Objectives: To assess trends in the ordering of cholesterol tests by general practitioners (GPs), and to assess whether the trend in ordering cholesterol tests is consistent with the recommendations in the Dutch guidelines for GPs.

Methods: Analysis of total cholesterol and lipid fraction tests at the Maastricht diagnostic centre, which serves all 85 GPs in the region over the years 1984-1992. Main outcome measures are the number of cholesterol, HDL, LDL and triglyceride tests per year, and the number of cholesterol tests per GP per year. The frequency of cholesterol and lipid fraction testing in 'new patients' (patients presenting for cholesterol testing for the first time) are indicators for adherence to the guidelines on the diagnostic procedure. Data on new patients were available for the years 1989-1992.

Results: There was an overall increase in the total number of cholesterol tests of 173% between 1984 and 1992. There is considerable and stable inter-doctor variation. In new patients, 13.5% of male and 23.0% of female patients did not fulfil the age criteria according to the national guidelines. Repeat testing regarding diagnosis of hypercholesterolaemia as recommended was not performed in 86% of the new patients in 1989, which increased to 94% in 1992. Lipid fraction testing during the first contact with a new patient was not recommended; nevertheless this was done in 38% of the cases in 1989, decreasing to 31% in 1992.

Conclusions: The strong increase in the number of cholesterol tests ordered over the years was accompanied by a large and sustained inter-doctor variation in cholesterol testing. The diagnostic procedure improved slightly for lipid fraction testing, but deteriorated for repeat testing. Improvement on these topics should be sought, to prevent non-rational cholesterol management, which can have a relevant impact on the GP's workload and the resources of the public health system. In pursuing improvement, more attention should be given to effective implementation strategies as well as to the scientific validity of the guidelines.

Introduction

Important developments on the cholesterol issue took place in the 1980s. Results of large cholesterol intervention studies were published, the HMG coenzyme-A reductase inhibitors were introduced, quickly followed by cholesterol guidelines for all Dutch physicians. These developments, and the ongoing debate about the controversial character of cholesterol testing, have raised questions whether a specific trend in GPs' behaviour in ordering cholesterol tests has developed over the last decade.

Specific guidelines for cholesterol management in the general practice setting were published by the Dutch College of GPs in November 1991. Caution with regards to testing characterises these guidelines; selective case finding is only indicated for people aged 18-65 years with an unfavourable coronary risk profile. Diagnosis of hypercholesterolaemia requires the mean of three serum cholesterol tests to be higher than 6.5 mmol/L. Determination of HDL and triglycerides is only indicated if cholesterol-lowering drugs are being considered.

Considerable discrepancy between usual care and the guidelines was reported for Dutch GPs before publication of these guidelines. Simply disseminating cholesterol guidelines does not change daily practice. To promote implementation of new guidelines, more insight into actual behaviour of GPs is required. In many countries a low adherence to cholesterol guidelines by GPs has been reported. A study of possible trends in ordering cholesterol tests will further explore the relation between usual care and the guidelines. It might improve insight into possible external factors that have the power to influence GPs in their cholesterol management, or factors that restrain GPs from working according the guidelines.
The need for information on trends in the ordering of cholesterol tests regarding implementation of the guidelines, together with the controversial character of cholesterol testing over the years, stimulated us to address the following questions:

1. What is the trend in cholesterol and lipid fraction testing in general practice over the period 1984-1992, and which patients are being tested?

2. What is the trend in diagnostic performance in relation to the guidelines for selective case finding, repeat testing and lipid fraction testing?

Methods

Materials

Data were used from the Diagnostic Coordinating Centre Maastricht (DCC). Since 1979, this centre has processed all diagnostic requests of GPs (about 85) in Maastricht and surroundings, covering a region with 187,000 inhabitants. All requests have been stored in a computerised database which provides a good opportunity to describe time trends. Every day these GPs ‘refer’ 125-150 patients to the diagnostic centre; that is, 30,000-35,000 patients yearly. A standardised form is used for diagnostic requests. Only tests requested regularly are printed on the form. Cholesterol and triglycerides are printed, while high density lipoproteins (HDL) and low density lipoproteins (LDL), if requested, have to be written on the form by the GPs themselves. The GPs are also invited to register clinical data on the patient and the reason for the request.

Trends in cholesterol testing

To analyse the volume of test ordering in the course of time, the total number of tests per year for cholesterol, triglycerides, HDL and LDL were extracted from the database. The age and sex characteristics, the reasons for request, as well as the prevalence of hypercholesterolaemia were analysed in all patients. An increase in compliance with the recommendations specified by the Dutch guidelines should subsequently result in a decreased inter-doctor variation in ordering tests. For a trend analysis of inter-doctor variation in ordering cholesterol tests, GPs who had not been participating for the whole year were excluded, still leaving an average of 81 GPs per year for this analysis. Due to skewed distribution, inter-doctor variation was not expressed using means and standard deviations, but using the median (= quartile 2) and quartiles 1 and 3 as indicators for inter-doctor variation. A higher inter-doctor variation, expressed as the distance between quartile 1 (Q1) and quartile 3 (Q3), may just be the consequence of an increasing median. Therefore we corrected the inter-doctor variation for the higher median by calculating the ratio (Q3-Q1)/median.

