Unnecessary repeated total cholesterol tests in biochemistry laboratory

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Abstract

Introduction: We aimed to determine the number of repeated cholesterol (RC) tests and the ratio of unnecessary-repeated cholesterol (URC) tests among patients admitted to Pamukkale University Hospital (Denizli, Turkey) and provide solutions to avoid URC testing.

Materials and methods: Total cholesterol (T-cholesterol) tests (N = 86,817) between June 2014 and May 2015 were evaluated. The tests performed more than once per patient were determined as RC test (N = 28,811). RC test with an interval shorter than 4 weeks were determined as URC test (N = 3968) according to the shortest retest interval stated in ACC/AHA blood cholesterol guideline. RC testing included internal medicine, surgery and paediatric outpatients and inpatients. Reference change value (RCV) of total cholesterol was calculated.

Results: The 33.1% of the T-cholesterol tests were RC tests (N = 28,811), 13.7% of them were URC tests (N = 3968). Our RCV value was 25%. The percentage change between consecutive tests was less than RCV in 86.1% (N = 3418) of URC tests. URC tests were performed more frequently in patients with desirable total cholesterol value ($P < 0.001$).

Conclusion: There is a significant part of repeated T-cholesterol tests requested in our hospital. URC test requests can be evaluated by laboratories and the obtained data should be shared with clinicians. Laboratories can calculate RCV for the tests they performed and report this value with the test result. To prevent from URC tests, a warning plug-in can be added to hospital information software in accordance with guidelines to prevent from URC test requests.

Key words: unnecessary repeated cholesterol test; cholesterol retest interval; reference change value; laboratory costs; preanalytical phase; test requesting

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Introduction

The laboratory test costs, which are the remarkable part of hospital expenditures, increases over the years (1-4). An important part of the laboratory tests consists of repeated tests (4-6). Repeated tests are used for patient monitoring, but some of these tests are performed unnecessarily (1,6,4,7). Unnecessary tests increase the laboratory workload and costs (1,8-10).

Cholesterol test is one of the common performed tests in laboratory. Over the last two decades, the number of total cholesterol requests *per* year increased more than 15-fold (4). Minimum retest intervals are recommended to avoid unnecessary repeated cholesterol (URC) tests (11-13). According to "National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults III", lipoprotein profile screening should be done once every 5 years in healthy adults above 20 years old (11). The American Diabetes Association (ADA) recommends lipoprotein profile screening at diabetes diagnosis, at an initial medical evaluation and/or at the age of 40 and every 1-2 years (12). American College of Cardiology/American Heart Association (ACC/AHA) blood cholesterol guideline recommends lipoprotein profile monitoring subsequent to initiation of statin therapy and followed by a second lipoprotein panel 4 to 12 weeks after.

Thereafter, monitoring should be performed every 3 to 12 months as clinically indicated (13).

In this study, we aimed to determine the number of repeated cholesterol (RC) test and the ratio of unnecessary repeated cholesterol (URC) tests among patients admitted to Pamukkale University Hospital (Denizli, Turkey) and to provide solutions in order to avoid URC testing.

Materials and methods

Study design

The results of all total cholesterol tests which were performed from June 2014 to May 2015 in Pamukkale University Hospital Central Laboratory Biochemistry Department were obtained from the laboratory information management system. Cholesterol tests which were performed during this period (86,817 tests) were evaluated in the study.

Request dates, requesting services and total cholesterol results were determined from the obtained data. The cholesterol tests which requested for once in study period were excluded. The tests which were performed more than once *per* patient in study period were included and determined as RC test (N = 28,811). Cholesterol retest intervals for RC tests were calculated with the interval between consecutive tests. Any RC test which had an interval shorter than 4 weeks were determined as URC test (N = 3968 tests) according to the shortest interval stated in ACC/AHA blood cholesterol guideline.

RC test rates were 84.3% (N = 24,288) in internal medicine outpatient, 7.3% (N = 2112) in internal medicine inpatient, 4.8% (N = 1385) in surgery outpatient, 2% (N = 573) in paediatric outpatient, 1.2% (N = 333) in surgery inpatient and 0.4% (N = 120) in paediatric inpatient services (Table 1).

