ORIGINAL ARTICLE

Statins are less effective in common daily practice among patients with hypercholesterolemia: the REALITY-PHARMO study*

Wim G. Goettsch[1], Donald D. Yin[2], Evo Alemao[2], Olaf H. Klungel[3], Anton F. Stalenhoef[4] and Ron M. C. Herings[1,3]

[1]PHARMO Institute, Utrecht, The Netherlands

[2]Merck & Co, Whitehouse Station, New Jersey, USA

[3]Department of Pharmaco-epidemiology and Pharmacotherapy, Utrecht Institute for Pharmaceutical Sciences, Utrecht University, The Netherlands

[4]Department of General Internal Medicine, University Medical Centre, Nijmegen, The Netherlands

Address for correspondence: Dr W. Goettsch, Research Manager, PHARMO Institute, P.O. Box 85222, 3508 AE Utrecht, The Netherlands. Tel.: +31-(0)30-2345620; Fax: +31-(0)30-2345568; email: wim.goettsch@pharmo.nl

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SUMMARY

Background: To study the use and effectiveness of lipid-lowering drugs with respect to lowering of cholesterol levels in routine daily practice

Methods: 20 392 patients for whom lipid levels records were available between January 1991 and December 2001 were included in this retrospective population based cohort study. From this group of patients 1899 patients started treatment during the study period and had at least one baseline cholesterol measurement during the six months prior to the initiation of lipid lowering drugs and at least one cholesterol measurement after initiation. A patient was defined to be 'at goal' if the patient had a total cholesterol less than 5.0 mmol/L.

Results: Our results indicate that only 30.2% of all treated patients achieved goal in the first year of treatment. After the introduction of new guidelines in 1998, recommending more aggressive treatment, the goal attainment percentage rose from 22.4% of those patients treated before 1998 to 42.3% for those in whom treatment was initiated after 1998.

Conclusion: The percentage of patients achieving guideline recommended goal is low in real-life even in patients treated with high dose statins.

Introduction

Results from randomized clinical trials with lipid lowering drugs, mainly statins, have shown that lowering cholesterol reduces the risk of coronary heart disease in those with and without manifest cardiovascular disease[1-6]. Hence, many health authorities and professional societies have developed guidelines that recommend the use of lipid lowering drugs, in particular statins, to prevent coronary heart diseases in patients with hypercholesterolemia[7,8]. There is however, some information indicating that lipid lowering drug treatment in (Dutch) daily practice is not always consistent with these guidelines[9]. Studies in other countries have also demonstrated that control of cholesterol in real-life clinical practice is suboptimal[10-12]. Although high-dose statins may lower cholesterol up to a maximum of 50% in clinical trial settings[13,14], most patients in daily practice do not receive high-dose statins. Because of safety concerns with higher doses, physicians and patients have not widely accepted the use of higher doses[15]. The withdrawal of cerivastatin in August 2001 following reports of more than 50 deaths associated with rhabdomyolysis has further highlighted the safety concerns of high dose statins[16]. Furthermore, it has been demonstrated that approximately 40% of all patients stop treatment with statins within a year for unknown reasons[17-19]. Hence, it is to be expected that in common, routine daily practice a substantial percentage of patients, more than in clinical trials, will not reach their total cholesterol goal.

In this manuscript we report the results of a retrospective follow-up study of patients with known cholesterol levels and who have, or have not, been treated with statins in order to investigate which factors predispose patients to be treated with lipid lowering drugs, goal attainment rates, and identify factors that are associated with goal attainment i.e. total cholesterol levels less than 5.0 mmol/L.

