An audit of lipid screening and management in patients undergoing diagnostic cardiac catheterization


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The aim of this study was to audit the management of hyperlipidaemia in a cohort of 206 consecutive patients, with known or suspected coronary artery disease, referred for diagnostic coronary angiography. The association of lipid subfraction values with the presence and extent of coronary artery disease was explored to identify the indices of greatest potential value to the hospital cardiologist, in the management of secondary prevention.

Patients were questioned about previous lipid tests performed, advice received and treatment prescribed. Referral letters and hospital notes were reviewed to identify documentation of lipid results and treatment strategies. De novo fasting lipid estimations were obtained on 205 subjects at the time of catheterization.

In only 46/206 (22%) cases was some form of lipid result recorded in the existing hospital notes or referral documentation. No patient was aware of the levels of the high or low density lipoprotein cholesterol subfractions (HDL, LDL) nor were these specifically recorded, or the subject of clinical comment, in any of the referral documentation.

Patients who knew their total cholesterol (in mmol L\(^{-1}\)) result either as a value or as a 'high' or 'normal' categorization proved accurate witnesses.

In keeping with other angiographic studies, we found that low values of HDL and high TC/HDL ratios were significantly associated with both disease presence and extent. Total cholesterol, calculated LDL and triglyceride levels had no such association.

In the group as a whole and despite current therapy, 169/206 (82%) patients had a total cholesterol >5.2 and 163/206 (79%) a TC/HDL ratio >5. Only 22 (11%) patients were on drug therapy with a further 43 (21%) practising dietary modification. In the vast majority of subjects receiving some form of lipid intervention, target lipid levels had not been achieved.

This study identifies the need for more intensive management of hyperlipidaemia in patients with coronary artery disease. Knowledge of HDL levels may be of value in guiding lipid secondary prevention management in the patient population evaluated at an angiographic centre.

Key Words: Lipids, coronary disease, secondary prevention, audit, coronary angiography.

Introduction

The value of lipid lowering therapy for the primary prevention of coronary artery disease is still the subject of debate and the focus of ongoing clinical trials.\(^1\) In contrast, the recently published Scandinavian Simvastatin Survival Study (4S)\(^2\) seems to confirm the benefits of secondary prevention intervention in patients with established coronary artery disease. Supported by earlier work\(^3\) there is now general agreement that patients with higher levels of cardiovascular risk have much to gain from lipid lowering interventions\(^4\).

A number of studies have highlighted that this important risk factor is often neglected by physicians, even in patients undergoing coronary artery bypass grafting\(^5,6\). The aim of this study was to audit the management of hyperlipidaemia in patients referred for diagnostic coronary angiography.

Current screening guidelines\(^7,8\) stress the importance of measuring total cholesterol or its low density lipoprotein subfraction (LDL), neglecting a...
routine role for estimation of the high density lipoprotein subfraction (HDL). The European Societies' Task Force on CHD Prevention identify that an HDL level of below 1 mmol.L⁻¹ in men and 1·1 mmol.L⁻¹ in women increases the level of risk and suggest that the ratio of TC/HDL may be a useful index, particularly in persons whose total cholesterol is in the range 5·6-5 mmol.L⁻¹. A ratio of >5 is believed to indicate increased risk⁹.

Previous angiographic studies have reported that low HDL levels were significantly and independently associated with the presence and severity of angiographically assessed coronary artery disease. No such association for total cholesterol or calculated LDL was described⁹.¹⁰ We have examined this issue in an attempt to define the indices of greatest potential value to the hospital cardiologist, in the management of secondary prevention.

Patients
A cohort of 206 consecutive patients undergoing day case diagnostic cardiac catheterization for known or suspected, stable coronary artery disease were prospectively identified. Patients with coexisting valvular disease, cardiomyopathy of non-ischaemic aetiology or other non coronary heart disease were excluded. The recruitment period was in Spring 1994, before the results of the 4S study were published. All patients had been evaluated in a primary and secondary care environment prior to this admission. The cohort included 91 (44%) patients who had previously sustained a documented myocardial infarction, 27 (13%) with previous bypass grafting and 18 (9%) with prior percutaneous coronary intervention. Fifty patients (24%) had been catheterized before. The majority were male (151/206 = 73%) and a total of 31 patients (15%) had been catheterized before. The majority were male (151/206 = 73%) and a total of 31 patients (15%) were found to have angiographically normal coronary arteries. The mean ages (SD) of the cohort were; all cases = 58(10), males = 60(10), females = 53(9).

