database showed that all practices had recorded the required clinical data at least once in patients other than the included patients with diabetes.

The 46 practices fulfilled the SQOF diabetes indicator set with 46.9% overall (min. 0.0%, max. 75.4%). The rate of practices fulfilling the respective SQOF diabetes indicators is depicted in table 1. Highest compliance was reached for blood pressure measurements (indicators 6 and 7; 97.8 and 95.7% of practices) and HbA1c measurements (indicators 2, 4 and 5; 95.7% each) and lowest compliance for influenza immunization (indicator 10; 45.7% of practices). Further, for the mean percentage of patients in whom the respective SQOF diabetes indicators had been fulfilled by practice, highest compliance was achieved in indicator 6 with 77.2% average (min. 0.0%, max. 100%), stating a record of the blood pressure in the previous 15 months since last consultation, and indicator 2, stating an HbA1c measurement in that period (72.5% average, min. 0.0%, max. 100%). Lowest compliance was achieved in indicator 10 with 12.8% average (min. 0.0%, max. 76.2%).

In general, for each indicator a minimum of 0% can be reported and the maximum varies from 76.2 to 100% across the indicators. The minimum values can be traced back to 33 different practices which produced at least 1 value of 0.0%. Online supplementary table 3 provides information about the number of practices which produced the minimum values by systematically lacking records in relation to specific indicators.

Comparison of SQOF with NHS QOF

Online supplementary figure 1 provides an overview of the achievements of GPs in Switzerland compared to those in England and shows the mean percentages of patients in whom the respective SQOF and NHS QOF diabetes indicators have been fulfilled by practice.

Of the general medical practices participating in the FIRE project, 46 practices were keeping records of 1,781 patients with diabetes within at least 15 months of treatment, on average 39 patients per practice (min. 1, max. 110) were counted. In England for the evaluated year 2010/2011, 8,245 general medical practices were included in the published results, covering almost 100% of registered patients with an average of 298 patients per practice (min. 0, max. 1,835). In general, the SQOF compliance is lower than the NHS QOF compliance. The 46 Swiss GP practices fulfilled the SQOF diabetes indicator set with 46.9% overall (min. 0.0%, max. 75.4%). The 8,245 general medical practices in England fulfilled the applicable NHS QOF diabetes indicators with 87.2% overall (min. 0.0%, max. 100.0%). Variations between practices in both countries are shown in online supplementary figure 2.

The lowest value is reported for SQOF indicator 10 (influenza immunization) with 15.6% of the study population and 12.8% of patient average at practice level compared with a NHS QOF patient average of 91.2% per practice. Indicator 6 (blood pressure control) showed the highest SQOF value with 82.0% of the study population and 77.2% of patients per practice. In England, likewise, highest compliance was shown in indicator 6, reaching a patient average of 98.4% at practice level. Patients with diabetes within the NHS QOF achieved a target blood pressure of ≤145/85 mm Hg with an average of 81.4% of patients per practice compared with 46.7% of patients on average per FIRE practice and with 48.8% of the study population. The lowest compliance within NHS QOF is shown for recorded last HbA1c of ≤7% (indicator 3) with an average of 54.4% of patients at practice level compared with 39.5% of patients per FIRE practice and with 41.4% of the study population. In England, HbA1c check (indicator 2) was carried out with 97.3% patient average per practice compared with 72.5% patient average per FIRE practice and with 75.6% of the study population.

The mean difference between practice achievements in Switzerland and England across all indicators was 40.2%.

Practice Achievements Reward

Table 2 shows the percentage of Swiss general medical practices achieving points in relation to a particular SQOF indicator and the average points achieved per practice in comparison with the average points achieved by GP practices in England.

