

Inappropriately repeated lipid tests in a tertiary hospital in Greece: the magnitude and cost of the phenomenon

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Abstract

Background. Demand and costs of laboratory testing are increasing worldwide. It seems that a considerable proportion of the tests requested do not follow the published guidelines. Tests comprising the lipid profile are advised for the entire population, as determinants of cardiovascular risk. Published guidelines exist for different groups of the population. This study is an attempt to assess the volume and the cost of the excessive demand for laboratory measurements of lipids concerning inpatients of a tertiary teaching hospital in Athens, Greece.

Methods. Tests were characterized as inappropriate through revision of guidelines for lipid measurement. The demand for laboratory measurement of lipid blood levels was studied by collecting data from the hospital's test result database. The study was conducted during the trimester October to December 2008 and 20,698 tests from 3,279 inpatients were reviewed.

Results. The results of this study are consistent with international observations showing a significant percentage of clinically inappropriate laboratory tests and the consequent financial burden. The inappropriately repeated lipid tests during the trimester reached the number of 7,938 costing € 12,680 to the hospital. Almost half of the inpatients were tested more than twice a month.

Conclusions. Physicians' behavior is an important factor, as is derived by certain profiles of the wards studied. Guidelines are not followed when ordering lipid tests. Curtailing of these excessive laboratory tests has been shown to be feasible using cheap strategies and will yield considerable benefits for patients and hospitals alike. Hippokratia 2012; 16 (3): 261-266

Key-words: Lipids, cholesterol, triglycerides, inappropriate test repeat, excessive laboratory use.

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Introduction

During the last several years a continuously increasing demand for laboratory tests has been observed. In the United States, corresponding expenditures make up 10% of the total healthcare expenditures and 50% of it comes from hospital laboratories. However, for a variety of reasons, a large percentage of the tests performed are proven to be inappropriately ordered¹⁻⁶.

The oldest investigation published⁷ on duplicate requests for the same test (Canada, early 1970s) concluded that only 0-1.1% of the tests were double-requested. Another scrutinizing study of inpatients' files showed that on the day of admission, 28.6% of the tests performed were redundant, a percentage that rises to 69.3% for the following days of hospitalization¹. Those tests could have been avoided with absolutely no effect on the patients' course.

Inappropriate test repeat occurs often to patients admitted to hospitals (one study revealed 30% of the tests were repeated within a month, before the baseline time

interval for repetition had elapsed) and is costly²⁻⁸. Moreover, repeats are requested many times despite the first results being within the normal limits³. A review⁶ presents the criteria used in different studies to characterize a test as inappropriate/redundant, using examples from all laboratories, which can easily be recognized by the laboratory personnel. Various studies have established the significant inappropriate and over-use of the laboratories, especially in hospitals with doctors in training⁵.

Excessive demand for laboratory tests is related among others to the population's access to health care insurance, increasing costs of tests (advanced technology), introduction of new tests, and overutilization of laboratories⁶. Factors recognized to lead to overutilization or misutilization of laboratory services are mainly linked to physicians behavior (e.g fear or insecurity) and imperfect medical training or knowledge, resulting in ordering tests based on criteria differing from those suggested by evidence-based medicine^{1,3,6,9}. In Greece, an additional factor is the weak (if any at all) interest of the hospital

Table 1: October 2008 – Cholesterol tests

Ward	Working days	Patients total	Total cholesterol tests
IM 1	28	226	318
IM 2	24	167	217
Surg 1	21	110	150
Surg 2	25	104	140
Cardio	21+9	130+6	159+9
ICU	29	36	171
KTU	31	269	456
Nephro	26	180	266
IM 3	24	267	438
Total		1,495	2,324

Table 2: Inappropriate test repeats during the trimester

Ward	Extra Chol	Extra Tg	Extra HDL	Extra LDL	Total
IM 1	154	144	88	41	427
IM 2	148	147	131	85	511
Surg 1	106	95	93	1	295
Surg 2	176	176	171	156	679
Cardio	80	82	71	11	244
ICU	339	337	47	46	769
KTU	620	620	607	559	2,406
Nephro	270	271	164	138	843
IM 3	722	697	160	140	1,719
Total	2,615	2,569	1,558	1,196	7,938

administration on the matter.