Methods
Lipid measurements
All patients were fasted overnight for the catheterization procedure and venous blood was drawn, from the antecubital fossa, prior to proceeding to the catheterization laboratory. Samples were analysed in the Clinical Biochemistry Laboratories at The Royal Brompton Hospital using a Beckman CX-7 machine. This determines the level of total cholesterol and HDL by a fully enzymatic method using cholesterol oxidase. The HDL subfraction is separated by phosphotungstate precipitation. Triglyceride levels are obtained using a fully enzymatic end point methodology.

Patient history and documentation review
Patients were questioned about previous lipid tests performed, advice given and lipid lowering treatment prescribed. Referral letters and hospital notes were reviewed to identify documentation of lipid results and treatment strategies. Treatment options were categorized and defined as follows: (a) no treatment prescribed or advice given at any time; (b) dietary modification recommended for the purpose of lipid modification; (c) drug therapy with prescription of any lipid lowering agent at any time.

Individual risk factors were recorded to describe (a) smoking exposure in pack years, (b) history of arterial hypertension, (c) history of diabetes mellitus of any type and (d) family history of ischaemic heart disease in a first degree relative, presenting before the age of 65 years.

Coronary angiography
Routine diagnostic angiography with selective injection of the coronary arteries was performed in all patients. In accordance with normal practice, primary operators reported the results of catheterization using a locally designed, graphical user interface database system. Operators were blinded to the results of the lipid estimation. Two indices of disease severity were established: (a) the number of major epicardial vessels demonstrating at least one stenosis reducing luminal diameter by greater than 50% compared to the adjacent reference vessel; (range 0–3); (b) the total number of lesions of any severity) recorded; (range 0–11).

Independent analyses using these parameters yielded near identical results and the results are presented in terms of vessel involvement.

Statistical analysis
Analysis was performed with the computer statistical analysis software, SPSS for Windows, Release 6·0, 1993. For patients with and without angiographic evidence of coronary disease the means of normally distributed continuous variables were compared with the t-test for independent samples. Stepwise multiple logistic regression was used to assess the independence of each of the variables to the presence of disease. Analysis of variance (simple factorial ANOVA) and linear regression were used to explore relationships of lipid levels to both indices of disease severity and a multiple linear regression model was established to test the independence of variables.

Results
Documentation of previous lipid screening
In the study group, in only 46/206 (22%) cases was some form of lipid result recorded in the existing hospital
Audit of lipid screening

Figure 1  Diagrammatic representation of prior lipid interventions. The 137 patients with some evidence of a previous lipid estimation are grouped by the patient's perception of their total cholesterol (TC) level into 'No idea', 'OK', 'High' or knowledge of an exact 'Value'. Each group is further divided by lipid intervention recommended. Mean TC values recorded in the study sample are shown for each group. Tx = treatment.

notes or referral documentation. The levels of high or low density lipoprotein cholesterol subfractions (HDL, LDL) were not specifically recorded, or the subject of clinical comment, in any of the referral documentation.

Patient reporting of lipid status

Many patients are aware of their lipid status and can help to communicate this information between health care professionals. Some 91/206 (44%) patients, with no documentary evidence of screening, were able to report the previous performance of lipid analysis. No patient was aware of the levels of high or low density lipoprotein cholesterol subfractions.

Figure 1 summarizes the patient reporting of lipid status. Patients with documentary evidence, or recollection, of lipid screening (137/206 — 66%) were grouped on the basis of the perception of their total cholesterol level into: (a) those who did not know the result — 33/137 (24%); (b) those who knew a precise value for total cholesterol — 55/237 (40%); (c) those who knew their total cholesterol value had been declared 'high' — 33/137 (24%); (d) those who knew their total cholesterol value had been declared 'OK' — 16/137 (12%).

Some 55 patients were able to report their total cholesterol result as a value. Of this group, 26 had received dietary advice and nine were taking lipid lowering agents. In the remaining 20 patients, the reported total cholesterol values correlated well with the fasting samples drawn for this study (mean total cholesterol = 60 (0-9), t=0-6, P<0-01). Knowledge of an 'OK' total cholesterol level was declared by 16 patients. We found their mean total cholesterol to be 5-32 (0-87) with values in the range 4-1-6-9.

