Identification of the Four Conventional Cardiovascular Disease Risk Factors by Dutch General Practitioners*

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Background: Detecting and managing the four major conventional risk factors, smoking, hypertension, diabetes mellitus, and hypercholesterolemia, is pivotal in the primary and secondary prevention of cardiovascular disease (CVD).

Objective: To assess the preventive activities of general practitioners (GPs) regarding the four conventional risk factors and the associated measurements for cardiovascular risk factors by GPs in relation to the time of the first clinical presence of CVD.

Setting: Large longitudinal general practice research database (the Integrated Primary Care Information database) in the Netherlands from September 1999 to August 2003.

Participants and methods: Patients > 18 year of age with newly diagnosed CVD with a valid history of at least 1 year before and after the first clinical diagnosis of CVD. Details on conventional risk factors and associated measurements for the four cardiovascular risk factors were assessed in relation to the first clinical diagnosis of CVD.

Results: In total, 157,716 patients met the study inclusion criteria. Of the 2,594 patients with newly diagnosed CVD, at least one of the four investigated risk factors was observed in 76% of women and 73% of men. In 40% of cases, no risk factor was recorded before the date of the first CVD diagnosis. In 16% of cases, no associated measurements were present before the first CVD diagnosis.

Conclusion: In daily practice, GPs seem to focus on the secondary prevention of CVD. Intervention strategies that aim to influence GPs’ case finding behavior should focus on increasing the awareness of physicians in performing risk factor-associated measurements in patients who are eligible for the primary prevention of CVD. Further research will have to show the feasibility and effectiveness of such intervention strategies.

Key words: cardiovascular disease; disease management; general practice; primary and secondary prevention; risk factors

Abbreviations: CVD = cardiovascular disease; DCGP = Dutch College of General Practitioners; DSS = decision support system; GP = general practitioner; ICPC = International Classification for Primary Care; IPCI = Integrated Primary Care Information

In the Netherlands, the Dutch College of General Practice (DCGP) develops evidence-based guidelines to assist general practitioners (GPs) in dealing with specific clinical conditions, including recommendations for preventive activities regarding cardiovascular disease (CVD) risk factor management.1–6 These guidelines correspond to internationally developed guidelines7,8 on the prevention of atherosclerotic disease.

Some studies9,10 have emphasized the value of the detection of the following so-called four conventional risk factors, or major risk factors, for CVD: smoking; hypertension; diabetes mellitus; and hypercholesterolemia. Managing these four risk factors plays an important role in the primary and secondary prevent...
tion of CVD. All international guidelines on the prevention of atherosclerotic disease emphasize the need to manage these four major risk factors.

However, a number of researchers have argued that, although authoritative guidelines are available, both the primary and secondary prevention of CVD are suboptimally performed. Little is known about the preventive activities of GPs regarding major risk factors and associated measurements for cardiovascular risk factors in relation to the first clinical presence of CVD. In this study, we assess the preventive activities of GPs regarding the four conventional risk factors and associated measurements for these risk factors in patients who are eligible for primary or secondary prevention of CVD in relation to the time of the first clinical presence of CVD.

**Materials and Methods**

**Setting**

We conducted a retrospective cohort study in the Integrated Primary Care Information (IPCI) database. IPCI is a longitudinal GP research database, which contains information from computer-based patient records of GPs in the Netherlands. Within the Netherlands, patients are registered at a single GP, and the record for each individual patient contains all medical information on that patient. The database contains information on approximately 500,000 patients.

The computer records contain information on patient demographics, symptoms (free text), diagnoses (using the International Classification for Primary Care [ICPC]), episodes, referrals, laboratory values, measurements (eg, BP and cholesterol levels), drug prescriptions with their ICPC-coded indications, and hospitalizations. Summaries of the hospital discharge letters or information from specialists are available in a free text format. To maximize the completeness of the data, GPs who participate in the IPCI project are not allowed to use paper-based records. The system complies with European Union guidelines on the use of medical data for medical research and has been proven valid for epidemiologic research.

**Source Population and CVD Study Cohort**

The source population comprised all subjects who were ≥18 years of age with at least 1 year of valid database history. This means that the patient had been registered for at least 1 year with the GP and that the GP should have participated in the IPCI project for at least 1 year. All subjects were followed up from the latest of the following dates: 1 year of valid history; age 18 years; or start of the study period (September 1999) until death, transferral out of the practice, last data draw down, or end of the study period. Subsequently, we assessed whether the diagnosis in the record and assumed that these conditions were chronic. Information on the risk factor smoking was obtained from the medical records, and information on active smoking as well as nonsmoking was considered.