Conducting numerous and frequent tests increases the patients' discontent, anxiety and the odds for false positive results, leads to further investigations, causes iatrogenic anemia, increases the health care costs, while inappropriate laboratory use may also be a sign of other deficiencies of the healthcare system^{4,8}.

This study is a first, for Greece, investigation aiming to prove and record the size of the problem of repeat laboratory testing, focusing on the tests that comprise the lipid profile (total blood cholesterol, fasting triglycerides, HDL-cholesterol, LDL-cholesterol), and at the same time to calculate the healthcare cost of the phenomenon. Data were collected during the trimester from October to December of 2008 (10/1/08 - 12/31/08) from the records of inpatients hospitalized in the major wards of the "Laiko" General Hospital of Athens, Greece.

Guidelines for lipid testing

According to the guidelines of the Third Report of the National Cholesterol Education Program (NCEP) expert panel, and depending on the risk factors and the levels of LDL, it is recommended that one should be tested no

sooner than every 6 weeks until the suitable regimen is defined and afterwards every 3, or 4-6 months or 1 or 5 years^{10,11}. The guidelines were confirmed by clinical trials¹². Healthy adults are advised to have their lipid profile measured every 5 years¹³.

For patients admitted with acute coronary disease, LDL must be measured on admission or within the first 24 hours¹¹. The American Heart Association has published guidelines for treating abnormal blood lipids¹⁴, emphasizing on lifestyle changes, but the frequency of measuring the lipid profile is not mentioned at all. Canadian guidelines include lipid testing no sooner than every 3 or 6 months¹⁵.

The American Diabetes Association recommends fasting lipid profile testing at least once a year or every 2 or 5 years, depending on the lipids levels^{16,17}. Diabetic patients trying to lower their blood lipids by diet should be examined every 6 weeks (up to 3-6 months, then pharmaceutical treatment may be necessary)¹⁸. Guidelines published by the NHS recommend measuring the lipid profile at the time diabetes is diagnosed, then once a year, unless treatment is needed. In that case lipid testing

Table 3: Total cost of inappropriate tests during the trimester October-December 2008

Test	Number of inappropriate tests	Cost per test	Total cost of inappropriate tests
Cholesterol	2,615	€ 1.611	€ 4,212.76
Triglycerides	2,569	€ 1.651	€ 4,241.42
HDL	1,558	€ 1.853	€ 2,886.97
LDL	1,196	€ 1.12	€ 1,339.52
Total	7,938		€ 12,680.67

should be performed before starting medications and then 3 months and one year after¹⁹.

Nephrologists and general practitioners should identify and treat dyslipidemia at the first stages of chronic kidney disease using the guidelines published for the general population²⁰. A fasting lipid profile must be measured yearly after the goals have been achieved and more frequently in patients on lipid lowering drugs²¹.

The definitions of the ATP III are in effect for kidney transplant recipients¹⁰ concerning lipid levels and risk groups. It is recommended that renal transplant recipients have their fasting cholesterol, triglycerides, HDL and LDL measured every 3-6 months and thereafter once a year. Changes in the immunosuppressive regimen, the graft's function or the risk factors for cardiovascular disease may demand more frequent testing²². Various research studies concerning patients with chronic kidney disease and kidney transplant patients measured lipid profiles no sooner than 4 or 8 weeks²³⁻²⁵.

Material and methods

“Laiko” General Hospital of Athens is a tertiary hospital of 550 beds and provides training to interns and residents of various specialties. Among the patients studied many are admitted for various diseases of Internal Medicine, there are patients with chronic kidney disease and kidney transplant recipients, surgical patients, patients with cardiological problems and acute myocardial infarction and patients with leukemias. A large proportion of all the inpatients suffer from diabetes and various infections.

The hospital's laboratories use integrated software for ordering tests and reporting results, which is connected to the analyzers so that all results are directly entered into the software's database, and then are checked by laboratory doctors and biochemists, verified and published to the wards as final results. The collection of this study's data was made by searching the databases of the software.