Lipid subfractions and coronary disease

The mean values of the lipid subfractions observed in patients with normal and diseased coronaries are shown in Table 1. These data show that levels of total cholesterol and calculated LDL are almost identical in the two groups and that statistically significant differences exist only for HDL (P<0-03) and for the TC/HDL ratio (P=0-02). A stepwise multiple logistic regression was performed entering patient age, sex, principal risk factors, and all of the lipid values as independent variables. This revealed that the presence of disease was strongly and independently related to only low HDL concentrations (P<0-01), advancing age (P=0-01) and male sex (P<0-01).

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Table 1 Mean age, and lipid levels for all cases and then subdivided for those with any coronary disease (D) and those with normal coronaries (N). The mean values have been compared with a t-test for independent samples. A P value of 0·05 is assumed to indicate statistical significance

<table>
<thead>
<tr>
<th></th>
<th>All cases n=206</th>
<th>Diseased (D) n=175</th>
<th>Normal (N) n=31</th>
<th>D v N P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age in years (SD)</td>
<td>58 (10)</td>
<td>60 (10)</td>
<td>53 (9)</td>
<td>&lt;0·001</td>
</tr>
<tr>
<td>Male n (%)</td>
<td>151 (73%)</td>
<td>137 (78%)</td>
<td>14 (45%)</td>
<td>&lt;0·001</td>
</tr>
<tr>
<td>Mean total cholesterol mmol. 1−1 (SD)</td>
<td>6.27 (1.05)</td>
<td>6.27 (1.06)</td>
<td>6.25 (0.98)</td>
<td>ns</td>
</tr>
<tr>
<td>Mean HDL cholesterol mmol. 1−1 (SD)</td>
<td>1·03 (0.34)</td>
<td>1·0 (0.31)</td>
<td>1·19 (0.44)</td>
<td>0·03</td>
</tr>
<tr>
<td>Mean LDL cholesterol mmol. 1−1 (SD)</td>
<td>4·11 (1.56)</td>
<td>4·10 (1.6)</td>
<td>4·16 (1.4)</td>
<td>ns</td>
</tr>
<tr>
<td>Mean total cholesterol/HDL ratio (SD)</td>
<td>6·66 (2·16)</td>
<td>6·82 (2·17)</td>
<td>5·81 (1·92)</td>
<td>0·02</td>
</tr>
<tr>
<td>Mean triglyceride mmol. 1−1 (SD)</td>
<td>1·91 (1·41)</td>
<td>1·97 (1·49)</td>
<td>1·57 (0·8)</td>
<td>ns</td>
</tr>
</tbody>
</table>

HDL = high density lipoprotein cholesterol; LDL = low density lipoprotein cholesterol; SD = standard deviation.

Table 2 Mean lipid levels for cases subdivided by the number of major epicardial vessels demonstrating disease. The mean values have been compared with a one way ANOVA. A P value of 0·05 is assumed to indicate statistical significance

<table>
<thead>
<tr>
<th></th>
<th>Normal n=35</th>
<th>1 vess dis n=33</th>
<th>2 vess dis n=37</th>
<th>3 vess dis n=101</th>
<th>ANOVA P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age in years (SD)</td>
<td>52 (9)</td>
<td>57 (10)</td>
<td>60 (8)</td>
<td>61 (9)</td>
<td>&lt;0·001</td>
</tr>
<tr>
<td>Mean ejection fraction % (SD)</td>
<td>70 (8)</td>
<td>63 (12)</td>
<td>60 (13)</td>
<td>59 (13)</td>
<td>0·001</td>
</tr>
<tr>
<td>Mean total cholesterol mmol. 1−1 (SD)</td>
<td>6.25 (1.0)</td>
<td>6.16 (0.9)</td>
<td>6.18 (1.0)</td>
<td>6.33 (1.1)</td>
<td>ns</td>
</tr>
<tr>
<td>Mean HDL cholesterol mmol. 1−1 (SD)</td>
<td>1·19 (0.4)</td>
<td>1·13 (0.4)</td>
<td>0·96 (0.3)</td>
<td>0·97 (0.3)</td>
<td>0·02</td>
</tr>
<tr>
<td>Mean LDL cholesterol mmol. 1−1 (SD)</td>
<td>4·2 (1.4)</td>
<td>4·1 (1.3)</td>
<td>4·3 (1.3)</td>
<td>4·0 (1.8)</td>
<td>ns</td>
</tr>
<tr>
<td>Mean total cholesterol/HDL ratio (SD)</td>
<td>5·8 (1·8)</td>
<td>5·9 (1·6)</td>
<td>6·9 (1·9)</td>
<td>7·1 (2·4)</td>
<td>&lt;0·01</td>
</tr>
<tr>
<td>Mean triglyceride mmol. 1−1 (SD)</td>
<td>1·6 (0·8)</td>
<td>1·5 (0·7)</td>
<td>2·2 (1·5)</td>
<td>2·1 (1·6)</td>
<td>ns</td>
</tr>
</tbody>
</table>