Table 1. Percentage of repeated cholesterol test requests based on services.

Services	Repeated Cholesterol Tests	
	%	N
Surgery inpatient	1.2	333
Paediatric inpatient	0.4	120
Internal medicine inpatient	7.3	2112
Surgery outpatient	4.8	1385
Paediatric outpatient	2.0	573
Internal medicine outpatient	84.3	24,288
TOTAL	**100**	**28,811**

Methods

We used the desirable total cholesterol value cut-off as 5.17 mmol/L in our study (11). All tests were run on Roche Cobas c701 chemistry analyser (Roche Diagnostics GmbH, Mannheim, Germany). Two levels of internal quality control (QC) materials, total cholesterol control level 1 (mean = 2.43 mmol/L, range: 2.17 – 2.68 mmol/L) and level 2 (mean = 4.57 mmol/L, range: 4.11 – 5.04 mmol/L) were assayed during the study period. Standard deviation (SD) and coefficient of variation (CV) values for the levels of internal quality control materials were calculated during June 2014 - May 2015 (Table 2).

Reference change value (RCV), which used for evaluating the clinical significance of changes in consecutive test results from an individual, were calculated for cholesterol tests of our laboratory**.** RCV was calculated according to naturally occurring variables (analytical CV and within subject CV) (14).

Statistical analysis

Descriptive statistics and chi-square analysis were done using SPSS 17.0 (SPSS Inc., Chicago, IL, USA). Number and percentage of the groups were calculated. RCV was calculated with formulae:

$$RCV = 2^{1/2} \times Z \times \sqrt{(CV_{analytical}{}^2 + CV_{intraindividual}{}^2)}$$ (14).

Z is the number of standard deviations appropriate to the probability (15). Z value is 2.58 for 99% probability ($P < 0.01$) (16). $CV_{intraindividual}$ value is 5.95 for total cholesterol (17). $CV_{analytical}$ value was calculated with the mean CV of our level 1 and level 2 internal quality controls. CV was calculated

Table 2. Standard deviation (SD) and coefficient of variation (CV) values for the levels of internal quality control materials during June 2014 - May 2015.

Months	Level 1 (normal)		Level 2 (pathological)	
	SD	CV (%)	SD	CV (%)
June	2.33	1.57	2.12	2.78
July	3.33	2.78	3.02	4.95
August	2.99	3.40	2.72	6.01
September	3.41	3.40	3.10	5.97
October	3.44	3.32	3.27	5.88
November	3.72	3.20	3.59	5.77
December	3.81	3.31	3.64	5.91
January	3.97	3.52	3.72	6.31
February	3.12	3.25	2.94	5.69
March	3.26	3.26	3.05	5.75
April	3.47	3.15	3.32	5.60
May	3.53	3.50	3.34	6.21
MEAN	**3.36**	**3.14**	**3.15**	**5.57**

SD – standard deviation, CV - coefficient of variation.

from the internal quality controls data over the one-year period using the following equation:

CV (%) = (standard deviation × 100) / laboratory mean (internal quality control).

Results

The 33.1% of the 86,817 total cholesterol tests performed during one-year period was RC test and 13.7% of RC tests were URC test. Distribution of RC tests according to services was shown in table (Table 1).

URC test frequencies in RC tests were highest in surgery inpatient and lowest in internal medicine outpatient service ($P < 0.001$). In RC tests, the ratio of URC tests according to services was shown in table (Table 3).

Our $CV_{analytical}$ value was 3.25%. According to our $CV_{analytical}$ value, we calculated the total cholesterol RCV value, which is specific for our laboratory. Our RCV value was 25%.

Table 3. The ratios of "unnecessary repeated cholesterol tests" in repeated cholesterol tests according to services.