Methods

Data Setting

Patient level data (pharmacy, hospital, laboratory) were obtained for all residents living in the period of 1991–2001 in a centrally located city with 97 500 inhabitants as one of 24 cities in the PHARMO system, described in more detail elsewhere[20-22]. Data included patient cholesterol measurements (total cholesterol (TC), low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, triglycerides),

hospital discharge records, and all dispensed drugs in the period 1991–2001. The cholesterol measurements were obtained from a regional clinical laboratory, which processes all requests for clinical laboratory procedures issued by all GPs, medical specialists or others. Cholesterol tests were performed on blood samples which were processed by robots, routinely validated and reported to those who requested the tests. Most commonly, the first request included a total serum cholesterol test, and when elevated (higher than 5 mmol/L) a test for LDL cholesterol, HDL cholesterol and triglycerides was performed. In total, more than 2.5 million test results were stored each year. Information on drug exposure was obtained as drug dispensing data from all pharmacies that used a single, central patient register linked to the clinical laboratory data. Data included type of drug, dose, dispensing date, dose regimen, duration of use and prescriber. By linkage of both patient-level pharmacy and laboratory files, the use of statins, other lipid lowering drugs and all other co-medication was integrated with unbiased results from clinical chemistry tests. For these patients we also had access to all hospital discharge records if admitted during the study period. These records included diagnostic information from ICD-9-CM and procedures during their stay in the hospital.

Ethical approval was not relevant because data were not retraceable after entering the PHARMO database. Researchers only had information on the gender and age of the patient. All other identifying information was deleted after the linkage with the hospital records from the National Medical Registry. This approach was approved by the Dutch Data Protection Authority.

Patient Selection

Patients with at least one total cholesterol (TC) measurement were included in the initial study group. Within the initial study group two subgroups were identified. The first subgroup (non-treated) included patients for which at least one clinical test for TC, LDL cholesterol, HDL cholesterol or triglycerides was recorded but did not result in any prescription of a lipid lowering drug. The second (treated) group included patients who started with lipid lowering treatment between January 1, 1991 and December 31, 2001 and had a cholesterol measurement within 180 days before the onset of lipid lowering treatment and, at least, a second measurement after treatment onset. Patients who started lipid lowering treatment before January 1, 1991, started lipid lowering treatment without a cholesterol measurement before onset of treatment, or started lipid lowering treatment and had no measurements after treatment onset were excluded.

Study design

For the comparison of the basic characteristics of the treated and non-treated patients a case-control design was used. Cases were treated patients and controls were non-treated patients.

A cohort design was used to study the characteristics of those who attained and those who did not attain cholesterol goal in the subgroup of treated patients. Follow-up started at the first day of lipid lowering treatment. The TC measurement prior to the first lipid lowering drug was defined as the baseline TC measurement. When more than one measurement was available during the 180 days prior to first lipid lowering drug the last cholesterol measurement prior to the first lipid lowering drug was selected as baseline measurement.

Exposure Definition

For each prescription of a lipid lowering drug, the legend duration of use was calculated by dividing the number of units dispensed by the number of units to be taken per day. All prescriptions were subsequently converted into uninterrupted episodes of consecutive use of lipid lowering drugs[19]. The end date of an episode is set at the end of the last prescription plus half the duration of use of the last prescription. It can be assumed that patients, on average, stop their medication sometime after the end of the last dispensing. Consequently, if patients interrupt therapy, they may have more than one treatment episode and multiple cholesterol level measurements in their life. Changing between different statins and/or doses within an episode was allowed.

All lipid lowering drugs, were grouped into 'equipotencies' according to Maron and Illingworth[23,24], combining the dose and type of statins into a single potency score. An increase of the score by one point indicated a doubling of the effective dose (see Appendix 1). Non-statins were grouped into the lowest equipotency (1)[25,26]. Hence, adjustment of dose or switching of lipid lowering drug therapy was based on a change of potency category. For patients who changed potency levels, the magnitude of the adjustment was also coded. For example, when a patient switched from fluvastatin 20 mg (equi-potency = 2) to atorvastatin 10 mg (equi-potency = 4), the magnitude was coded as two; switching from atorvastatin 20 mg (equi-potency = 5) to simvastatin 10 mg (equi-potency = 3) was coded as minus two.