HDL = high density lipoprotein cholesterol; LDL = low density lipoprotein cholesterol; SD = standard deviation.

With regard to the extent of coronary artery disease, Table 2 shows the mean values of individual lipid subfractions found in patients with normal coronaries and one-, two- and three-vessel disease. Analysis of variance identifies a significance association between more extensive vessel involvement and (a) an elevated TC/HDL ratio (P<0·01) and (b) reduced HDL levels (P=0·02). A multiple linear regression model was established as above and revealed independent relationships for only advancing age (P<0·0001), male sex (P<0·0001), and the TC/HDL ratio (P=0·02). When patients taking lipid lowering medication are excluded from the regression model these findings are unchanged but the presence of diabetes mellitus emerges as an independent predictor of disease extent (P=0·03).

Numbers treated

Analysis of the blood samples drawn for this study reveals that some 82% of the total cohort had a total cholesterol >5·2 and 79% had a TC/HDL ratio >5·0. This is despite the effect of current treatment regimes. Dietary modification was the most commonly prescribed lipid intervention, recommended to 43 (21%) patients. Drug therapy had been prescribed at any stage to only 22 (11%) patients. Of the remaining 141 untreated patients, 112 (79%) had a total cholesterol >5·2 and 111 (79%) patients had a TC/HDL ratio of >5·0.

Discussion and conclusions

Lipid values in treated patients

The lipid profiles of the untreated patients and those treated with diet and drugs are shown in Table 3. In the drug-treated group (n=22) the mean total cholesterol was 6·3 (0·9) with only two patients <5·3. The mean TC/HDL ratio was 6·5 (1·7) and only six patients had values <5·1. Treatment effect was even less marked in the diet treated group (n=43). Here the mean total cholesterol was 6·9 (0·9) with only three patients <5·3. The mean TC/HDL ratio was 7·2 (2·2) and only six patients had values <5·1.

Study limitations

Our study has a number of limitations. Conclusions have been based on a single lipid estimation. Whilst this mirrors common screening practice, it ignores the small
but real biological and laboratory variation observed with this test\(^2\). The effects of anti-anginal medication on lipid levels have been ignored. Furthermore, in the consideration of disease presence and extent, the study did not control for any reduction in lipid levels induced by targeted dietary modification. Only 43 patients claimed to have received advice about lipid lowering diets at some stage of their management. Compliance and food history were not formally assessed but it is likely that only a small proportion of this group will have been able to achieve the reductions in lipid levels of up to 15% that have been reported with dietary modification\(^8\).

### Secondary prevention management

This study supports the findings of earlier work\(^{15,6}\), suggesting inadequate management of lipids for the secondary prevention of coronary artery disease. All patients had been reviewed in primary and secondary centres before referral for this catheterization procedure. Over 24% had prior angiographic demonstration of coronary artery disease and 22% had undergone some revascularization procedure. Despite this level of medical attention, lipid levels were recorded in only 22% of patient’s referral documentation and it is likely that lipid estimation had never been performed in a third of all patients.

The management of hyperlipidaemia usually involves shared care between primary, secondary and tertiary care physicians. The accurate and timely communication of a patient’s lipid status and therapeutic history is important in this setting. Health care professionals frequently have to rely on lipid results communicated to them by the patient. We conclude that patients can accurately communicate their lipid status, whether expressed as an absolute value or as a categorization.

For the 33 patients who reported the performance of lipid estimation but did not know any form of result it was interesting to note that the clinical documentation also did not record these data. Despite a group mean total cholesterol of 6.25 no patient had been recommended any form of lipid intervention. In comparison, of the 33 patients declaring a ‘High’ result only four patients were untreated. This suggests that patient ignorance may, to some extent, be related to poor clinical follow-up of the results of lipid estimation.

