Abstract

Background: The CArdiac MARker Guidelines Uptake in Europe Study (CAMARGUE) initiated by the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM) aims to survey the current use of evidence-based guidelines for dyslipidemia testing in Europe.

Methods: In 2019 a web-based questionnaire was distributed via EFLM National Societies to clinical laboratories in Europe. Questions covered pre-analytics, analytical methods, measurement units, flagging of decision thresholds, and use of decision-enhancing comments.

Results: Returns were obtained from 452 laboratories from 28 countries. Most laboratories always use nonfasting blood samples for lipid assays (66%). Lipid profiles are reported in mmol/L by 59% of the laboratories, mainly from 14 countries promoting the use of SI units. Important differences in flagging of decision thresholds were observed, with less than half of the laboratories applying the guideline-recommended LDL cholesterol threshold. Only 17% of the laboratories add an alert comment when familial hypercholesterolemia is suspected and 23% when risk of pancreatitis from hypertriglyceridemia is high.

Conclusions: There are marked differences among laboratories in Europe in terms of pre-analytical, analytical, and post-analytical lipid management that could have an important clinical impact. This relates to different availability of assays or different laboratory practices on reporting and flagging of lipid profiles.

Highlights

- Overall adherence to guidelines and harmonization of lipid profiles across European laboratories is unsatisfactory.
- Two-thirds of laboratories routinely use nonfasting blood samples for lipid measurements.
- Less than half of the laboratories use guideline-recommended risk thresholds for flagging elevated LDL cholesterol and low HDL cholesterol concentrations.
- Less than half of the laboratories automatically calculate and report non-HDL cholesterol.
- Less than one-fourth of laboratories apply alerts to values of triglycerides at risk of pancreatitis or to LDL cholesterol values to encourage screening for familial hypercholesterolemia (FH).

How well do laboratories adhere to recommended guidelines for dyslipidaemia management in Europe?
The CArdiac MARker Guideline Uptake in Europe (CAMARGUE) Study.

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Keywords

Guidelines; Lipids; Pre-analytical; Analytical; Post-analytical

1. Introduction

The CAMARGUE (CArdiac MARker Guideline Uptake in Europe) study aims to monitor the implementation of guidelines encompassing the use of biomarker tests for cardiovascular risk assessment and diagnosis [1-3]. A CAMARGUE follow-up study was initiated in 2019, which additionally included a survey on the adaptation of recommendations for dyslipidaemia testing in European laboratories.

The poor implementation of guidelines in clinical practice is of major concern, despite significant progress in primary and secondary prevention of cardiovascular disease (CVD) over the past decades. Alarming results emerged from the EUROASPIRE V (European Action on Secondary and Primary Prevention by Intervention to Reduce Events) surveys of CVD prevention management of patients in European countries [4,5]. These surveys have shown that high-risk individuals in secondary as well as primary prevention programs are still not being managed effectively, with many patients undertreated and not achieving the LDL cholesterol (LDLC) targets recommended in the European guidelines [4,5]. Similarly to the EUROASPIRE V Study, a systematic review of European observational studies confirmed poor LDLC goal attainment in patients at high-risk (<50% attainment) and very high-risk (<20% attainment) estimated by Systematic Coronary Risk Evaluation (SCORE) [6].

Multidisciplinary efforts can effectively enhance implementation of health strategies and measures to promote cardiovascular health and prevent CVD. Clinical laboratories play an important role in assisting the physicians to fulfil their role in this endeavour, by producing laboratory measures that are used to drive preventive interventions. In order to achieve these objectives, there is an urgent need for updating and harmonizing lipid profiles produced by laboratories throughout Europe in concordance with the guidelines. To that end, the Task Group on Cardiac Markers (TG-CM) of the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM) created this part of the CAMARGUE survey to monitor, but also to indirectly encourage the harmonization of laboratory tests used for dyslipidaemia-related CVD prevention strategies.

2. Methods

A web-based questionnaire was developed by the EFLM TG-CM. The questions focused on recommendations of the EAS (European Atherosclerosis Society), ESC (European Society of Cardiology), and EFLM published in 2016 [7-9]. This questionnaire included 14 multiple-choice questions regarding dyslipidaemia testing and covered topics of the pre-analytical phase, analytical methods and manufacturers of the assays used, measurement units, decision threshold, and the use of decision-enhancing comments (Table 1). Except for the analytical methods, the first answer option to each question was the EFLM- and EAS-

recommended choice in order to make the questionnaire easier to fill in if guidelines were followed and also for educational purposes. There was also the option for other choices, where the data could be answered as free text or comment.