Potential Factors Influencing Lipid-lowering Treatment and Goal Attainment

A literature search in Medline was performed to identify factors that may influence initiation of treatment or goal attainment. The following factors were included in the analysis of therapy start and/or goal attainment: (a) patients who were ever hospitalized before the date of the baseline cholesterol measurement with the following ICD-9-CM codes 410–414 (ischemic heart disease), 430–438 (cerebrovascular accidents) and 443.9 (peripheral heart disease) or the procedure codes 883.6 and 883.7 (percutaneous vascular interventions) were classified as having a history of manifest cardiovascular disease[27–29]; (b) patients were defined as diabetic if they had antidiabetic medication (ATC code A10) dispensed in the year prior to the date of baseline cholesterol measurement or if they were admitted to the hospital for diabetes complications (ICD-9 250, 251)[27–29]; (c) patients were labeled as hypertensive if they had prescriptions for antihypertensive medication in the year prior to the date of baseline cholesterol measurement (ATC codes C02 (antihypertensives), C03 (without C03C) (diuretics), C07 (beta blocking agents), C08 (calcium channel blockers,) C09 (ACE inhibitors and angiotensin II antagonists)); (d) concomitant drug use data in the year prior to the date of baseline cholesterol measurement were used to construct a measure for chronic disease status (CDS) according to Von Korff[30]; (e) patients were labeled as therapy persistent if they used lipid lowering drugs without any interruptions during total patient follow-up.

Outcome Definition

Cholesterol goals were defined according to the Dutch National Organization for Quality Assurance (CBO) guidelines[7]. A patient was defined to be 'at goal' if they had a total cholesterol less than 5.0 mmol/L. If a patient had a TC level of 5.0 mmol/L or higher, the patient was classified as 'not at goal'. Those patients who lowered their cholesterol during the study period from 'not at goal' to 'at goal' were defined as those who attained cholesterol goals.

Analysis

The association between treatment with lipid lowering drugs and potential factors influencing treatment in the case control study was determined using logistic regression (PROC LOGISTIC SAS V8.2).

To calculate the percentage of patients attaining the treatment goal, three-month intervals, after the first lipid lowering drug, were used to assess goal attainment. Because the maximal reduction of plasma total cholesterol by statins is normally achieved after approximately 6 weeks of therapy and is maintained thereafter during continuous statin use, the first period of three months started 1.5 months after the beginning of the

Table 1. *Basic characteristics of hypercholesterolemia patients receiving lipid-lowering drug treatment (cases) and comparable patients who did not receive lipid lowering treatment (controls) (1991–2001)*

Characteristics		Cases		Controls		Adjusted[5]	
		No	%	No	%	OR[1]	95%CI[1]
Gender							
	Male	1100	57.9	9212	50.1	1.0	Ref
	Female	799	42.1	9181	49.9	0.6	0.5–0.6
Age							
	≤ 39	81	4.3	4915	26.7	1.0	Ref
	40–49	255	13.4	3624	19.7	2.1	1.6–2.8
	50–59	508	26.8	3199	17.4	3.1	2.4–4.1
	60–69	627	33.0	2948	16.0	3.2	2.5–4.2
	≥ 70	428	22.5	3707	20.2	1.3	1.0–1.8
Year of start of treatment							
	1991–1997	1152	60.7	11 409	62.0	1.0	Ref
	1998–2001	747	39.3	6984	38.0	1.0	0.9–1.1
Total cholesterol at baseline							
	< 5 mmol/L	48	2.5	5274	28.7	1.0	Ref
	5–6 mmol/L	236	12.4	6348	34.5	3.6	2.6–4.9
	6–7 mmol/L	602	31.7	4738	25.8	12.5	9.2–17.0
	7–8 mmol/L	597	31.4	1628	8.9	48.6	35.4–66.6
	> 8 mmol/L	416	21.9	405	2.2	170	121–238
History of manifest cardiovascular disease[2]		588	31.0	1217	6.6	4.5	3.9–5.3
Diabetes[2]		263	13.9	1127	6.1	2.2	1.8–2.7
Hypertension[2]		1105	58.2	4452	24.8	2.2	1.9–2.5
Chronic disease score[3]		1204	63.4	4856	9.2	2.8	2.4–3.2
Polyfarmacy[4]		375	19.8	1687	9.2	0.8	0.7–0.9