Services	Unnecessary Repeated Cholesterol Tests* N (%)	Appropriate Repeated Cholesterol Tests* N (%)
Surgery inpatient	228 (68.4)	105 (31.6)
Paediatric inpatient	65 (54.1)	120 (45.9)
Internal medicine inpatient	911 (43.1)	1201 (56.9)
Surgery outpatient	275 (19.8)	1110 (80.2)
Paediatric outpatient	107 (18.6)	466 (81.4)
Internal medicine outpatient	2382 (9.8)	21,906 (90.2)

*Unnecessary repeated cholesterol test is any repeated cholesterol test which had an interval shorter than 4 weeks.

The percentage of the change in total cholesterol values between consecutive tests were less than RCV in 86.1% (N = 3418) of URC tests.

Table 4. Distribution of repeated cholesterol tests according to reference change value and desirable total cholesterol concentration.

Total cholesterol concentration (mmol/L)	< RCV		≥ RCV		Total
	N	%	N	%	
< 5.17	15,520	86.3	2447	13.7	17,967
≥ 5.17	9176	84.6	1668	15.4	10,844

RCV - reference change value

URC tests were performed more frequently in patients with desirable total cholesterol value ($P < 0.001$). Previous cholesterol test results were below desirable total cholesterol value in 62.3% of RC tests (N = 17,967). The percentage of the change in repeated total cholesterol values were less than RCV (N = 15,520) in 86.3% of these tests (Table 4).

Discussion

Our findings indicate that one of three total cholesterol tests performed in our hospital was RC tests and also 13.7% of these tests were repeated unnecessarily. As we were not able to investigate the clinical features of these patients, we used the shortest retest interval stated at 2013 ACC/AHA blood cholesterol guideline. We consider that, if appropriate retest intervals for different clinical features were used, the rate of URC tests would be higher.

One of the ways to evaluate the significance of difference between measurements is using RCV (18). RCV is caused by changes which are arisen from analytical and biological variation between consecutive tests (19). The percentage change between consecutive total cholesterol tests were less than RCV in 86.3% of the URC tests in our study. This situation suggests that the change below RCV between consecutive URC tests is not associated with clinical intervention in our hospital.

Doll *et al.* (4) had evaluated cholesterol test requests between the years 1987–2007; the proportion of RC tests were 47% in years 1987–1989 and rose to 79% in years 2005–2007. A considerable part of cholesterol test requests consists of RC tests, as in our study. Majority of RC tests were from the outpatient internal medicine service in our study but the rate of URC tests was highest in inpatient services. Bridges *et al.* (9) had evaluated 6 common laboratory test requests in a group of hospitalized patients over a 12-month period and 7.7% were considered as unnecessary requests. It was stated that those unnecessary requests had increased the total cost and decreased the patient care efficiency. Oliveira *et al.* (3) found the rate of unnecessary tests 41% in intensive care unit. Miyakis *et al.* (20) found that 28.6% of tests conducted at the day of hospitalization are unnecessary and in the following days, it can increase up to 69.3%. We consider that, inadequate examination of previous test results in inpatient clinics of our hospital was the reason for this situation.

Biochemical profile tests are performed more frequently in patients with normal test results (21). In our study, previous test results were below the desirable total cholesterol value in 62.3% of RC test requests. The percentage of the change between consecutive tests was above RCV in majority of these tests. This situation supports the importance of minimum retest intervals suggested in guidelines.

This study had several limitations. First of all, we were not able to investigate the clinical features of the patients. Secondly, the study was conducted in tertiary care hospital setting, which may limit generalizing of our findings to other hospitals. And the last, evaluation was made only for total cholesterol test.

In conclusion, this study revealed that, an important part of total cholesterol tests requested in Pamukkale University Hospital are repeated tests. Unnecessary repeated test requests can be evaluated by laboratories and the obtained data should be shared with hospital managers and clinicians. Laboratories can calculate RCV for the tests they performed and report this value with the test result. To prevent from unnecessary repeated tests, a warning plug-in can be added to hospital information software in accordance with guidelines to prevent from unnecessary repeated test requests.

Potential conflict of interest

None declared.

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