On average, Swiss GP practices gained a proportional achievement reward for 6.4 (min. 0, max. 11) out of 11 indicators and scored maximum points for 2.0 (min. 0, max. 7) indicators. Highest compliance rate was reached for indicator 6 (blood pressure control) with 93.5% of all practices gaining an average of 2.2 points of 3 points available. Lowest compliance rate is reported for indicator 10 (influenza immunization) with 15.2% of all practices gaining an average of 0.2 points of 3 points available. Maximum points were scored most frequently (41.3% of all practices) for indicator 4 (HbA1c of ≤8%) and most rarely (0.0% of all practices) for indicator 10. The variation is depicted in online supplementary figure 3.

In England, GPs gained a proportional achievement reward for 10.9 (min. 0, max. 11) out of 11 indicators and scored maximum points for 5.7 (min. 0, max. 6) indicators on average. Compliance rates varied across indicators between 99.7 and 99.9% of all practices. For most indicators over 90% of all practices scored maximum points, except for indicators 3, 4 and 5. The lowest rate was found in indicator 3 (HbA1c of ≤7%) with only 0.2% of all practices achieving maximum points (online suppl. fig. 3).

Discussion

Swiss health care is characterized by an almost complete lack of monitoring and evaluation of medical practice at the health system level and primary care is no exception in this context. Within a pilot study we evaluated to what extent it is feasible to implement a QOF to reflect the current quality of diabetes care in Swiss primary care practices. We used the internationally well accepted QOF diabetes indicators of the UK NHS as the methodological basis of our framework. The data were obtained from Swiss general medical practices participating in the FIRE project. This project pools clinical routine data for research and quality

Table 2. SQOF practice achievement points compared with NHS QOF practice achievement points

Indicator No.	SQOF indicators	Points available (according to QOF 2009/2010)	Payment stages in percent (according to QOF 2009/2010)	Percentage of SQOF practices achieving points >0 in relation to indicator	Mean points achieved by SQOF practice	Percentage of NHS QOF practices achieving points >0 in relation to indicator	Mean points achieved by NHS QOF practice in 2010/2011
Ind_01	Percentage of patients with diabetes whose notes record BMI in the previous 15 months since last consultation	3	40–90	43.5	0.7 (23.3%)	99.9	3.0 (100.0%)
Ind_02	Percentage of patients with diabetes who have a record of HbA1c in the previous 15 months since last consultation	3	40–90	89.1	2.1 (70.0%)	99.9	3.0 (100.0%)
Ind_03	Percentage of patients with diabetes in whom the last HbA1c is 7% or less in the previous 15 months	17	40–50	54.3	7.4 (43.5%)	99.8	14.7 (86.5%)
Ind_04	Percentage of patients with diabetes in whom the last HbA1c is 8% or less in the previous 15 months	8	40–70	80.4	5.2 (65.0%)	99.7	7.8 (97.5%)
Ind_05	Percentage of patients with diabetes in whom the last HbA1c is 9% or less in the previous 15 months	10	40–90	87.0	6.2 (62.0%)	99.8	9.4 (94.0%)
Ind_06	Percentage of patients with diabetes who have a record of the blood pressure in the previous 15 months since last consultation	3	40–90	93.5	2.2 (73.3%)	99.9	3.0 (100.0%)
Ind_07	Percentage of patients with diabetes in whom the last blood pressure is 145/85 mm Hg or less, measured within the previous 15 months	18	40–60	58.7	7.6 (42.2%)	99.8	17.9 (99.4%)
Ind_08	Percentage of patients with diabetes who have a record of total cholesterol in the previous 15 months since last consultation	3	40–90	41.3	0.7 (23.3%)	99.9	3.0 (100.0%)
Ind_09	Percentage of patients with diabetes whose last measured total cholesterol within the previous 15 months is 5 mmol/l or less	6	40–70	19.6	0.6 (10.0%)	99.9	6.0 (100.0%)
Ind_10	Percentage of patients with diabetes who have had influenza immunization (ATC J07BB) in the preceding 1 September to 31 March	3	40–85	15.2	0.2 (6.7%)	99.9	3.0 (100.0%)
Ind_11	Percentage of patients with diabetes who have a record of serum creatinine testing in the previous 15 months since last consultation	3	40–90	58.7	1.1 (36.7%)	99.9	3.0 (100.0%)

Values in parentheses indicate percentage of maximum points available.

improvement in Swiss primary care. Participants import standardized structured clinical routine data from their EMR software to a database. We investigated whether clinical routine data extracted from EMRs provide valid quality indicators of diabetes care with reference to quality indicators defined by the NHS QOF.