[1]Odds ratio and 95% Cumulative Interval
[2]Compared to persons with no history of manifest cardiovascular disease or diabetes or hypertension (Ref)
[3]Chronic disease score of more than 1
[4]Five or more different prescriptions at the date of baseline measurement of laboratory test
[5]All variables included in one model

lipid lowering treatment and ended 3 months afterwards. Subsequently, the next three months interval started 4.5 months after start of therapy and ended three months afterwards. If a patient did not have a total cholesterol measurement during the 3-month interval, the last known cholesterol measurement was used. The percentage of patients achieving goal was calculated for the different lipid lowering drug potencies (see Appendix 1).

Because loss to follow up (maximum follow-up time was five years; minimal follow-up time was three months) was frequent in this type of routine laboratory data, leading to a significant percentage of missing values, we used a Generalized Estimating Equations (GEE) model for binary data with a logit link function in order to assess the association between goal attainment and potential factors affecting goal attainment. GEE was used to control for the intra-patient-correlation between different treatment episodes and correlation of repeated measurements of cholesterol within one treatment episode. In order to control for the missing values it was important to use a robust longitudinal statistical analysis method. It has been indicated that GEE with and without several methods of imputations of the missing values will deliver similar point estimates only with small differences in the estimated standard errors[31].

The SAS GEE macro used was based on data of Stokes, Davis and Koch[32] and was fit using the REPEATED statement in the GENMOD procedure of SAS V8.2.

Results

From the total group of 21 347 patients with at least 1 TC measurement, 1055 patients were excluded because they started lipid lowering treatment before January 1, 1991, started lipid lowering treatment without a cholesterol measurement before onset of treatment, or started lipid lowering treatment and had no measurements after

Table 2. *Crude and adjusted odds ratios for the most relevant determinants for goal attainments (TC below 5). An increased OR indicates that this factor increased goal attainment*

	N[&]	AG[$]	Potency mean + (95%CI)	Crude OR	Crude 95% CI	Adjusted* OR	Adjusted* 95% CI
Gender							
men	1100	36.9	2.9 (2.9–3.0)	1.0	Ref	1.0	Ref
women	799	21.0	3.0 (3.0–3.1)	0.49	0.42–0.57	0.60	0.50–0.72
Year of start of therapy							
1991–1997	1152	22.4	2.6 (2.6–2.7)	1.0	Ref	1.0	Ref
1998–2001	747	42.3	3.5 (3.4–3.5)	2.32	1.99–2.71	1.66	1.38–2.00
History of CVD							
no	1311	24.3	2.9 (2.9–3.0)	1.0	Ref	1.0	Ref
yes	588	43.5	3.0 (3.0–3.1)	2.43	2.08–2.84	1.29	1.08–1.54
Type of prescriber at baseline							
cardiologist	1047	39.4	3.0 (3.0–3.1)	1.0	Ref	1.0	Ref
general practitioner	852	19.0	2.9 (2.8–3.0)	0.38	0.32–0.44	0.78	0.64–0.94
Potency at baseline							
non-statins	201	14.4	–	0.73	0.53–1.00	0.75	0.54–1.03
2	324	19.8	–	1.0	Ref	1.0	Ref
3	771	29.8	–	1.45	1.15–1.81	1.79	1.43–2.24
≥ 4	603	41.6	–	2.46	1.95–3.11	3.31	2.54–4.31
Total cholesterol at baseline							
< 5 mmol/L	48	54.2	3.3 (3.0–3.7)	1.0	Ref	1.0	Ref
5–6 mmol/L	236	61.9	2.9 (2.7–3.0)	1.13	0.68–1.83	1.64	0.92–2.90
6–7 mmol/L	602	39.5	3.0 (2.9–3.1)	0.50	0.32–0.80	0.71	0.41–1.22
7–8 mmol/L	597	20.4	2.9 (2.8–3.0)	0.18	0.11–0.28	0.30	0.17–0.52
> 8 mmol/L	416	10.1	3.0 (2.9–3.1)	0.11	0.07–0.17	0.17	0.10–0.30
Persistence							
no	1204	22.8	2.8 (2.8–2.9)	1.0	Ref	1.0	Ref
during follow-up (yes)	695	43.2	3.2 (3.2–3.3)	2.26	1.93–2.64	1.45	1.22–1.73