**Associated measurements** were measurements used to determine the presence of a risk factor. For smoking, the measurement was a question regarding smoking status. For hypertension, the associated measurement was the recording of a BP value. For diabetes, it was the presence of a glucose measurement. For hypercholesterolemia, it was the presence of a serum cholesterol test.

**Preventative Activities of GPs**

We established whether any patient in our CVD cohort had hypertension, hypercholesterolemia, or diabetes, or had smoked. We calculated the prevalences at the end of the observation period. Subsequently, we assessed whether the diagnosis in the patient record of these risk factors occurred before the first recorded diagnosis of clinical atherosclerotic disease, on the same day that clinical atherosclerotic disease was recorded, or after the recording of clinical atherosclerotic disease.

We established whether any patient in our CVD cohort had undergone a cholesterol measurement, a BP measurement, a glucose test, or a noted enquiry on smoking status. We calculated prevalences at the end of the observation period. Subsequently, we assessed whether the measurements were performed before the first recording of a diagnosis of clinical atherosclerotic disease, on the same day that a diagnosis of clinical atherosclerotic disease was recorded, or after the recording of a diagnosis of clinical atherosclerotic disease.

**Definition of the Risk Factors Hypertension, Diabetes Mellitus, Hypercholesterolemia, and Smoking, and Associated Measurements**

We evaluated the so-called modifiable conventional risk factors, or major risk factors, for developing atherosclerotic disease. The guidelines of the DCGP dealing with the primary and secondary prevention of CVD focus on smoking, hypertension, diabetes, and hypercholesterolemia as modifiable risk factors. These guidelines are familiar to and considered authoritative by Dutch GPs. Because our objective was to assess the preventive activities of Dutch GPs in daily practice, we restricted ourselves to these four so-called conventional risk factors. The Dutch guidelines on the prevention of CVD correspond to widely accepted international guidelines on the prevention of CVD (ie, National Cholesterol Education Program's Adult Treatment Panel III guideline, the European guidelines on prevention of coronary heart disease, the guidelines of the American College of Physicians, and the guidelines of the American Heart Association/American College of Cardiology).

Patients were considered to have the risk factor hypertension if they had an ICPC-coded diagnosis of hypertension by the GP or a specialist, or if they had been treated with antihypertensive drugs (eg, thiazides, β-blockers, calcium channel blockers, angiotensin-converting enzyme inhibitors, or angiotensin-II antagonists), while excluding prescriptions for angina pectoris or heart failure. The risk factor diabetes mellitus was identified by an ICPC-coded diagnosis of diabetes by the GP or a specialist, or if treatment was present with insulin or oral antidiabetes agents.

Because the ICPC classification does not distinguish between the various lipid abnormalities, patients were considered to have the risk factor hypercholesterolemia in the presence of a total cholesterol value > 5 mmol/L (1999 DCGP cholesterol guideline). For all conditions, we determined the date of the first presence of the condition in the record and assumed that these conditions were chronic. Information on the risk factor smoking was obtained from the medical records, and information on active smoking as well as nonsmoking was considered.

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Table 1—Associated Measurements and Prevalence of Conventional Risk Factors for CVD 1 Year After First Diagnosis of CVD*