Details of how the survey was performed were published previously by the TG-CM [1,2]. In brief, the questionnaire was implemented using a web-based survey system consisting of a HTML-AJAX interface and a CGI program storing the results in XML files on a database server. Results from raw data XML files were tabulated and the numbers of different answers for each question were calculated for further analysis using Microsoft Excel. The questionnaire was compiled with experience from the two previous questionnaires but also incorporated some modifications to allow more in-depth analysis of certain responses.

A link to the online questionnaire was sent on March 1, 2019 to EFLM National Societies from 40 European member countries. The questionnaire was open till August 31, 2019. A total of 452 European laboratories from 28 countries responded (Table 2). Of these, 253 were accredited according to the ISO15189 standard for medical laboratories (n=223) or more general standards ISO9001 for quality systems (n=12) and ISO17025 for testing laboratories (n=18). More than half of the laboratories were located in central or university hospitals (60%), the others were local/private hospital laboratories (37%) or private laboratories (3%).

3. Results

3.1. Pre-analytical phase

Two-thirds of the participating laboratories (66%) routinely perform non-fasting lipid tests. In some countries (Ireland, Macedonia, the Netherlands, and Norway), 100% of the responding laboratories reported adoption of this operational simplification in routine practice. The remaining laboratories are still using fasting blood samples routinely (27%) or advise a fasting sample in certain circumstances (7%), such as high triglyceride (TG) concentration or the presence of pancreatitis.

3.2. Measurement units

Système International (SI) units (mmol/L) are used by 59% of the laboratories to report lipid measurements, and conventional mg/dL is used by all others, with the exception of one laboratory in Germany which stated using g/L. In Austria, Belgium, Italy, Portugal, Spain and Turkey all lipid profiles in this survey are reported in mg/dL, whereas in 14 countries all participating laboratories declared utilizing mmol/L (Table 2). In Germany, there was a mixture of both units. A remarkable geographical distinction of reported measurement units was seen between former East (mmol/L) and West Germany (mg/dL).

3.3. Analytical phase

Less than half of the laboratories (44%) routinely calculate LDLC with the Friedewald equation without offering an alternate LDLC measurement by direct assay when the calculation is invalid (in samples with TG >4.5 mmol/L) [10]. Thirty-four percent of the laboratories always measure LDLC with a direct method in all patient samples, and 22% of the laboratories use either calculated or directly measured LDLC depending on conditions (Table 3). When directly measured, 53% of the laboratories stated that they use a method from Roche Diagnostics, followed by Siemens Healthineers (16%), Beckman Coulter (15%), Abbott Diagnostics (12%) Ortho Clinical Diagnostics (2%) or another, not specified, LDLC assay (2%). Similar proportions of manufacturers were found for HDL cholesterol (HDLC) assays, probably because HDLC is usually measured on the same automated analyser in the laboratory.

Less than half of the laboratories (47%) automatically calculate and report non-HDL cholesterol (non-HDLC) as total cholesterol minus HDLC [10]. In 7% of laboratories non-HDLC is calculated only when requested by the physician, and 46% of the laboratories do not calculate non-HDLC.

3.4. Post-analytical phase: flagging

The guideline-recommended low risk threshold of 3 mmol/L (115 mg/dL) is used for flagging elevated LDLC concentrations in 42% of laboratories, while 7% systematically display all three SCORE risk-stratified LDLC targets of lipid-lowering treatment for moderate, high, or very high risk patients on the laboratory reports [7,8]. An unacceptably large variety of other LDLC thresholds was observed in 49% of the laboratories, with 100 mg/dL, 130 mg/dL, and 160 mg/dL as the most frequently used within a broad range of reported thresholds in mg/dL and mmol/L. Flagging of a reference interval was observed in 2% of the laboratories.

A similarly wide variety of different risk thresholds, with a minority of laboratories using reference intervals, was observed for flagging of total cholesterol and non-HDLC (Table 4). Less than half of the laboratories (43%) use the recommended threshold of 5 mmol/L (190 mg/dL) for total cholesterol [9,10]. Additionally, in 41% of all laboratories this threshold of 190 in mg/dL was rounded to 200 mg/dL for setting the flags.

