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# Identifying people at risk for undiagnosed type 2 diabetes using the GP's electronic medical record

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**Background.** Screening for type 2 diabetes is recommended in at-risk patients. The GP's electronic medical record (EMR) might be an attractive tool for identifying them.

**Objective.** To assess the value of the GP's EMR in identifying patients at risk for undiagnosed type 2 diabetes and the feasibility to use this information in usual care to initiate screening.

**Methods.** In 11 Dutch general practices (25 GPs), we performed an EMR-derived risk assessment in all patients aged  $\geq 45$  and  $\leq 75$  years, without known diabetes, identifying those at risk according to the American Diabetes Association recommendations. Patients with an EMR-derived risk or risk after additional risk assessment during regular consultation were invited for capillary fasting plasma glucose (FPG) measurement.

**Results.** Of 13 581 patients, 3858 (28%) had an EMR-based risk (hypertension, cardiovascular disease, lipid metabolism disorders and/or obesity). Additional risk assessment in those without an EMR-based risk showed that in 51%, greater than one risk factor was present, mainly family history (51.2%) and obesity (59%). Ninety per cent returned for the FPG measurement. In both groups, we found patients with an FPG exceeding the cut point for diabetes (5.9% versus 4.1%).

**Conclusions.** With additional risk assessment during consultation, the GP's EMR was valuable in identifying patients at risk for undiagnosed type 2 diabetes. It was feasible to use this information to initiate screening. At-risk patients were willing to take part in screening. Better registration of family history and obesity will improve the EMR as a tool for identifying at-risk patients in opportunistic screening in general practice.

**Keywords.** Diabetes, diagnostic tests, information technology, family medicine, patient record.

## Introduction

Main reason to urge for screening for type 2 diabetes mellitus is the long preclinical period of diabetes. One-third to half of all people with diabetes remain undiagnosed for many years. In the mean time, complications already begin to develop.<sup>1</sup> Starting treating patients with type 2 diabetes at an earlier stage might prevent or delay the development of complications.<sup>2</sup> However, at this moment, no evidence is available for the effectiveness of screening programmes in reducing diabetes-related morbidity and mortality. There is also little knowledge about the ethical, psychological, and

social consequences of both true and false screening results, and there is no consensus on the applied screening test and diagnostic cut off points.<sup>3,4</sup>

Notwithstanding these considerations, nowadays screening for type 2 diabetes is encouraged. It is recommended to perform screening in a subgroup of patients at risk for undiagnosed type 2 diabetes.<sup>5–8</sup> As screening should also be a systematic and continuous process,<sup>3</sup> opportunistic screening of such at-risk patients might be an interesting screening method in general practice. This involves screening of at-risk individuals during usual care, who are seen by health care professionals for reasons not related to the condition for which

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screening is offered.<sup>9</sup> At-risk patients can be identified using questionnaires or risk scores.<sup>10–12</sup> A pragmatic approach might be assessing risk using risk factors for undiagnosed type 2 diabetes that are already registered in the medical records of the GP.

Relevant medical informations like diagnoses, medication use and referrals are available in the GP's medical record system, nowadays often computerized. If GPs are well trained and software is user-friendly, an electronic medical record (EMR) can be accurate and complete.<sup>13</sup> The GP's EMR might therefore be an attractive, inviting tool for identifying at-risk patients in opportunistic screening.

The aim of this study was to assess the value of the GP's EMR in identifying people at risk for undiagnosed type 2 diabetes and the feasibility to use this information in usual care to initiate screening.