<table>
<thead>
<tr>
<th>Variables</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age,† yr</td>
<td>69.9 (12.5)</td>
<td>65.4 (12.5)</td>
</tr>
<tr>
<td>Measurements and risk factors‡</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking measurement</td>
<td>372 (30.5)</td>
<td>585 (42.6)</td>
</tr>
<tr>
<td>Smoking</td>
<td>293 (24.0)</td>
<td>439 (32.0)</td>
</tr>
<tr>
<td>Glucose measurement</td>
<td>830 (68.0)</td>
<td>805 (58.8)</td>
</tr>
<tr>
<td>Diabetes mellitus§</td>
<td>206 (16.9)</td>
<td>222 (16.2)</td>
</tr>
<tr>
<td>BP measurement§</td>
<td>1,165 (95.5)</td>
<td>1,298 (94.5)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>568 (46.6)</td>
<td>489 (35.6)</td>
</tr>
<tr>
<td>Cholesterol measurement∥</td>
<td>604 (49.5)</td>
<td>737 (53.6)</td>
</tr>
<tr>
<td>Hypercholesterolemia∥</td>
<td>521 (42.7)</td>
<td>560 (40.8)</td>
</tr>
<tr>
<td>Risk factors,‡§</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>297 (24.3)</td>
<td>367 (26.7)</td>
</tr>
<tr>
<td>1</td>
<td>434 (35.6)</td>
<td>479 (34.9)</td>
</tr>
<tr>
<td>2</td>
<td>340 (27.9)</td>
<td>381 (27.7)</td>
</tr>
<tr>
<td>3</td>
<td>122 (10.0)</td>
<td>119 (8.7)</td>
</tr>
<tr>
<td>4</td>
<td>27 (2.2)</td>
<td>25 (2.0)</td>
</tr>
</tbody>
</table>

| Patients                  |       |      |
| Total No.‡                | 1,220 (47.3) | 1,374 (52.7) |
| No. with at least one risk factor§                   | 923 (75.7) | 1,007 (73.3) |

*Risk factor prevalence differences between men and women in CVD subgroups were statistically significant at p < 0.001, unless otherwise noted.
†Values given as mean (SD).
‡Values given as No. (%).
§Risk factor prevalence differences between men and women in CVD subgroups were nonsignificant.
∥Risk factor prevalence differences between men and women in CVD subgroups were statistically significant at p < 0.05.

Statistical Analysis

Categoric data are presented as percentages, and continuous data are presented as the mean (SD). Where applicable, frequencies were analyzed using χ² tests, and continuous variables were analyzed by Mann-Whitney U tests. We used a statistical software package (SPSS, version 11; SPSS Inc; Chicago, IL) for analyzing the data. We considered comparisons significant at p < 0.05.

Results

Of the 157,716 patients who met the inclusion criteria in the source population, a first recorded diagnosis of clinical atherosclerotic disease occurred in 2,594 patients (men, 52.7%; women, 47.3%) during the study period. At the end of the observation period of all patients with newly diagnosed CVD, 40.7% had recorded hypertension, 41.7% had recorded hypercholesterolemia, 16.5% had recorded diabetes mellitus, and 28.2% had been or were smokers. At the end of the observation period, 74.4% of newly diagnosed CVD patients had at least one of the four risk factors. Table 1 shows the number of associated measurements for conventional risk factors and risk factors by gender.

Table 2 shows when individual risk factors were recorded in relation to the first diagnosis of CVD. As shown in Table 2, of the 732 patients who smoked, 62% were known to smoke before the CVD event (the primary prevention window), 19% were recorded as smokers on the same day that CVD was diagnosed, and 19% were recorded as smokers after the first CVD event.

Table 3 shows the cumulative number of risk factors present per patient related to the time of the first CVD diagnosis. The total number of risk factors present per patient increased on or after the date of the first CVD diagnosis. The percentage of patients with no risk factors decreased from 39.7 to 25.6%.

Table 4 shows the first entry of associated measurements for cardiovascular risk calculation related to the time of the first CVD diagnosis. Of all new CVD patients, 957 patients (36.9%) had a measurement for smoking. When measurements were related to the first diagnosis of CVD, 61.8% of measurements were made before the first diagnosis of CVD, 20.2% were made on the same day as the diagnosis, and 18.1% were made after the diagnosis.

Table 5 shows the total number of associated measurements for cardiovascular risk factors per patient related to the time of the first CVD diagnosis. In 15.9% of cases, no measurements were present before the first CVD diagnosis. The percentage of patients with no associated measurements decreased on or after the date of the first CVD diagnosis to 2.4%. Only 18.2% of patients had all associated measurements performed after the first diagnosis of CVD.

Table 1—Associated Measurements and Prevalence of Conventional Risk Factors for CVD 1 Year After First Diagnosis of CVD*
Discussion

Statement of Principal Findings

The aim of this study was to assess the identification of the four conventional risk factors and associated measurements by GPs in patients who were eligible for primary or secondary prevention of CVD. The prevalence of conventional risk factors in our data set corresponds to previously published data on conventional risk factors. All of the 2,594 patients in our study were required to have had at least 1 year of observation before the first CVD event was diagnosed, a time during which they were eligible for primary prevention. In approximately 60% of patients, the risk factor was known before the first diagnosis of CVD; however, only a fraction (10%) of patients had all risk factor measurements before the first diagnosis of CVD. More than half of patients had one or no risk factor measurement before the first diagnosis of CVD. We think that benefit can be gained for patients who are at risk of CVD by screening for risk factors at an earlier stage.