A total of 11 out of 17 NHS indicators could be adopted and built the SQOF. Comparing the practice achievements of Swiss GPs to achievements of GPs participating in the NHS QOF in England, great discrepancies of 40.2% average were found across all indicators. For example, in indicator 3 (HbA1c of ≤7%) Swiss practices gained a

mean point score of 7.4, which is lower than the mean score in England (14.7). On the other hand, only 0.2% of all English practices achieved maximum points for this indicator compared to 37% of the Swiss practices. Generally, GP practices in England showed a high and stable performance across all indicators with compliance rates close to 100%, whereas Swiss practices showed high variance between the indicators and between practices.

Our results show that Swiss EMR software products are currently lacking structured data elements in order to implement all 17 diabetes indicators of the NHS QOF. Software products for EMR currently available in Switzerland do not provide specific fields and check boxes that would allow structured entry of specific clinical findings and laboratory results related to certain diabetes-related exams. Users have to rely on 'work-arounds' and document clinically important outcomes in the form of free text notes or scan paper documents into the EMR as PDF files. Both free text notes and PDF files are not searchable electronically and such information cannot be exported and is thus not available for subsequent statistical analysis. Indicators of both process and outcome quality of care are therefore difficult to establish.

In concrete terms this means that we had to drop all indicators reflecting the control of macro- and microvascular complications of diabetes, particularly examination of peripheral pulses, neuropathy testing, microalbuminuria testing and retinal screening.

Nevertheless, we were able to adopt 11 indicators for the evaluation of diabetes treatment, which reflect both relevant processes of care and outcome achievements. A crosscheck against the original FIRE database showed that all practices had recorded the required clinical data at least once in patients other than the included patients with diabetes. So, we were reassured that all practices were technically capable of providing data for an evaluation.

Thus, we conclude that it is technically feasible to rely on clinical routine data extractions from EMRs in order to establish a diabetes QOF in Swiss primary care.

However, technical feasibility is not the only requirement for the establishment of a QOF. It must be assured that the data provided by the practices are complete and truly reflect their working processes and outcome achievements.

Within a QOF system there are two steps of data processing that might be a source of bias compromising the reliability of data and therefore the validity of the evaluation's results: (1) data capturing with EMR software and (2) data extraction from EMR software and transmission to the evaluation institution.

Our results suggest that Swiss GPs miss or are hindered in capturing complete data for all patients to all times with their EMR software: despite general technical capability to extract and export the requested data, only 12 out of 46 practices in the FIRE project actually identified all 11 SQOF indicators. The high amount of missing values explains the great discrepancy between the practice achievements of GPs in Switzerland and England.

The question arises as to why Swiss GPs seemingly use different practices of electronic medical documentation than GPs in England.

In England, the QOF is inseparable from a pay-for-performance reimbursement system that rewards participating GPs for fulfilling the quality indicators. So, GPs have an incentive to keep complete EMRs of their patients and to document every treatment process related to the quality indicators. Participation in the QOF program requires use of certified EMR software particularly supporting data extraction and transfer to the QMAS (Quality Management and Analysis System), a national IT system developed by NHS Connecting for Health, designed to calculate the practice achievements and provide the QOF statistics. Under these circumstances, it can be supposed that missing values in the data sets provided for evaluation would mostly correspond to failing treatment performances.

In contrast to that, GPs in our study received no incentives nor were they aware of the specific evaluation of their data entries. In this case, it is possible that missing values are not only due to failing treatment performances but also due to failures in data capturing.