For flagging elevated TG, 55% of the laboratories use the fasting threshold of 1.7 mmol/L (150 mg/dL) and 12% implemented the non-fasting threshold of 2 mmol/L (175 mg/dL) [9,10]. In 10% of the laboratories, flagging of elevated TG is still only applied if above 2.3 mmol/L (200 mg/dL), the value often used before the EAS-redefinition of hypertriglyceridemia in 2014 [11].

For flagging a low HDLC, 19% of laboratories use the recommended thresholds of 1 mmol/L (40 mg/dL) in men and 1.2 mmol/L (45 mg/dL) for women, and 22% implement the 1 mmol/L threshold for both genders [9,10]. In the majority of laboratories, a wide spectrum of different thresholds for flagging a low HDLC value was observed ranging from 0.8 mmol/L (30 mg/dL) to 1.7 mmol/L (65 mg/dL).

Less than one third (30%) of participating laboratories measure lipoprotein(a) (Lp(a)). A minority (2%) uses the EAS-recommended 80th population percentile of 50 mg/dL as risk threshold for elevated Lp(a) [8], and the 75th percentile (30 mg/dL) is flagged by 13% of the laboratories. Other laboratories are using a threshold for Lp(a) measured in nmol/L, most frequently 75 nmol/L (15%).

3.5. Post-analytical phase: interpretative commenting

In addition to flagging of mild-to-moderate hypertriglyceridemia, only 23% of laboratories apply comments to alert for severe hypertriglyceridemia and risk of pancreatitis [9,10]. The TG threshold of 10 mmol/L or 880 mg/dL (as recommended by EAS) is used by 6% of the laboratories [11], and 17% of laboratories are using another value between 8 mmol/L and 20 mmol/L for alerting and the interpretative commenting on severe hypertriglyceridemia.

A minority of participating laboratories (17%) apply LDLC alert values to encourage the requestors to consider screening for Familial Hypercholesterolemia *(*FH) [9,10]. Only 4% of the laboratories routinely use guideline-recommended alert values of 5 mmol/L (190 mg/dL) for adults and 4 mmol/L (155 mg/dL) for children [9], 4% of the laboratories use the alert value for adults only, and 9% are using a broad spectrum of other values to alert for FH. Three percent of laboratories are using an alert value of total cholesterol only.

4. Discussion

This survey by the EFLM TG-CM clearly shows that the overall harmonization of lipid profiles is unsatisfactory in a large proportion of laboratories. There is substantial variation in lipid profiles between laboratories from different participating countries and between laboratories within any one country. Lack of harmonisation in the post-analytical phase is the most eye catching feature and suggests that guidelines are not being followed by most laboratories. In contrast, in the pre-analytical phase, non-fasting blood samples are already used by two-thirds of the laboratories, in line with recent recommendations [9,10].

Although fasting blood samples have previously been recognised as the standard for lipid measurements, current guidelines endorse non-fasting measurements for capturing the average atherogenic lipoprotein load over a 24-h period [12]. Despite the practical advantages of non-fasting lipid tests, such as simplifying blood sampling for laboratories and

improving patient comfort and compliance, about one third of the laboratories still opt for routinely using fasting blood samples for all lipid test requests. This can be explained by a reluctance to deviate from the traditional belief that fasting is critical for lipid testing, or by concomitant requests for additional tests that require fasting or morning samples (for example, fasting glucose, or markers with circadian rhythm).

LDL-driven risk assessment is, currently, the cornerstone of CVD prevention [7,8] and merits precise, accurate measurement. Two-thirds of the laboratories reported using the Friedewald equation to calculate LDLC. The Friedewald formula has its limitations because it erroneously assumes a fixed TG:cholesterol ratio (TG/2.2 in mmol/L or TG/5 in mg/dL) in very low density lipoproteins (VLDL) and a lack of chylomicrons and remnant particles [13]. The Friedewald equation becomes increasingly inaccurate as the serum TG concentration increases above 2.3 mmol/L (200 mg/dL) and is invalid above 4.5 mmol/L (400 mg/dL) [13]. Several other modified equations have been proposed to improve the calculation of LDLC, including the novel Martin Hopkins equation, but none of these are currently used by the laboratories participating in the survey. Rather than dividing TG by a fixed factor, the Martin-Hopkins equation requires matching each patient's TG and non-HDLC with 1 of 180 different factors to give a more personalized, adjustable factor [14]. Despite recently published evidence of improved accuracy compared to the Friedewald formula, particularly at very low LDLC <1.8 mmol/L (<70 mg/dL) and in non-fasting samples [15,16], this novel equation is not yet widely used for LDLC calculation. Problems with installing the complex approach used by this formula into automated laboratory information systems (LIS) could be a reason. Furthermore, at the time of the survey there was no guideline recommending the use of this modified equation.