## Methods

### Patients and setting

Patients were recruited from 11 general practices (25 GPs) in the Netherlands: seven of these practices were participating in the Academic Research Network of the Department of General Practice of the Radboud University Nijmegen Medical Centre, CMR/NMP,<sup>14</sup> two in the Registration Network Family Practices of the University Maastricht (RNH)<sup>15</sup> and two practices were related to the network of the VU University Medical Center Amsterdam.<sup>16</sup> All patients aged  $\geq 45$  and  $\leq 75$  years and not known with type 2 diabetes who were listed with these practices were considered for the study. Diabetes—both known and undiagnosed—was defined as having a fasting plasma glucose (FPG)  $\geq 7.0$  mmol/l on two different days in asymptomatic patients or a single random plasma glucose  $> 11.0$

mmol/l in patients with diabetes-related symptoms. Impaired fasting glucose (IFG) was classified as having a single FPG value  $\geq 6.0$  and  $< 7.0$  mmol/l.<sup>17,18</sup>

All practices used the Promedico EMR software (Promedico ICT Inc., Nieuwegein, the Netherlands). Registration of diagnoses was based on the electronic version of the International Classification of Primary Care (ICPC codes).<sup>19</sup> Prescribed medication was coded according to the Anatomical Therapeutic Chemical classification system (ATC codes).<sup>20</sup> This study is part of an opportunistic screening programme for type 2 diabetes in general practice—the Diabscreen study.

### Methods

People were considered to be at risk for undiagnosed type 2 diabetes when having one or more of the following diabetes risk factors, derived from the American Diabetes Association's (ADA) recommendations in screening for type 2 diabetes: a family history of diabetes (parent and/or brother and/or sister with diabetes), hypertension, cardiovascular disease (myocardial infarction, heart failure, atrial fibrillation, stroke, peripheral vascular disease), lipid metabolism disorders, obesity [body mass index (BMI)  $> 27$ ] and a history of gestational diabetes mellitus (GDM).<sup>6</sup> We translated these risk factors into a set of matching ICPC and ATC codes (Table 1). Family history of diabetes and a history of GDM were not consistently coded in the EMR by the GPs and could therefore not be used in this list. At the time of study, no medication was registered to treat obesity and therefore an ATC code was not yet available. Almost all patients were Caucasian, so ethnicity was in this study not used as a risk factor. Having children with a birth weight more than 4000 g was left out as it was not registered. An EMR-derived risk assessment was conducted to identify the patients with ICPC and/or ATC codes mentioned in

TABLE 1 Selection codes matching diabetes risk factors

	Diagnoses (ICPC codes)	Medication (ATC codes)
Hypertension	Elevated blood pressure (K85) Hypertension, complicated (K86) Hypertension, uncomplicated (K87)	Diuretics (C03) Beta blockers (C07) Calcium channel blockers (C08) Angiotensin-converting enzyme inhibitors (C09) Angiotensin II receptor blockers (C09)
Cardiovascular disease	Ischaemic heart disease with angina (K74) Acute myocardial infarction (K75) Ischaemic heart disease without angina (K76) Heart failure (K77) Atrial fibrillation/flutter (K78) Transient cerebral ischaemia (K89) Stroke/cerebrovascular accident (K90) Cerebrovascular disease (K91) Atherosclerosis/peripheral vascular disease (K92)	Anticoagulants (B01) Platelet aggregation inhibitors (B01) Cardiac glycosides (C01) Antiarrhythmics (C01) Nitrates (C01)
Lipid metabolism disorders	Lipid disorder (T93)	Serum lipid reducing agents (C10)
Obesity	Obesity (BMI $> 30$ kg/m <sup>2</sup> ) (T82) Overweight (BMI 27–30 kg/m <sup>2</sup> ) (T83)	NA

Table 1. For this purpose, we had developed software that enabled us to extract ICPC and ATC information of each patient from the practices' EMR and to analyse these data anonymously at the university department.

When ATC but no ICPC codes for cardiovascular disease and hypertension were present, the patients' own GPs were asked to check clinical information in the EMR. In case medication matching these codes had been prescribed for other conditions than cardiovascular disease or hypertension, this was considered not a diabetes risk factor.