[&]Number of patients
*Adjusted for all variables such as age, magnitude of switch of potency during follow-up, diabetes and hypertension
[$]Goal attainment at one year
[#]CVD = patients with a history of manifest cardiovascular disease

treatment onset. Of the other 20 292 patients, 1899 (treated) were dispensed lipid lowering drugs and had a cholesterol measurement within 180 days before the onset of lipid lowering treatment and, at least, a second measurement after treatment onset. 18 393 patients (untreated) had at least one cholesterol measurement but did not have any prescription of a lipid lowering drug. The characteristics of the treated and untreated groups are summarized in Table 1. Given similar baseline cholesterol levels, men and elderly patients were more likely to be treated than women and younger patients. The likelihood of receiving lipid lowering therapy was positively related to the baseline TC level. Relative risks (RR) increased from 3.6 (95%CI 2.6–4.9) for patients with TC between 5 and 6 mmol/L to 170 (95%CI 121–238) for patients with a TC above 8 mmol/L. Lipid lowering therapy was also more likely to be dispensed for patients who had a history of manifest cardiovascular disease (RR = 4.5, 95%CI 3.9–5.3), diabetes (RR = 2.2, 95%CI 1.8–2.7) and patients who are on anti-hypertensive drugs

(RR = 2.2, 95%CI 1.9–2.5) The likelihood of lipid lowering treatment decreased significantly with increase in polypharmacy, indicating that patients who already had five or more different prescriptions had a lower chance of receiving lipid lowering treatment.

Goal attainment was estimated in 1899 patients after one year of follow-up in relation to the initial lipid lowering drug (Table 2). Overall, only about 30.2% of patients receiving lipid lowering therapy achieved goal after one year. Average goal attainment during the follow-up period of at most three years for the different three months periods remained quite constant between 28.3 and 32.4%. Goal attainment at the first year was higher among patients who started their first lipid lowering therapy in the period of 1998 to 2001 (42.1%) compared to those who started their first lipid lowering therapy between 1991 and 1997 (22.3%). When lipid lowering therapy was started by a cardiologist, goal attainment was twice as high (39.4%) compared to treatment started by a general practitioner (19%). Goal

attainment was also higher in patients who had a history of manifest cardiovascular disease (43.5%). Although goal attainment increased from 19.8% for patients starting at a low potency level to 41.6% for patients who started at the highest potency level (Table 2), a majority of patients did not achieve goal after one year of therapy.

Results from the General Estimating Equations model indicated that most of the determinants, presented in Table 2, were independently related to goal attainment. After correction for other factors, women still had a lower goal attainment than men and patients who started their therapy under the supervision of a cardiologist had a higher goal attainment than those supervised by a general practitioner. There were however, some indications that the effect of year of therapy on goal attainment could be partly explained by the higher potency used at baseline in the more recent years.

Discussion

Our study shows that despite treatment with lipid lowering drugs, only 30.2% of all treated patients attained goal after 1 year of therapy. Given the observational nature of the study data and the fact that physicians might have stopped ordering lab values when cholesterol levels were in agreement with their own criteria rather than attaining goal, or when the patients did not show up, it is possible that patients with more cholesterol measurements might have been in nature different from those with fewer cholesterol measurements.