One third of the laboratories always measure LDLC directly using a homogeneous assay, and 15% of the laboratories use the direct method when TG are >4.5 mmol/L, the limit of use of LDLC calculation. The direct methods also have limitations. External quality assessments of laboratories show important between-method and between-laboratory biases for different manufacturers' LDLC and HDLC assays [17]. These differences are due to non-specific measurement of other lipoproteins especially in dyslipidaemic samples where atypical lipoproteins are present [18]. Depending on the method used by the laboratory, different treatment decisions may be taken when LDLC values are close to guideline-driven decision thresholds [13]. There is further potential for confusion if patient samples for therapeutic follow-up are sent to different laboratories using different methods [13].

Less than half of the laboratories automatically calculate non-HDLC. This can be easily installed in the LIS by subtracting HDLC from TC data without the additional cost of extra

measurement. Non-HDLC includes the cholesterol carried by all atherogenic lipoproteins, that is, LDL, VLDL and their remnants, and Lp(a) [10]. In the nonfasting state it additionally includes the cholesterol of chylomicrons and their remnant particles [10]. In contrast to LDLC calculation, non-HDLC is not dependent on biological and postprandial variability of TG and can be used when TG concentrations are 4.5 mmol/L or higher [13]. Given these advantages, it would be justified to strongly encourage use of this calculation and it could also be considered an alternative therapeutic target, making direct LDLC measurement unnecessary when LDLC is not available due to invalid calculation [10].

Less than one third of the laboratories surveyed measure Lp(a). The 2016 ESC/EAS guideline recommended measurement of Lp(a) in selected cases at high risk, such as those with family history of premature CVD [8]. More recent 2019 ESC/EAS recommendations advise that Lp(a) should be measured at least once in all patients at CVD risk, to identify those with high inherited Lp(a) concentrations [19]. A desirable Lp(a) concentration of <50 mg/dL (80^{th} population percentile) is recommended by the EAS consensus statement [20]. This is higher than the 75^{th} percentile (30 mg/dL or 75 nmol/L) that for a long time was defined as the risk threshold and apparently is still used by many laboratories that took part in this survey. There is no consensus yet on the preferred measurement unit (mg/dL, mg/L, or nmol/L) for Lp(a) and not either on which conversion factor to be used (despite a proposed rough estimate of 2-2.5x conversion factor from mg/dL to nmol/L). This is because simple conversion of Lp(a) from mg/dL to nmol/L or vice versa is complicated by the size heterogeneity of apolipoprotein(a) isoforms (number of kringle IV type 2 repeats) measured in Lp(a) immunoassays [20,21].

Flagging abnormal concentrations based on threshold values defined by guidelines is recommended [9,10]. Nevertheless a large degree of heterogeneity was observed among laboratories choosing a wide variety of thresholds, and often higher values than those recommended by international guidelines. Many settings for result flags are arbitrarily installed or based on local or national consensus, either in SI units (mmol/L) or in traditional units (mg/dL). This variability highlights the need for harmonization. Laboratories are reluctant to use guideline-recommended thresholds for flagging because this will lead to many lipid profiles reported with flags, as with more than 50% of LDLC results [10]. There is a concern that flagging too many results will make the physician ignore very high concentrations, especially when used for screening in primary care.

For LDLC, default flagging based on the threshold for low risk (3 mmol/L) is recommended, although for intervention strategies the LDLC targets are dependent on the patient's SCORE [7,8]. However, implementation of personalized flagging based on the individual's risk factors

and clinical condition is difficult in a laboratory. A number of surveyed laboratories therefore systematically display a list of all three LDLC and also non-HDLC targets for moderate, high, and very high risk SCORE on the test reports.

A minority of laboratories still use reference intervals for flagging. However, using reference intervals as threshold is not advised because the upper reference limits for lipids are very high and far above the thresholds of increased cardiovascular risk [10]. Flagging based on reference intervals instead of threshold values should be avoided, as use of reference limits would not flag the majority of LDLC test results (>50%) associated with increased CVD risk [10].