Depending on the examination and the individual IT equipment of a practice, certain laboratory values and clinical results are recorded automatically in the EMR, whereas other values and results have to be typed in by the GP or the practice nurse. Automatic data input is considered to be reliable so that missing data would also correspond to failing treatment performances. On the other hand, manual data input is considered to be less reliable and a potential source of bias.

In order to fulfil the SQOF indicators, GPs had to undertake 5 different examinations within 15 months, i.e. measurements of BMI, blood pressure, HbA1c, total cholesterol and serum creatinine. With the existing EMR software products in Switzerland, both BMI and blood pressure measurement acquire manual data input by the examiner, whereas the values of HbA1c, total cholesterol and serum creatinine could possibly be imported automatically from a laboratory database or the practice's own electronic laboratory equipment. However, interfaces

connecting EMR software and external data sources such as laboratory databases and laboratory equipment are expensive and many GPs in Switzerland still refrain from implementation of such interfaces and rely on manual data input or file paper documents instead.

Our analysis of individual practice achievements showed that 18 practices were systematically lacking records of BMI, blood pressure, HbA1c, total cholesterol and/or serum creatinine measurements in their patients with diabetes type 1 or 2. As the FIRE database contains no information about the individual IT equipment of participating practices, it remains unclear whether the respective data of HbA1c, total cholesterol and serum creatinine measurements were imported from external data sources or entered manually. It is very likely that these practices document the respective laboratory results constantly elsewhere than in the designated EMR input field, so that the results are 'invisible' for data extraction and evaluation. Similar considerations apply to immunizations that are often only documented on the patient's paper-based vaccination certificates. Still, it is also possible that these practices do not follow the state of the art in diabetes care and simply do not undertake the corresponding examinations. The different possibilities of data capturing also explain the great variations of achievements that were seen between Swiss practices. Financial rewards for complete data capturing might have motivated all GPs to check medical records for completeness and add information that is stored elsewhere before importing data to the FIRE database. Without financial incentives, it is very likely that many GPs use not all functions for structured data entry of their EMR software.

In summary, it was not possible in our study to distinguish between poor indicator achievements due to a poor treatment performance and poor indicator achievements due to poor data input.

Thus, we conclude that it is not appropriate to evaluate the actual quality of Swiss diabetes care today on the basis of clinical routine data extracted from EMRs.

Strengths and Limitations

There are several strengths and limitations in this study that need to be acknowledged. The main strength of the study is the use of quality indicators based on the well-established NHS QOF. The NHS QOF indicators are developed and tested in a multistep and methodological process designed to reassure clarity, necessity, feasibility, reliability, acceptability and cost-effectiveness [26]. In particular, the diabetes indicators and the effect of associated pay-for-performance schemes on the quality of diabetes care have been investigated intensively [27–30]. Irrespective of discussions on whether the introduction of financial incentives led to an improvement of the recorded quality of primary care for patients with diabetes, it is acknowledged that the NHS diabetes indicator set covers relevant processes of diabetes care. As a consequence, these indicators can be seen as the general basis when investigating whether a set of clinical routine data extracted from EMRs is qualified for the monitoring of quality in diabetes care.

Furthermore, the alignment with the NHS QOF allowed us to benchmark the results of the quality and outcomes assessment of the Swiss GP population against the real life results of English GPs. Of course, it should be acknowledged that the comparability between these two populations is very limited, because the groups were not randomized and analyses did not control for potential confounders. So, the results of our study cannot be used to compare the actual quality of diabetes care in Switzerland and England. However, it is feasible to derive important conclusions about the different practices of medical documentation and EMR use – prerequisites for the successful participation of GPs in a QOF system.

In this context, it is clearly the strength of this study that the analyses are based on the substantial FIRE database. To date this database is the largest collection of structured primary care clinical routine data in Switzerland, providing data of 776,679 consultations derived from 136,132 patients. Given the fact that approximately 10–20% of all Swiss GPs currently keep EMRs [31], the total of consultation records represents an adequate sample. Therefore, our results can be considered applicable to all physicians currently using EMRs in Swiss primary care, even though the study was restricted to data entries of 46 GPs treating patients with diabetes for at least 15 months.