A comparison of when risk factors were present in relation to the date of CVD diagnosis showed that if a risk factor was present, diabetes, hypertension, and hypercholesterolemia were diagnosed in greater numbers (75 to 79%) than smoking (62%) before the first recorded diagnosis of CVD. Of patients who smoked and had hypertension, 19% and 5%, respectively, had the first entry of the risk factor recorded on the date of CVD diagnosis. In 40% of patients, no risk factor was present before the first recorded diagnosis of CVD. However, on the day of CVD diagnosis the number of patients without a risk factor decreased by 6%, and by a further 9% after the CVD diagnosis. We concluded that GPs tend to complete their screening for risk factors when confronted with a new CVD event. In the light of the evidence on reducing the number of CVD events by the early identification and management of risk factors, much is to be gained in influencing GP case-finding behavior in the primary prevention of CVD.

Only BP measurements were recorded in the majority of new CVD patients. Measurements for cholesterol, smoking, and glucose were recorded in 50 to 60% of patients. Physicians frequently recorded measurements on or after the first recorded diagnosis of CVD. This indicates that the confrontation with the CVD event triggered the physician to assess additional risk factors. The DCGP guidelines recommend cholesterol, glucose, BP, and smoking status measurements in all patients with CVD. The fact that only BP measurements were performed in most patients with CVD indicates that GPs show moderate compliance with DCGP guidelines recommendations regarding the secondary prevention of CVD. Of all patients, 15.9% had no risk factor measurements in their records before the first recorded diagnosis of CVD. This could explain why

<table>
<thead>
<tr>
<th>Cumulative Risk Factors Per Patient, No.</th>
<th>Before</th>
<th>On the Same Day</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. (%)</td>
<td>No. (%)</td>
<td>No. (%)</td>
</tr>
<tr>
<td>0</td>
<td>1,031</td>
<td>(39.7)</td>
<td>893</td>
</tr>
<tr>
<td>1</td>
<td>880</td>
<td>(33.9)</td>
<td>951</td>
</tr>
<tr>
<td>2</td>
<td>518</td>
<td>(20.0)</td>
<td>566</td>
</tr>
<tr>
<td>3</td>
<td>139</td>
<td>(5.4)</td>
<td>156</td>
</tr>
<tr>
<td>4</td>
<td>26</td>
<td>(1.0)</td>
<td>28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Patients With Measurement, No.</th>
<th>Before</th>
<th>On the Same Day</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking</td>
<td>957</td>
<td>591</td>
<td>(61.8)</td>
<td>193</td>
</tr>
<tr>
<td>Glucose</td>
<td>1,602</td>
<td>804</td>
<td>(50.2)</td>
<td>525</td>
</tr>
<tr>
<td>BP</td>
<td>2,463</td>
<td>2,059</td>
<td>(83.6)</td>
<td>241</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>1,341</td>
<td>966</td>
<td>(72.0)</td>
<td>29</td>
</tr>
</tbody>
</table>
approximately 40% of all the patients who developed CVD did not have a risk factor present before the first diagnosis of CVD. For primary prevention to be successful, a case finding of risk factors by performing associated measurements is a prerequisite.

**Strengths and Weaknesses of the Study**

Our study benefits from the fact that it was done in an observational database, reflecting the actions of GPs without any intervention by the researchers. GPs are not forced to adhere to study protocols and are free to record what they want. That our study reflects the prevalence found by other groups makes our findings generalizable. As is noted by other authors, a weakness of observational data is that they reflect what GPs chose to capture in their records. This can lead to an underestimate of risk factor identification and measurements in our study. The prevalence of smoking shown in our work is an example of the difficulties in determining the risk status of individuals purely from observational data. The prevalence of smokers in our study was lower compared to the known Dutch prevalence. This can be partly explained by smokers hiding their smoking status from physicians, resulting in a lower than expected smoking prevalence observed in general practice, and GPs not recording normal values (i.e., “non smoker”).