Trends in diagnostic performance related to the guidelines

According to the national guidelines, cholesterol testing in ‘new patients’ (patients presenting for the first time for cholesterol testing) should be restricted to people aged between 18 and 65 years. Technical advances made it possible to identify the subgroup of new patients for the years 1989-1992. The age and sex distribution of this subgroup, repetition of cholesterol testing, as well as the frequency of triglyceride and HDL testing were analysed. Repeat testing is indicated for patients with a cholesterol value higher than 4.9 mmol/l. Proper repeat testing in 6 weeks’ time was described, in addition to a milder variant: at least one repetition of cholesterol testing in 6 months’ time. As lipid fraction testing is only indicated if cholesterol-lowering drugs are being considered, there should not be an indication for HDL or triglyceride testing in new patients. Instead of taking a sample, full population data of the diagnostic centre could be used; statistical testing was not indicated.

Results

Trends in cholesterol testing

Figure 1 illustrates the trend in the total number of total cholesterol, HDL, LDL and triglyceride tests in the Maastricht region. There was an increase of 219% in cholesterol testing in the period 1984-1990, which stabilised and slightly decreased by 21% in the period 1990-1992, resulting in an overall increase of 173% between 1984-1992. There were no clear trends in triglyceride and HDL-cholesterol testing. Triglyceride testing was performed about three times more often than HDL testing in this period. LDL testing was hardly observed.

The age and sex distribution of the patients tested did not change during the nine-year period. Fifty-three percent of the patients tested were male (mean age 49 years, SD 12.9); the mean age of female patients was 55 years (SD 13.6). The prevalence of hypercholesterolaemia was already high in 1984 (51%), increased to 63% in 1987 and then decreased to 45% in 1992.

The inter-doctor variation for the number of serum cholesterol tests per year is illustrated in Figure 2. There is considerable inter-doctor variation which, in absolute num-
bers, seems to have increased during the nine-year period. However, although the ratio (Q3-Q1)/median remains higher than 1.0 throughout the period, there was no clear increasing or decreasing trend in this ratio.

**Trends in diagnostic performance related to the guidelines**
The age and sex distribution of the new patients (patients presenting for cholesterol testing for the first time) did not change during this four-year period (table 1). On average 55% of the new patients were male, 13.5% of whom were not in the 18-65 age range which is the first criterion for selective case finding. Of the new female patients 23.0% did not fulfil the 18-65 age criterion.

Table 2 illustrates the number of tests used to diagnose hypercholesterolaemia per new patient per year. Proper diagnosis of hypercholesterolaemia was performed in 0.3-0.4% of the new patients. In 1989 13.7% of these patients had at least two cholesterol tests in a period of six months, which decreased to 6.4% of the patients in 1992. Figure 3 illustrates that in 1989, GPs requested HDL and triglyceride testing in 38% of new patients, which is not indicated according to the guidelines. This lipid fraction testing in new patients decreased to 31% in 1992.

**Discussion**
Cholesterol testing by GPs affiliated to the Maastricht diagnostic centre increased by 173% in the period 1984-1992. Inter-doctor variation remained high, even after stabilisation of the increase in testing in 1990, despite publication of Dutch cholesterol guidelines in 1987 and 1991. There is considerable discrepancy between behaviour in ordering cholesterol tests and the guidelines. It is remarkable that, while the evidence on the benefits of cholesterol lowering is less for women than for men, relatively more women (23%) than men (13.5%) of 65 years and older are tested. The poor and even deteriorating performance on repeat testing, which has also been reported elsewhere, is alarming because insufficient repeat testing will impair the precision of diagnoses and the cost-effectiveness of cholesterol testing. Many forces seem to influence GPs' behaviour in ordering cholesterol tests, despite the guidelines. Patients actively requesting cholesterol testing might be one of the important determinants of GPs' behaviour in this field, as one in every five cholesterol tests were initiated by the patient in 1992 (the only year in which valid data could be collected on this aspect).

It is clear that cholesterol testing is taking up far more of GPs' time and attention than 10 years ago. The high prevalence of hypercholesterolaemia gives an indication of the impact of cholesterol testing on the workload of GPs, because established hypercholesterolaemia consequently implies intervening activities.