Since we based goal attainment on the last measurement carried forward there may be an overestimation of goal attainment rates. However, such a bias is preferable to that in which we would have underestimated goal attainment rates. The percentage goal attainment varied from 19.8% to 41.7%, depending on dose and the dispensed statin. Among those who failed to attain goals, less than half (45.1%) had a dose adjustment.

Over the course of this study new guidelines for cholesterol management were introduced in 1998. We observed that the percentage of patients achieving goal rose from 22.3% to 42.1% under the new guidelines. We must take into account that before the introduction of the CBO guidelines it was common to use the (more conservative) 1990 guideline of the Health Council of the Netherlands[33]. In this guideline an endpoint of lipid lowering treatment was less clearly defined and only patients with a TC higher than 8.0 mmol/L or patients with risk factors such as coronary atherosclerotic disease, a family anamnesis of coronary atherosclerotic disease, familial hypercholesterolemia, diabetes or hypertension with TC higher than 6.5 mmol/L were indicated to be treated with lipid lowering drugs.

Women, given the same baseline cholesterol and corrected for differences in cardiovascular co-morbidity were not only under-treated but also a larger percentage of women did not attain goal (men vs women: 36.9% and 21% respectively). While the percentage of men in most clinical trials is substantially higher than 50%[34], these trials do not indicate that women have a lower response to lipid lowering drugs than men[35]. However, others also revealed a significant difference in goal attainment between men (61.9%) and women (43.2%)[11]. Our data indicate that women had a higher TC level at baseline (mean 7.4; 95%CI 7.3–7.4) than men (mean 6.9; 95%CI 6.8–7.0) which (partly) explains the differences in goal attainment.

Another interesting difference in goal attainment is related to the type of prescriber. The relatively high goal attainment in patients treated by a cardiologist may be explained by factors like the type of patient treated (history of CHD) and higher persistence of use due to more intense supervision of patients. Our data do not indicate that cardiologists generally prescribe higher doses of statins. However, the Dutch current guidelines for lipid lowering therapy for GPs[36] advocate a less aggressive approach compared to the Dutch National CBO guidelines[7,37]; CBO guidelines recommend doubling of the statin dose if goal is not attained with the initial dose of statin and also the addition of a resin in a third step. In contrast, Dutch GP guidelines only recommend doubling the statin dose when therapy fails after an initial treatment with simvastatin 20 mg but do not recommend doubling dose after an initial treatment with pravastatin 40 mg.

Goal attainment increased in the more recent years (1998–2001) partly as a result of an increased potency used for therapy and possible changes in the guidelines for treatment of hypercholesterolemia as mentioned previously. Additionally, there were also indications that the mean baseline TC level of patients on therapy decreased over the years: the mean TC level at baseline between 1991 and 1997 was 7.2 mmol/L (95%CI 7.2–7.3 mmol/L) whereas in the period from 1998 onwards the TC level was 6.9 mmol/L (95%CI 6.8–7.0 mmol/L). The increased goal attainment may also be accounted for by the increased persistence of treatment in the more recent years (51.5%), whereas persistence was low in patients starting between 1991 and 1997 (26.9%).

Although our data suggest that goal attainment increased over the years, the overall percentage of patients achieving goal is still very low. Even in more recent years, more than 50% of patients receiving lipid lowering treatment did not attain goal. Our study demonstrated even lower goal attainment percentages (42% after one year from 1998 onwards) than a recently published UK study in which 57% of the patients on statins attained goal[11]. There are multiple reasons for the