The EMR-derived risk status (risk/no risk) was then marked in the EMR with an alert to trigger GPs when patients visited the practice for usual care during the following year. GPs were asked to initiate FPG measurement in at-risk patients. For patients without risk factors, the GPs needed to verify the EMR risk profile by checking and in case of missing data completing risk factors coded in the EMR (hypertension, cardiovascular disease, lipid metabolism disorders and obesity) and checking risk factors not coded in the EMR (family history of diabetes and a history of GDM). In case this additional risk assessment revealed risk, the patient was invited by the GP for FPG measurement similar to patients with an EMR-derived risk. FPG measurement was conducted in the patients' own general practice by their own practice assistant. In all participating practices, a Gluco Touch® (LifeScan Beerse (Belgium; LifeScan Benelux)) plasma calibrated capillary blood glucose metre was used. Prior to the start of the study, all metres were checked and adjusted if necessary by its manufacturer. The practice assistants were trained in using the metres. Patients with a screening FPG >6.0 mmol/l (the cut point for IFG as earlier defined) were followed up for further diagnostic testing according to the earlier described definition. The two-step screening strategy we used is topic of a separate publication.

#### Statistical tests

Statistical analysis was performed using the chi-square test for categorical data and the Student's *t*-test or Kruskal–Wallis test for means where appropriate. Data were analysed by means of the SAS 8.0 software package.

## Results

In the 11 participating practices, 49 229 patients were registered, of whom 14 457 were aged  $\geq 45$  and  $\leq 75$  years. In 876 (6%) patients, diabetes mellitus had already been diagnosed, leaving 13 581 patients for the study (Fig. 1). EMR-derived risk assessment identified 3858 (28%) at-risk patients leaving 9723 (72%) patients without an EMR-derived risk. Characteristics of patients with and without an EMR-derived risk and

patients already diagnosed with diabetes are shown in Table 2. No significant difference in sex was found between the three groups. Patients with known diabetes were older than patients with an EMR-derived risk (mean age 61.4 versus 60.5 years), who in turn were older than those without an EMR-derived risk (mean age 60.5 versus 55.2 years). Younger patients were less likely to be at risk than older patients. We found little interpractice variation. For example, Table 2 shows little interpractice variation concerning mean age.

#### EMR-derived risk

In the course of 1 year, the GPs succeeded in bringing up and discussing screening during consultation in 2270 (59%) of the patients with an EMR-derived risk (Fig. 1). Of them, 2081 (92%) could be included for the study (reasons for exclusion mentioned in Fig. 1). We found a risk factor prevalence of 42.4% for hypertension, 25.6% for cardiovascular disease, 16.5% for lipid metabolism disorders and 30.0% for obesity. All 2081 patients were invited for FPG measurement.

#### At risk after additional risk assessment

In 3363 (35%) of the patients without an EMR-derived risk, screening was discussed during consultation (Fig. 1). Of them, 3196 (95%) could be included for the study. Additional risk assessment showed that in 1643 (51%), at least one risk factor for diabetes was present. In particular, family history of diabetes and obesity was found as a source of missing data (prevalence after checking 51.2% (family history), 59.0% (obesity) and 1.0% (history of GDM)). All 1643 patients at risk after additional risk assessment were then invited for an FPG measurement.

#### FPG measurement

In total, 1886 patients with an EMR-derived risk (91%) and 1449 patients at risk after additional risk assessment (88%) returned for an FPG measurement. See Figure 1 and Table 3. Patients of the first group were more often male (44.2% versus 39.9%) and older (mean age 60.3 versus 55.6 years) than patients of the latter group. In both groups, we found patients with an FPG exceeding the cut point for IFG (13.5% versus 9.6%) and diabetes (5.9% versus 4.1%). Patients with an EMR-derived risk had a slightly higher mean FPG (5.6 versus 5.4 mmol/l).