Due to large amounts of missing clinical data on the test ordering form, no analyses could be done with the patient's coronary risk profile or reasons for request. The strength of the study is the quality of the data source; considering the high number of participating practices and the fact that no apparent shifts have occurred, the population was very stable throughout the years. The participating GPs were comparable to other Dutch GPs, except for the fact that GPs served by the Diagnostic Centre Maastricht have been provided twice yearly with individual feedback on selected behaviour in ordering tests (there has been no structural feedback on cholesterol diagnosis until now). The volume of ordering these selected tests, as well as tests on

**Table 1. Age and sex of new patients, 1989-1992.**
Percentages per total number of new patients per year.

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<tbody>
<tr>
<td>Sex</td>
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<tr>
<td>♂</td>
<td>54</td>
<td>54</td>
<td>55</td>
<td>55</td>
<td>55</td>
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<tr>
<td>♂</td>
<td>46</td>
<td>46</td>
<td>45</td>
<td>45</td>
<td>45</td>
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<tr>
<td>&lt;18 or ≥65 yrs</td>
<td>13</td>
<td>24</td>
<td>13</td>
<td>24</td>
<td>15</td>
</tr>
<tr>
<td>18-65 yrs</td>
<td>24</td>
<td>22</td>
<td>23</td>
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Total new patients: 2616 3131 2439 2131
What are the implications of the results for implementation? Diagnostic centre. The reference diagnostic centre with a mix of several strategies for implementation; e.g. complex programme for improvement that meets prevailing attention and skills. Patient involvement is fundamentally an interpersonal experience, drawing on little performance measurement, as medical practice necessarily mean a low quality of care. Guidelines imply that high-risk groups benefit most by cholesterol screening. The discrepancy between behaviour which high-risk groups benefit most by cholesterol screening needs clarification. It is remarkable that the practice guidelines that have been published internationally are conflicting in several aspects. Cholesterol guidelines seem to be influenced more by moral and economic factors than by evidence of health benefit. The method of developing the guidelines determines the scientific validity of the guidelines. Recently, a method for grading health care recommendations was proposed in which both scientific validity and cost-effectiveness considerations (number of patients that need to be treated) are combined.

We conclude that the strong increase in the number of cholesterol tests ordered over the years was not accompanied by a decrease in inter-doctor variation and improvement in quality of testing. We recommend that improvement on these topics should be sought, to prevent non-rational cholesterol management. In pursuing improvement, more attention should be given to effective implementation strategies as well as to the scientific validity of the guidelines.

Table 2. Trend in number of tests for diagnosis of hypercholesterolaemia in new patients, 1989-1992. Column percentages of the group of new patients with cholesterol higher than 4.9 mmol/l per year.

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<tbody>
<tr>
<td>One test only</td>
<td>86.3</td>
<td>86.3</td>
<td>89.0</td>
<td>93.6</td>
</tr>
<tr>
<td>&gt; 1 test in 6 months</td>
<td>13.3</td>
<td>13.4</td>
<td>10.7</td>
<td>6.1</td>
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<tr>
<td>Repeat testing according to the guidelines*</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
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</table>

New patients with cholesterol > 4.9 mmol/l | 2249 | 2591 | 1941 | 1667 |

* Diagnosis of hypercholesterolaemia requires the mean of three serum cholesterol tests, determined in a period of six weeks, to be higher than 6.5 mmol/l. If the first test-value is lower than 5.0 mmol/l, or the mean of two values is lower than 6.5 mmol/l, there is no indication for (further) repetition of testing.

which no feedback was given, decreased compared to a reference diagnostic centre. The reference diagnostic centre showed a much steeper increase in cholesterol testing of 377% over the years 1984-1990, with a comparable stabilisation in 1990. Therefore the trend found at the Maastricht diagnostic centre seems to be an underestimation of the trends found in other Dutch diagnostic centres.

What are the implications of the results for implementation of the guidelines? The discrepancy between behaviour in ordering cholesterol tests and the guidelines does not necessarily mean a low quality of care. Guidelines imply little performance measurement, as medical practice necessarily mean a low quality of care. Physicians cite barriers for adherence to the guidelines such as: limitations in time, reimbursement, motivation and skills. Based on the barriers to change, a complex programme for improvement that meets prevailing administrative and reimbursement policies, is needed with a mix of several strategies for implementation; e.g. individualised feedback on GPs' behaviour in ordering tests, in combination with strategies such as an adjustment of the forms for ordering tests, peer discussions in small groups, or outreach visits from academically-qualified representatives or local opinion leaders.

To increase the likelihood of the guidelines changing medical practice, the feasibility of the guidelines should be discussed at local level.

In addition to a discussion on the implementation of the guidelines, the results prompt a critical look at the scientific validity of the guidelines. The ongoing debate about which high-risk groups benefit most by cholesterol screening needs clarification. It is remarkable that the practice guidelines that have been published internationally are conflicting in several aspects. Cholesterol guidelines seem to be influenced more by moral and economic factors than by evidence of health benefit. The method of developing the guidelines determines the scientific validity of the guidelines. Recently, a method for grading health care recommendations was proposed in which both scientific validity and cost-effectiveness considerations (number of patients that need to be treated) are combined.

We conclude that the strong increase in the number of cholesterol tests ordered over the years was not accompanied by a decrease in inter-doctor variation and improvement in quality of testing. We recommend that improvement on these topics should be sought, to prevent non-rational cholesterol management. In pursuing improvement, more attention should be given to effective implementation strategies as well as to the scientific validity of the guidelines.

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