It is of utmost importance in the post-analytical phase of laboratory testing to alert for potentially life-threatening conditions. Extremely abnormal lipid test results should be flagged with special alert notifications to quickly initiate further diagnostic and possibly therapeutic actions by the clinician [9]. Less than one-fourth of the laboratories flag severe hypertriglyceridemia for risk of acute pancreatitis [22]. An unacceptably lower number of laboratories applies LDLC alert values to encourage screening for FH. An LDLC >5 mmol/L in adults or >4 mmol/L in children should always trigger investigation for FH [9]. This may not always be necessary in hospital laboratories supporting specialized lipid clinics, but it is very important to assist general practitioners in identifying high-risk patients in first-time screening. If a diagnosis of FH is confirmed by genetic testing in the index case, cascade family screening of LDLC is desirable [23,24]. Early diagnosis and treatment of FH are important to prevent premature onset of CVD (at age <50 years) [23,24].

Limitations

A limitation of this study is that not all laboratories of the countries involved in this survey responded, and in certain countries responses from <5 laboratories were obtained. Results might have been different if all clinical laboratories had participated, however, a high response rate is hard to obtain in such surveys. The proportions of different laboratory types (university versus local) were very similar to those obtained with previous CAMARGUE and other EFLM questionnaires so we strongly believe that our results reflect the present situation of lipid testing in European laboratories [2,3]. However, results may not be considered to represent the national consensus in certain countries with a low response rate.

Another limitation is that nonstandard lipid tests, such as apolipoproteins, were not investigated in the questionnaire. At the time of the survey, the 2016 ESC/EAS guideline stated that apolipoprotein B should be considered an alternative risk marker [8]. However all contemporary guidelines concur that LDLC should remain to be the primary focus of lipid-lowering strategies to prevent CVD in clinical practice, based on very solid evidence [25].

This makes it difficult to examine adherence to recommendations with regard to apolipoprotein B, which are still a matter of debate among expert panels [26]. The 2019 updated ESC/EAS guidelines more strongly recommend apolipoprotein B for risk assessment [19], but these guidelines were published after completion of the survey (August 31, 2019).

Conclusion

The results of the CAMARGUE survey clearly demonstrate an important gap between existing recommendations and laboratory practice. The primary area where there is room for improvement is the postanalytical phase. Flagging of lipid profiles is inconsistent among European laboratories and, of particular concern, many laboratories apply LDLC thresholds which are not recommended by available guidelines [7-9]. The causes are multiple and in immediate need of professional strategies aiming at adequate and harmonized reporting of lipid tests. Among such strategies the present data strongly underline the need for enhanced coordination of the clinical laboratory activities in Europe [27,28]. The striking variability between countries and laboratories with several examples of well-reported lipid profiles serves as evidence that the present situation should be improved. The goal of laboratory medicine specialists must be to adopt best practice and to assist and encourage clinicians to adopt the evidence-based guidelines. The ultimate goal must be to achieve optimal lipid targets for CVD prevention strategies in their patients.

Ethical approval

This article does not contain any studies with human participants performed by any of the authors.

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Declaration of Competing Interest

The authors have no other competing interests or conflicts of interest to declare.

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Table 1 Multiple choice questions included in the CAMARGUE survey.

1.	**Are nonfasting blood samples used for lipid assays?**		
	Routinely	In specific condition(s)	No
2.	**In which units the lipid profiles are reported in your laboratory?**		
	SI (mmol/L)	Conventional (mg/dL)	Other
3.	**Is LDL cholesterol calculated or measured?**		
	Friedewald equation	Other (modified) equation	Direct measurement[a]
4.	**Which assay/manufacturer is used to measure LDL cholesterol?**		
5.	**Which assay/manufacturer is used to measure HDL cholesterol?**		
6.	**Is non-HDL cholesterol (=total – HDL cholesterol) automatically calculated and reported?**		
	Routinely	On specific request	No
7.	**Which desirable (risk) threshold is flagged for triglycerides?**		
	2 mmol/L (175 mg/dL)[b]	Other threshold	Reference limit
8.	**Which desirable (risk) threshold is flagged for total cholesterol?**		
	5 mmol/L (190 mg/dL)	Other threshold	Reference limit
9.	**Which desirable (risk) threshold is flagged for LDL cholesterol?**		
	3 mmol/L (115 mg/dL)	Other threshold	Reference limit
10.	**Which desirable (risk) threshold is flagged for non-HDL cholesterol?**		
	3.8 mmol/L (145 mg/dL)	Other threshold	Reference limit
11.	**Which desirable (risk) threshold is flagged for HDL cholesterol?**		
	1 mmol/L (40 mg/dL)[c]	Other threshold	Reference limit
12.	**When measured, which desirable value for Lp(a) is reported in your laboratory?**		
	<50 mg/dL	Other threshold[d]	Not measured
13.	**Is severe hypertriglyceridemia flagged for risk of pancreatitis?**		
	If triglycerides ≥10 mmol/L (880 mg/dL)	Other alert threshold	No
14.	**Do you add comment to screen for familial hypercholesterolemia (FH)?**		
	If LDL cholesterol ≥5 mmol/L (190 mg/dL)[e]	Other alert threshold	No

The first answer options to questions 1, 2, and 6-14 are the EFLM- and EAS-endorsed choice [7-9].