## Discussion

#### Summary of main findings

Identifying people at risk for undiagnosed type 2 diabetes mellitus using the medical data stored in the GP's EMR could be achieved during daily routine practice, without any further support, e.g. from trial

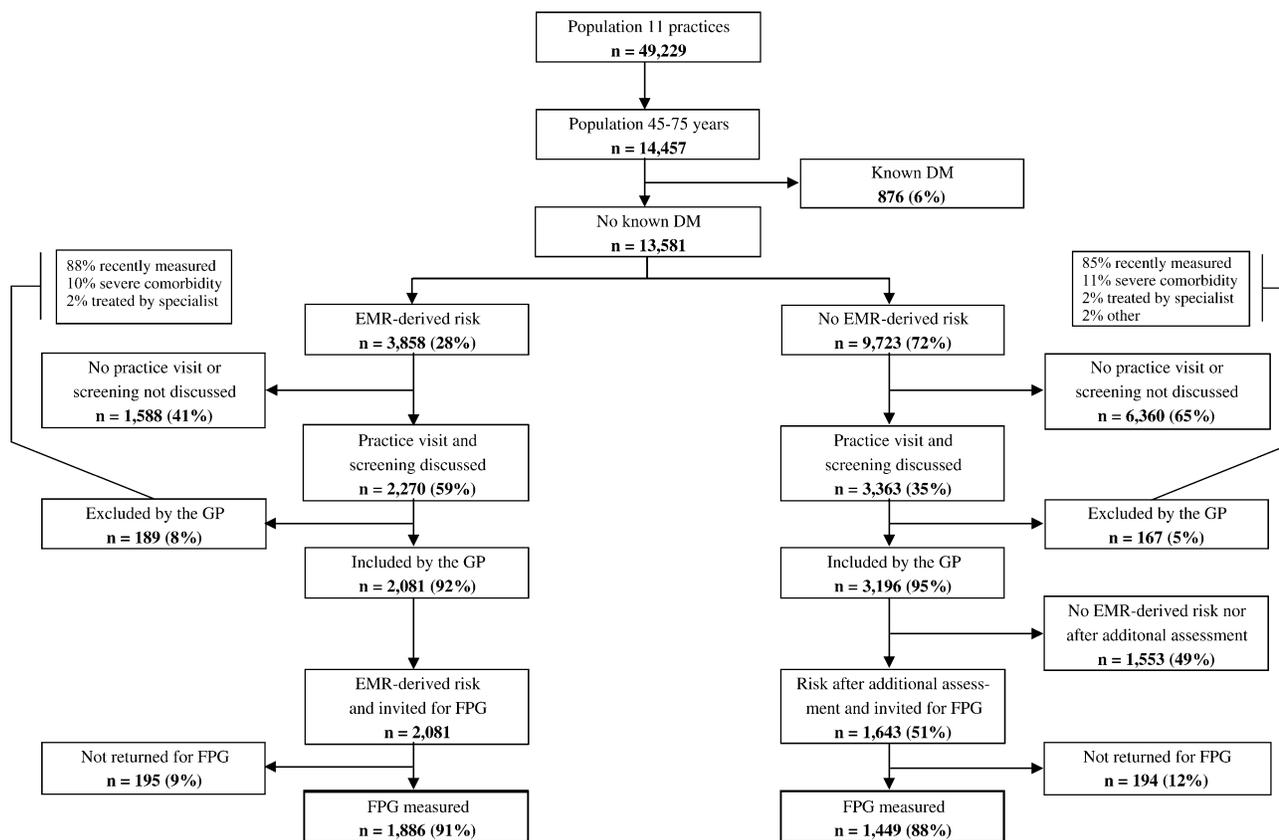


FIGURE 1 Study design

TABLE 2 Baseline characteristics of the study subgroups and known diabetes mellitus