It is interesting to note that the observed prevalence of diabetes type 1 and 2 in the FIRE database with 4,832 of 136,132 patients was lower than epidemiological experts would expect. However, it must be acknowledged that our study was not designed to assess the epidemiology of the disease but processes of care. So, we sought undisputed indicators of the disease that would not be the subject of the quality indicator set at the same time. If we had also included all patients with at least 1 HbA1c value over the 6.5% threshold, the observed prevalence of diabetes would have been closer to the expected prevalence.

The general question of whether concentration on easily measurable clinical processes would be sufficient to

describe quality of care comprehensively cannot be answered by our results. However, the characteristics of our study population indicate that future approaches of health politics towards quality measures need to take into account that patients with diabetes in Swiss primary care are of advanced age and have multiple chronic conditions. As Hunger et al. [32] reported, diabetes combined with cardiovascular comorbidities has superadditive effects on HRQL. This evidence should promote the development of additional quality indicators that mirror the dealing with issues of patients concerning HRQL. GPs can act as an important resource in patients' social network and the influence of social support on HRQL of patients suffering from multiple chronic conditions has been shown [33], so the development of respective quality indicators could be considered, particularly because a simple clinically focused QOF which fails to make allowance for age or multimorbidity involves the danger of overtreatment, especially when associated with a pay-for-performance reimbursement [34].

In our study, we deliberately refrained from informing the participating practices about the assessment of quality indicators or from any incentives for participating. We aimed to document the current routine of medical documentation free from any incentives and set a landmark, assessing baseline data that will help to observe future trends in the quality of medical documentation. A recent cross-sectional survey among elderly patients with diabetes in Swiss primary care supports the hypothesis that the rate of electronically documented processes of care could be lower than the rate of processes that are really conducted in daily practice [35]. In this survey, over 90% of patients claimed to have received annual testing of HbA1c, blood pressure, lipids and body weight, indicating much higher rates than our observation based on EMR entries.

A lack of financial incentives has been identified to be an important barrier to structured work flows in diabetes care from the physician's point of view [36]. Moreover, experience from the NHS QOF and similar incentive-based disease management programs in other countries underline the influence of financial incentives on the quality of medical documentation. For instance, in Germany, the Saxon Diabetes Management Program that compromised, inter alia, incentives for data documentation by GPs, reported an increase of completed data to 91–98% [37]. On the other hand, retrospective investigations in England have shown that an overall increase of the recorded quality of diabetes care had already existed in the pre-QOF period, just like in other countries and irrespective of the introduction of the pay-for-performance scheme in 2004 [28, 38, 39]. It is very likely that such trends will also appear in Switzerland when the fraction of GPs using EMR software rises. Against this backdrop, further research on the impact of different incentive programs will benefit from our baseline data.

Conclusions

Our study shows that the Swiss ambulatory health care system lacks important prerequisites for the successful implementation of a QOF in diabetes care with or without associated pay-for-performance reimbursement system. Despite technical feasibility of a structured data export from EMRs to an evaluation institution, it was not possible to obtain data that reliably reflect the relevant working processes and outcome achievements of the participating GPs. A high amount of missing data made it impossible to evaluate the actual quality of care. Thus, there is no basis for a simple monitoring of quality of care nor for a reimbursement policy that rewards achievements in quality of care.

As a first step, Swiss EMR software products need to be adapted so that the content of structured data is increased and the data capturing is eased. Standards for electronic medical documentation and EMR use need to be set.

It should also be acknowledged that important dimensions of suffering from one or more chronic diseases are not reflected by a system focusing only on somatic aspects of a disease. It should be carefully considered how psychological and psychosocial demands of multimorbid patients can be addressed appropriately if such a system should be introduced.

Disclosure Statement

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