low goal attainment in daily practice, especially when compared to clinical trials. The authors from the UK study suggested that the pre-treatment cholesterol levels in daily practice were higher than in most clinical trials, so getting below TC of 5 mmol/L was unrealistic. Interestingly, goal attainment percentages in our investigation were even lower than in the UK study but the mean levels of total cholesterol at baseline (6.9 mmol/L) in our investigation were also lower than the mean pre-treatment levels recorded in the UK study (7.2 mmol/L). The data from our study may suggest other reasons for the low goal attainment percentages. Firstly, our data indicate that only a relatively small percentage of patients will attain goal on the basis of the initial therapy, in spite of the relative increase in use of aggressive therapies in recent years[11]. Secondly, only 443 (35%) of the 1274 patients who did not achieve goal with initial therapy increased their potency level of lipid lowering therapy (data not shown). Thirdly, when therapy was adjusted, only 128 of these 443 patients (29%) attained goal (data not shown). This may indicate that the most common strategies for therapy adjustment, such as doubling of the statin dose, may not be sufficient to attain goal. Overall, we conclude that, in order to increase goal attainment in daily practice, a more forceful treatment alternative and a better supervision of the patients is essential[38,39].

This UK study was based on GP data and also indicated that a large percentage of patients did not achieve goal even when the guidelines were strictly followed[11]. Our results are consistent with these findings.

Patients with high CHD risk such as those with a history of cardiovascular disease, major cardiovascular risk factors such as high blood pressure and diabetes, and a high total TC level at baseline were more likely to receive lipid lowering drugs. Approximately 30% of our patients received lipid lowering therapy for secondary prevention (history of manifest cardiovascular disease). This is also in line with data from the Dutch College of Health Insurances indicating that the ratio of primary/secondary prevention in lipid lowering drug users is 2:1[40]. Our data also provide some information on under- and over-treatment of these patients. Overall 433 (6.2%) patients from the untreated group from 1998 onwards had a TC level higher than 8 mmol/L or a history of manifest cardiovascular disease and a TC level higher than 5 mmol/L. These patients should have been treated under the guidelines of the Dutch College of Health Insurances[7]. In contrast, 146 (19.5%) patients from the treated group from 1998 onwards had a TC level lower than 5 mmol/L or were older than 70 (male) or 75 (female). These patients should not have been treated under the CBO guidelines[7]. These results indicate that under- and over-treatment exist in real-life practice. Decision support of treating physicians as suggested by others may improve the performance compared with guidelines[41].

Our results on goal attainment can be compared with data from other countries, but differences in guidelines must be taken into account. We defined goal attainment according to the guidelines of the Dutch CBO (TC below 5 mmol/L). Other guidelines such as the National Cholesterol Education Program (NCEP) use LDL levels to set goals. In the NCEP guidelines there is also a difference between the LDL goal for high-risk patients (secondary prevention) that is lower than the LDL goal for primary prevention patients[8]. Overall, the effects of the various determinants on goal attainment as were demonstrated in this study were comparable using CBO or NCEP guidelines (data not shown).

Conclusion

Results from this study indicate that the selection of patients and the initial lipid lowering treatment for this cohort are in line with the national guidelines in the Netherlands. However, the percent of patients achieving the recommended cholesterol goal according to established treatment guidelines is rather low in daily clinical practice. Our data also seem to suggest a positive relationship between goal attainment and the potency of lipid lowering therapy. However, the overall percentage of patients achieving goal remained low. Even among patients who received high dose of statins, a majority of patients did not achieve goal. These results suggest that more effective lipid lowering treatments and better patient management are needed.

Acknowledgments

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Appendix 1

Potency conversion table for different statins. Individual statins, dosages, stratified by efficacy (reduction in total cholesterol) and adapted from Maron and Illingworth[23–26].

Potency (2^x)	Statin (mg/day)					Non-statins	Reduction in total cholesterol
	Atorvastatin	Simvastatin	Pravastatin	Fluvastatin	Cerivastatin	Fibrates, resins, acipimox	
1	–	–	–	–	–	+	6–15%
2 (low)	–	–	10	20	0.1	–	15–17%
3 (medium)	–	10	20	40	0.2	–	22%
4 (high)	10	20	40	80	0.4	–	27%
5	20	40	80	–	–	–	32%
6	40	80	–	–	–	–	37%
7	80	–	–	–	–	–	42%