	EMR-derived risk, n = 3858	No EMR-derived risk, n = 9723	Known diabetes mellitus, n = 876	P
Sex (% male)	48.6	49.3	49.2	NS
Mean age, years (95% CI)	60.5 (60.2–60.8)	55.2 (55.0–55.3)	61.4 (60.9–61.9)	<0.0001
Interpractice variation in mean age (years)	57–63	52–57	57–64	—
45–55 years (%)	17.1	79.7	3.2	<0.0001
55–65 years (%)	31.3	61.0	7.7	
65–75 years (%)	44.0	45.2	10.8	

TABLE 3 Sex, mean age and mean FPG and percentage of patients with FPG values exceeding IFG or diabetes cut points (bold printed border in Fig. 1)

	EMR-derived risk and FPG measured, n = 1886	At risk after additional risk assessment and FPG measured, n = 1449	P
Sex (% male)	44.2	39.9	<0.05
Mean age, years (95% CI)	60.3 (59.9–60.6)	55.6 (55.2–56.0)	<0.0001
Mean FPG, mmol/l (95% CI)	5.6 (5.5–5.6)	5.4 (5.4–5.5)	<0.001
FPG 6.1–7.0 mmol/l (%)	13.5	9.6	—
FPG ≥ 7.0 mmol/l (%)	5.9	4.1	—

nurses. Of the population aged ≥45 and ≤75 years and not known with diabetes, 28% had an EMR-derived risk. Of the remaining 72% without an EMR-derived risk, 51% were also found to be at risk after

additional risk assessment during usual care. So, in total, about 65% of the study population were at risk.

The diabetes risk factors hypertension, cardiovascular disease and lipid metabolism disorders were well

registered in the EMR and could easily be retrieved. Hypertension and cardiovascular disease accounted for 62% of the number at risk. In particular, obesity and a family history of diabetes were poorly registered, and were mainly retrieved with additional risk assessment during consultation.

Although patients had to return in a fasting state for the FPG measurement, they were highly willing to do so. Ninety per cent of patients who were invited returned for the measurement.

In both risk groups (EMR-derived and additional risk assessment), we found patients with an FPG value exceeding the cut point of both IFG and diabetes mellitus. Their mean FPG values were about equal. So, EMR-derived and additional risk assessment followed by screening in at-risk patients from both groups seems worthwhile.

#### *Strengths and limitations of the study*

As mentioned earlier, screening should be performed systematically and continuously. This important condition can be fulfilled if one uses the GP's EMR combined with an EMR generated alert, as applied in our study. In order to include possible new at-risk patients, identification and labelling of people at risk for undiagnosed type 2 diabetes should be repeated by running the EMR risk extraction software, for example every 3 years.

In 1 year, the GP succeeded in bringing up and discussing screening during consultation in about 60% of patients with an EMR-derived risk, and in 35% of those without an EMR-derived risk. As this screening method could be used continuously, it is estimated that within a period of 3 years, all patients, especially those at risk, would have visited their GP. This equals the 3-year interval recommended by the ADA in screening for type 2 diabetes. The higher enrolment of patients for screening from the group identified by the EMR might be caused by the fact that, especially in the beginning of the study, GPs were focused on screening within patients with risk factors registered in the EMR. It may also indicate the user-friendliness of such approach. Their risk was clear and discussing screening took less time than additional risk assessment as was done in the second group. Furthermore, the fact that one or more risk factors were recorded in the EMR reflected that co-morbidity was present. Such patients usually visit the GP more often, increasing the possibility to discuss the need for screening.

All participating general practices were related to a university department of general practice, which might have positively influenced adherence to protocol. Nevertheless, they were all standard community practices with a population representative of the Dutch population and a diabetes prevalence equal to that in the Netherlands.<sup>14–16,21</sup> And although we found

that some GPs recruited better than others, overall we found little interpractice variation.

The fact that the Dutch system of primary care provides for universal access and continuity of patient registration enabled us to use the GP's EMR in a continuous screening programme. In countries with a different health care system, our screening approach might therefore be less feasible.

Cross-checking of medication information by the patients' GPs was necessary to improve validation, but was time consuming. When clinical information (ICPC) in the future is more complete, this would not be necessary anymore, as risk then can be reliably assessed merely on the basis of clinical information.