The laboratory aspect of lipid testing

NCEP Laboratory Standardization Panel has published the acceptable limits of bias from analytical variations, as well as the acceptable specimen for lipid testing¹⁰, which taken under consideration, lead to the conclusion that the specimens quality is uncertain, as all

inpatients suffer from some illness that forced them to be admitted to hospital (i.e. their metabolic situation is not stable) and take various medications. Also, the timing of blood drawing and samples arrival at the laboratory vary greatly (from 8 a.m. to 2 or 2:30 p.m.) and possibly patients have had a meal just before the blood drawing. In other words, the conditions for the right sample are not met¹³.

The following equipment and methods are used in the Clinical Chemistry laboratory of the hospital “Laiko”: The chemical analyzers used are: Aeroset (Abbott laboratories, IL, USA), ADVIA 1800 (Siemens Healthcare Diagnostics, Deerfield IL, USA, <http://diagnostics.siemens.com>), and OLYMPUS 640 (Olympus America Inc., Center Valley, PA, USA, www.olympusamerica.com, represented in Greece by Medicon Hellas, www.mediconsa.com). For determining total blood cholesterol the enzymatic method is used (cholesterol esterase, cholesterol oxidase and peroxidase). The triglyceride assay is the one of glycerol phosphate oxidase. HDL is measured by using two methods: an anti-antibody to human lipoprotein, and the direct method of accelerator selective detergent (Ultra HDL, Abbott Laboratories, IL, USA). LDL is indirectly calculated using the Friedewald equation ($LDL = \text{total cholesterol} - HDL - \text{triglyceride}/5$).

The analytical protocols and all reagents for these assays for the three analyzers are provided by the same companies that provide each analyzer. The laboratory conducts daily internal and monthly external quality assurance schemes for all analytes, which are within the acceptable variation.

According to the published guidelines presented, we set for this study the minimal interval for repeating a lipid test to one month (4 weeks), which is also the shortest interval mentioned in the literature. The choice of 4 weeks helps with calculations and is modest, since it refers to research papers and not guidelines, where the minimal repetition interval is 6 weeks.

Costing

In order to estimate the costs of the lipid profile tests we took under consideration the prices of the consumables used in the process of blood drawing, samples transport and preanalytical treatment, preparing the analyzers, conducting the internal quality control checks and running the tests, and the salaries (approximately the