**Strengths and Weaknesses in Relation to Other Studies, Discussing Important Differences in Results**

Khot et al showed that the four conventional risk factors are related to the development of CVD. Our data confirmed this in an observational setting. As mentioned before, our study might have underestimated the number of risk factors in CVD patients (patients with at least one risk factor and CVD, 71 to 75% in our study vs 85 to 90% in the study by Khot et al). This can be explained partly by the difficulty in obtaining complete data in an observational setting. In addition, our data indicate that the records of patients without CVD but with a risk factor present show few associated measurements for cardiovascular risk calculation.

We do not know of other studies that have looked at the time frame of risk factor diagnosis in relation to the first diagnosis of any clinical atherosclerotic disease, nor do we know of any studies that have evaluated when the first associated measurements for risk profile estimation were performed in relation to the first CVD diagnosis. One study in a similar observational setting looking at risk factor management in CVD patients found that the management of these risk factors was poor. A Dutch study showed that in a selected population the underscreening and undertreatment of patients who were eligible for the primary or secondary prevention of CVD was common. The identification of risk factors based on abnormal values of associated measurements for cardiovascular risk calculation precedes the adequate management of risk factors. Our study has shown that insufficient attention to performing associated measurements for cardiovascular risk calculation hampers effective primary prevention.

With respect to the management of the four conventional risk factors, the Dutch guidelines on the prevention of CVD correspond to the international guidelines. The main focus of the guidelines is the early detection and management of these four modifiable risk factors.

Our definition of hypercholesterolemia is a blood cholesterol value > 5 mmol/L. This value is used in the Netherlands to define abnormally high blood cholesterol; in the presence of atherosclerotic disease, it warrants medical treatment. This differs from other international guidelines that emphasize low-density lipoprotein cholesterol testing as an important indicator of abnormal lipid values. However, since all international guidelines emphasize the early detection of abnormal blood lipid values, we do not think that this will make our results less generaliz-
able; we think that the threshold of GPs for early detection is low, irrespective of which blood lipid value is used. In the Netherlands, the DCGP guidelines are viewed as authoritative. However, having authoritative guidelines available does not directly translate into compliance with guidelines. Different strategies of guideline implementation have shown varying degrees of success in improving compliance. A number of studies have shown that an effective strategy for guideline implementation is integrating guideline-based decision support systems (DSSs) into the electronic medical record. The objective of the DSS is to help the practitioners in making guideline-based health-care decisions at the point of care, therefore increasing adherence to guidelines and indirectly, favorably influencing patient outcomes, which is the main aim of evidence-based medicine. The availability of enough relevant data, however, is a prerequisite for any DSS to give proper support.

The majority of GPs in the Netherlands has replaced their traditional paper-based patient records with computer-based patient records, with the physicians entering patient data themselves into the computer during patient encounters. The use of electronic patient records creates new opportunities for the implementation of DSSs; the integration of decision support facilities with electronic patient records provides a natural way to support clinical practice.

Our study shows that, concerning the management of CVD patients, data regarding risk factors are available, but frequently are too “late.” The essence of primary prevention is the identification of risk factors by performing associated measurements in patients at the risk of atherosclerotic disease preceding the event. Giving GPs the tools to identify patients who are eligible for primary prevention might invite them to perform the associated measurements for cardiovascular risk calculation at a much earlier stage. Therefore, unlike previous efforts in DSSs, we argue that the focus should not be on the rules and algorithms that guide these systems, which is contained in evidence-based medicine itself, but rather on increasing the awareness of physicians in obtaining the relevant data. Giving effective feedback on the values in relation to cardiovascular risk might lead to better case findings for patients. Further research will have to show whether this approach is feasible and effective.

**CONCLUSION**

In daily practice, GPs seem to focus on the secondary prevention of CVD. Intervention strategies that aim to influence the case finding behavior of GPs should focus on increasing the awareness of physicians in performing associated measurements in patients who are eligible for the primary prevention of CVD. Further research will have to show the feasibility and effectiveness of such intervention strategies.

ACKNOWLEDGMENT: J.T. van Wyk had full access to all the data in the study, and takes responsibility for the integrity of the data and the accuracy of the data analysis.

**REFERENCES**

36 Dowie R. A review of research in the United Kingdom to evaluate the implementation of clinical guidelines in general practice. Fam Pract 1998; 15:462–470