The guidelines issued by the British European Hyperlipidaemia Associations\(^{7,8}\), suggest that, for this type of patient, total cholesterol levels should be maintained <5.2. Application of this standard reveals that too few patients are recommended a lipid lowering intervention. Furthermore, in patients receiving treatment, optimum lipid levels are rarely achieved. Even for those taking drug treatment, more than 90% demonstrated unacceptably high values. There is a clear need to monitor treatment effect and intensify therapy as appropriate.

### The measurement of lipid subfractions

A direct relation between coronary artery disease events and increased levels of total cholesterol and LDL cholesterol is well established. A strong and inverse relation between the HDL cholesterol concentration and coronary artery disease is also recognised\(^{14}\). Although elevated serum triglyceride levels have been similarly implicated, studies that include HDL measurement usually show no independent relationship for triglyceride concentration and coronary artery disease\(^{15}\).

Kannel studied the Framingham cohort and found that, at 12–14 years of follow-up, the TC/HDL ratio was the best predictor of coronary artery disease both in the group as a whole and in those patients with elevated or normal lipid level\(^{16}\). Previous angiographic studies from America have reported that low HDL levels significantly and independently predicted the presence and severity of angiographically assessed coronary artery disease. No such association for total cholesterol was described\(^{9,10}\). In a separate study of female patients the TC/HDL ratio was found to be the best independent predictor of disease presence and the lone predictor of disease severity\(^{17}\). Our findings echo these conclusions.

It would appear that there may be merit in measuring the concentrations of the HDL cholesterol subfraction, particularly in the highly selected population undergoing diagnostic angiography. In this study no patient was aware of the levels of high or low density lipoprotein cholesterol subfractions (HDL, LDL) nor

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**Table 3 Characteristics of patients subdivided by treatment group**

<table>
<thead>
<tr>
<th></th>
<th>No Tx (n=141)</th>
<th>Diet Tx (n=43)</th>
<th>Drug Tx (n=22)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean age in years (SD)</strong></td>
<td>52 (9)</td>
<td>57 (10)</td>
<td>60 (8)</td>
</tr>
<tr>
<td><strong>Mean total cholesterol mmol. (1^{-1}) (SD)</strong></td>
<td>6.25 (1.0)</td>
<td>6.16 (0.9)</td>
<td>6.18 (1.0)</td>
</tr>
<tr>
<td><strong>Mean HDL cholesterol mmol. (1^{-1}) (SD)</strong></td>
<td>1.19 (0.4)</td>
<td>1.13 (0.4)</td>
<td>0.96 (0.3)</td>
</tr>
<tr>
<td><strong>Mean total cholesterol/HDL ratio (SD)</strong></td>
<td>5.8 (1.8)</td>
<td>5.9 (1.6)</td>
<td>6.9 (1.9)</td>
</tr>
<tr>
<td><strong>No of patients with TC &gt;5.2 (%)</strong></td>
<td>112 (79%)</td>
<td>40 (93%)</td>
<td>20 (91%)</td>
</tr>
<tr>
<td><strong>No of patients with TC/HDL ratio &gt;5.0 (%)</strong></td>
<td>111 (79%)</td>
<td>37 (86%)</td>
<td>16 (73%)</td>
</tr>
</tbody>
</table>

HDL = high density lipoprotein cholesterol; SD = standard deviation; TC = total cholesterol; Diet Tx = diet treatment; Drug Tx = drug treatment; No Tx = no treatment.

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were these specifically recorded, or the subject of clinical comment in any of the referral documentation. In the study blood samples a TC/HDL ratio >5 was observed in 12% patients with a TC <5.2 mmol. l⁻¹ and in 40% of patients with a TC <6.5. These patients demonstrate an adverse lipid profile that will not be detected with a screening programme based solely on the estimation of total cholesterol levels.

Any screening recommendations must represent a balance between practicality and increasing complexity for greater precision. Total cholesterol is probably the most commonly used parameter and the recent 4S study recruited patients by this criterion alone. The findings of angiographic studies relate to a small and highly selected population and cannot be generalized outside the specialist centre. Nevertheless it is likely that increasing attention will be paid to lipid secondary prevention and for patients reviewed at a tertiary centre knowledge of HDL levels and the TC/HDL ratio may provide a better index for the initiation and monitoring of lipid lowering intervention.

References