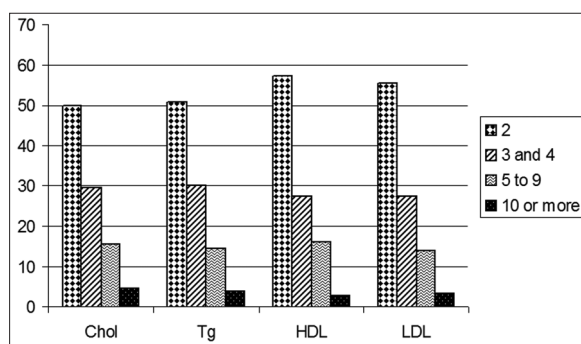


Figure 1: Percentages of repeats during the trimester

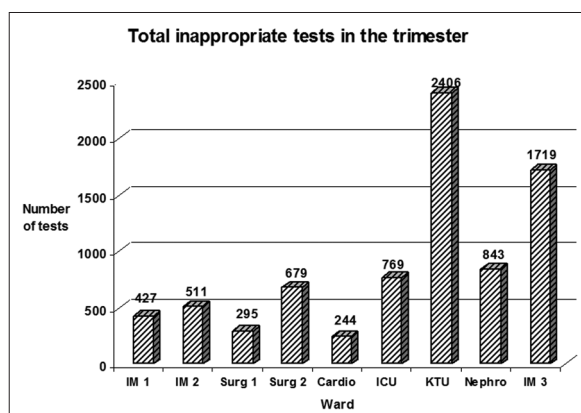


Figure 2: Total inappropriate lipid tests during the trimester

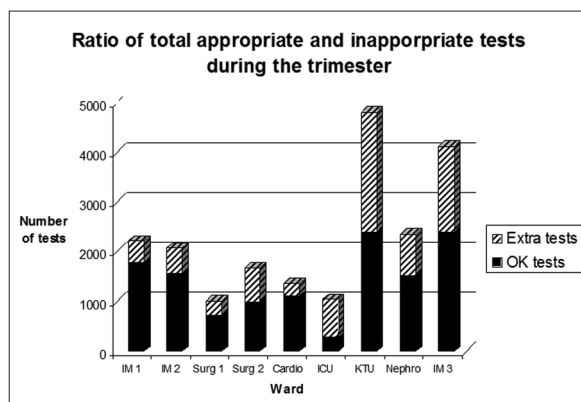


Figure 3: Ratio of total appropriate and inappropriate tests during the trimester

gross monthly salary of an average professional of each category) of the health professionals engaged in the procedures. The consumables prices' source is the hospital's supplies competitions. In many financial studies of health services the cost-charge ratio may be the only available mechanism for estimating the production cost²⁶. Cost does not coincide with charges²⁷.

The costs of consumables per test were calculated as follows: € 0.491 for cholesterol, € 0.531 for triglycerides, and € 0.733 for HDL. The labor cost (from blood drawing to result publication) was the same for all tests, calculated at € 1.12. The cost of LDL is comprised only by the corresponding labor cost, as it is automatically calcu-

lated using the Friedewald equation and is almost never ordered alone. Labor cost for producing 10 lipid results was calculated at €11,084. We assumed that 2 residents, 3 medical laboratory technicians and 1 clinical chemist are engaged in the tasks. This is the minimal composition for the daily workload in the Clinical Chemistry lab, so the calculated labor cost is also the minimal possible. A resident's gross monthly salary is approximately €1,350, a clinical chemist's €1,750 and the technician's €1,500.

No amount was calculated for the capital cost and depreciation for the following reasons: the analyzers have not been bought by the hospital, thus depreciation can not be estimated (the analyzers are provided by the companies as "equipment accompanying the reagents"). Moreover, the amount for bills of water, electricity etc. that is proportionate to the lipid tests would be very difficult to define and of small value, as the laboratory conducts about 2,886,290 tests per year (laboratory data for the year 2008).

Results

Number of lipid tests

In Table 1, the column "working days" refers to the distinct calendar days that the particular test was requested from the lab. "Patients total" stands for the number of inpatients of each ward that month that were also tested for the particular analyte (not the general total of the inpatients). The column "total tests" shows the number of cholesterol measurements made in the specific month for each ward.

From the column "working days" of Table 1, comes the conclusion that the doctors of the wards who ordered cholesterol tests on more than 22 days, did so on a holiday too (October 2008 had 9 non-working days in Greece). Cholesterol testing is not an emergency test and shouldn't be performed after-hours (the lab personnel shares some responsibility).

Comparing the number of patients to the number of tests easily reveals that some patients were tested for cholesterol more than once during the month. Similar tables were compiled according to data for all tests of the lipid profile, for the 3 months of the study.

Patients with multiple repeats

The maximum number of repeats climbed up to 21 times for cholesterol and triglycerides, 20 for HDL and 19 times a month for LDL (Figure 1). Patients in the 3 first positions were hospitalized in KTU, Surg 2, IM 3, Nephro and ICU. The same wards have the highest numbers of multiple repeats (at least 7 times a month).

Number of futile repeats

Based on the one-month limit for repetition, the following data accrue (Table 2):

Figure 2 illustrates well the size of the problem. The Cardiology ward has the smallest amount of futile repeats (is the specialty mostly concerned with the levels of cardiovascular risk factors). Two of the three Internal Medi-

cine wards show medium rates; while IM 3 shows a very different picture (the three wards are approximately of the same size and admit approximately the same number of patients). The size of lab over-use by KTU is really impressive.

Figure 3 shows the ratio of the tests that shouldn't have been ordered in relation to the total tests for each ward.

In conclusion, the overall cost of inappropriately repeated lipid tests during the three months of this study rose up to the amount of 12,680.67 euros that is approximately 4,226.89 euros per month (Table 3).