To screen for type 2 diabetes, we used the FPG test rather than the oral glucose tolerance test (OGTT). The OGTT consists of an FPG and 2-hour plasma glucose value and has been considered as the gold standard test in diagnosing diabetes. The FPG test is nevertheless recommended for screening in clinical settings as it is easier and faster to perform, more convenient and acceptable to patients and less expensive.<sup>6,22</sup>

The portable glucose metres we used are user-friendly and readily available in general practice. A potential set back is their variability,<sup>23</sup> and consequent risk of false-positive and false-negative outcomes. This study was directed at the analysis of identification of at-risk patients and reviewed a single testing. The two-step approach, in which patients with glucose levels above the threshold were measured again, did address the problems of false positives. To take care of false-negative results, the procedure must be repeated—something that is beyond the scope of this paper, but feasible in daily care.

#### *Comparison with existing literature*

In literature, several methods for identifying at-risk patients have been described. Smith *et al.*<sup>24</sup> described an opportunistic diabetes screening study performed in general practice using a questionnaire presented to patients while waiting to see their doctor. Participation rate was also high (93%) and 43% had at least two risk factors. If performed continuously or repeated regularly, such a method might help improving quality of the EMR in a continuous screening programme. Greaves *et al.*<sup>25</sup> showed that identifying patients with type 2 diabetes and IFG using data stored in the GP's databases was feasible. Screening of patients with a BMI  $\geq 27$  and aged  $>50$  by fasting glucose identified a substantial prevalence of undetected type 2 diabetes and IFG. But instead of an opportunistic approach, they invited at-risk patients to screening clinics run by trained practice nurses, and other risk factors like family history of diabetes or hypertension were not considered. Nevertheless, the simple screening system they describe—like ours—would promote an efficient use of scarce primary care resources especially when part of a broader cardiovascular disease reducing screening

programme. Other studies concerning screening for type 2 diabetes mainly used questionnaires or risk scores to identify at-risk patients, instead of data already present in the EMR.<sup>10–12</sup>

#### Implications for clinical practice and future research

Although it was feasible to use the EMR in diabetes screening, it was not valuable without additional risk assessment and updating risk information during consultation. Jordan *et al.*<sup>26</sup> concluded in a recent systematic review concerning morbidity coding in the GP's EMR that a high quality of coding can be achieved, although it is not yet clear which methods can encourage and help GPs to improve quality of coding.

Our study showed that 65% of the population consulting the GP were at risk when applying the current ADA recommendations. About the same figure (70%) was found in the US National Health and Nutrition Examination Survey.<sup>1</sup> Although high percentages, we would not recommend screening all middle-aged people, for example, considering the possible consequences of falsely positive test results, the burden of invasive blood testing and costs of screening tests. Our figures showed that 62% of those at risk have either hypertension or cardiovascular disease. The US Preventive Services Task Force recommendations stress that patients at increased risk for cardiovascular disease may benefit most from screening for type 2 diabetes. Diabetes screening should be part of an integrated approach to reduce cardiovascular risk.<sup>5–8</sup> If FPG measuring would be a structural part of care in all patients with cardiovascular morbidity and hypertension, the number of at-risk patients to be screened would be considerably reduced. This emphasizes the importance of a systematic registration of overweight/obesity and family history of diabetes in primary care databases.

#### Conclusion

The GP's EMR is an attractive tool for identifying at-risk patients to initiate screening during usual care. With additional risk assessment during consultation, the GP's EMR was valuable in identifying patients at risk for undiagnosed type 2 diabetes. It was feasible to use this information to initiate opportunistic screening. Patients found to be at risk were highly willing to take part in screening.

Better registration of family history of diabetes and obesity will improve the EMR as a tool for identifying at-risk patients in opportunistic screening in general practice.

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#### Declaration

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Conflicts of interests: None.

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