Additional answer options were:

[a] Either routinely measured by direct assay or only directly measured on specific request or indication, e.g. invalid LDL calculation at high triglycerides >4.5 mmol/L (>400 mg/dL).

[b] Or 1.7 mmol/L (150 mg/dL) in fasting samples.

[c] Or gender-adjusted HDL cholesterol: 1 mmol/L (40 mg/dL) in men, 1.2 mmol/L (45 mg/dL) in women.

[d] Other threshold of Lp(a) measured in mg/dL or in nmol/L

[e] Or age-adjusted FH alert threshold: 5 mmol/L (190 mg/dL) in adults, 4 mmol/L (155 mg/dL) in children

Table 2 Reported lipid measurement units by participating laboratories in Europe

	Participating laboratories (n)	mmol/L (%)	mg/dL (%)
Austria	34	0	100
Belgium	30	0	100
Bulgaria	7	100	0
Croatia	26	100	0
Denmark	10	100	0
Estonia	9	100	0
Finland	9	100	0
France	6	100	0
Germany	55	20	80[b]
Ireland	6	100	0
Italy	9	0	100
Macedonia	9	100	0
The Netherlands	6	100	0
Norway	11	100	0
Portugal	26	0	100
Serbia	21	100	
Spain	9	0	100
Sweden	13	100	0
Switzerland	26	100	0
Turkey	38	0	100
United Kingdom	80	100	0
Other countries[a]	12		

[a] Countries with responses obtained from <5 laboratories are not included in this table: Albania (n=1; mg/dL), Bosnia and Herzegovina (n=2; mmol/L), Czech Republic (n=2; mmol/L), Greece (n=3; mg/dL), Poland (n=1; mg/dL), Russia (n=2; mmol/L), Slovenia (n=1; mmol/L).

[b] Including one laboratory using g/L.

Table 3

Measurements and calculations of LDL cholesterol and non-HDL cholesterol by the surveyed laboratories.

Measurement or calculation options	Answers (%)
Calculated LDL cholesterol	
Friedewald equation	44%
Other equation	0%
Measured LDL cholesterol	
Routinely (in all patients' samples)	34%
On specific request[a]	7%
When TG are ≥4.5 mmol/L (≥400 mg/dL)[a]	15%
Calculated non-HDL cholesterol	
Routinely (in all patients' samples)	47%
On specific request	7%

[a] When not directly measured, LDL cholesterol is calculated using the Friedewald equation in all other patients' samples.

Table 4

Reported flagging of lipid profiles in either SI or conventional units.

Desirable values by consensus of EAS, ESC and EFLM	Guideline-recommended threshold, %	Other thresholds, %	Targets according to SCORE, %	Reference interval, %
LDL cholesterol <3 mmol/L or <115 mg/dL	42	49	7	2
Total cholesterol <5 mmol/L or <190 mg/dL	42	56[a]	NA	2
Triglycerides <2 mmol/L or <175 mg/dL	67[b]	30	NA	3
HDL cholesterol >1 mmol/L or >40 mg/dL	41[c]	58	NA	1
Non-HDL cholesterol[d] <3.8 mmol/L or <145 mg/dL	9	38	7	0
Lp(a)[e] <50 mg/dL	2	28[f]	NA	0

[a] 41% is using the total cholesterol threshold of 190 in mg/dL rounded to 200 mg/dL.

[b] Including 55% using the fasting threshold 1.7 mmol/L or 150 mg/dL.

[c] Including 22% using gender-specific thresholds.

[d] 46% of the laboratories do not calculate non-HDL cholesterol.

[e] 70% of the laboratories do not measure Lp(a).

[f] Including 13% using 30 mg/dL (75th percentile) for flagging of Lp(a).

Abbreviations are: SCORE, Systematic Coronary Risk Evaluation; NA, not applicable.

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