Discussion

This investigation revealed that lipid testing is performed much more often than recommended by guidelines, even multiple times within a month. The number of approximately 2,600 inappropriate tests every month is significant and must cause skepticism about the reasons and its impact, from the scientific through the financial field. The financial burden on "Laiko" hospital is approximately € 4,230 per month just from the redundant lipid tests ordered for the inpatients. Aside from the hospital's financial burden, there's a waste of work-hours and creative energy of the lab's personnel, wearing out of the equipment and concomitant more frequent damage and increased maintenance requirements.

Each ward presents stable trends in test orders during the trimester of the investigation. The same wards request a lipid profile even on holidays, doctors of Surg 1 generally do not test their patients for LDL, Cardiology shows less orders comparing to other wards, especially when cardiovascular risk is the field for cardiologists mainly.

In Greece, the price charged by public hospitals for each test is defined by the state. It is not set by calculating the real costs of conducting each test and prices do not escalate parallel to the rise of consumables prices or salaries. Charges are the same for all public hospitals, regardless of the way each laboratory runs, the methods and equipment used and the personnel of each laboratory.

Also, public hospitals are reimbursed with a fixed amount per day of hospitalization, regardless of the type of disease, surgery, medications or tests provided to the patient. Thus, the lab is a cost center for the hospital, the hospital is remunerated with the same amount, regardless of the number of tests each patient had during their hospitalization. On the contrary, when tests are performed for outpatients, the laboratory is a revenue center for the hospital because it is reimbursed separately for every single test, usually by social insurance of the recipient. If we assume that this fixed reimbursement is not in effect, but every medical action and laboratory tests performed during the hospitalization of a patient are individually charged (as is the case of private clinics), even with the state charges, the financial burden on the patients or their social insurance would be enormous. The estimated amount from excessive tests during the trimester is € 7,531.20 for cholesterol, € 11,534.81 for triglycerides, € 7,400.50 for

HDL and € 5,681.00 for LDL. Thus, the average monthly charges to the social security funds would be € 10,715.84 (just from redundant lipid tests of the inpatients of a single hospital). This example shows the problem of utilization of excessive healthcare resources and confirms studies of inappropriate use of health resources and inefficiency in the Greek hospitals²⁸.

The laboratory could change its role from a cost center to a revenue center for the hospital by attracting external clients²⁹ but that depends on the organization and the operational costs of the lab as well as the prices charged for the tests, so that there is a profit margin³⁰. In the case of Greece, assuming the separate charge for each test and according to the aforementioned data, if clinicians continued with the same tactics of ordering tests, the hospital could earn €6,490 per month, instead of losing €4,230 per month, from lipids only. However, such possibility does not conform to the actual circumstances (social, financial and political) of the Greek reality.

Suggestions/measures for a more rational use of the laboratory

The most successful interventions to curtail the excessive test demand have used a combination of methods, such as training and constricting measures on ordering freedom, which have low cost and are easily applied³¹. Other efficient methods are presenting each clinician's test orders with or without financial data and comparing his performance to his colleagues³²⁻³³, in combination with reminding messages for appropriate test ordering³⁴, incorporation of a submenu in the electronic ordering form, supervision by more experienced doctors³⁵, even ordering of preoperative investigations by anesthesiologists instead of surgeons³⁶. Finally, the display of the price during each test's ordering may lead to a lesser or larger reduction of test requests³⁷⁻³⁸, but doctors are rarely sensitive about constricting expenses due to redundant tests³⁹.

What is suggested

- ✓ training doctors on rational laboratory utilization
- ✓ improved communication between clinicians and laboratorians⁵
- ✓ implementation of the recommendations of evidence-based medicine and the guidelines published by medical societies
- ✓ empowerment of the laboratory's role (the Chief must define the services to the clinics)

The Chief of the Clinical Chemistry Lab of "Laiko" hospital has implemented an adjustment to the test ordering software of the hospital, comprising of instructions and obligation to justify orders for repetition of lipid (among others) tests requested for the same patient within a period of 4 weeks. The intervention is very recent and its outcomes have not been evaluated yet. A similar arrangement has been established in at least one hospital referred in the literature⁴.

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