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Rational Laboratory Practice in the "Savings and Revenue Enhancement Program" Perspective: Calculated LDL

"Tasarruf ve Gelir Artırıcı Program" Perspektifinde Akılcı Laboratuvar Uygulaması: Hesaplanmış LDL Kullanımı

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Abstract

Objective: Rational laboratory practices can provide significant savings in hospital expenses. In recent years, the use of Friedewald formula has been accepted as a cost-effective calculation method in the measurement of lipid parameters of a patient in the risk group screened for hypercholesterolemia. In patients with triglyceride (TG) ≤400 mg/dL, it can be said that measurements using the direct-low density lipoprotein (LDL) kit instead of this formula bring unnecessary testing costs to laboratories.

Methods: In our study, the test orders of registered outpatients between 01.01.2022-31.12.2022 were examined and 112,649 patient results were obtained with measurement of total cholesterol (TC), high density lipoprotein (HDL), TG and direct-LDL or at least one of them. After exclusion of patient results for TC, TG, HDL and direct-LDL tests not ordered together, results with TC >400 mg/dL and results with non-numeric test results, 720 patient results were included in the study. The ratio of the unnecessary test order cost to the SUT package reimbursement fee and the package fee excluding the examination fee was calculated.

Results: Of the 720 patient results included in the study, the highest number of unnecessary direct-LDL orders belonged to the internal medicine outpatient clinic with 261 (36.25%), while the lowest number of orders belonged to the dermatology, pulmonology, hematology and psychiatry outpatient clinics with one order each (0.14%). Since the tender price of the direct-LDL test was fixed at 4.75 TL per unit test, the unnecessary test cost ratio is proportional to the number of orders is 36.25% and 0.14%, respectively.

Conclusion: With this study, it can be said that it is more cost-effective in terms of institutions and national economy to use computational LDL test instead of direct-LDL test ordering when requesting lipid profile in individuals with risk factors and who are met for the first time, and then to request targeted test ordering.

Keywords: Low-density lipoprotein, cost-effectiveness analysis, clinical laboratory techniques

Öz

Amaç: Sağlık harcamalarının verimli kullanılması, devlet politikası olarak hedeflenmiştir. Akılcı laboratuvar uygulamaları ile hastane giderlerinde önemli kazanç sağlanabilir. Hiperkolesterolemi taraması yapılan risk grubundaki bir hastanın lipit parametreleri ölçümünde maliyet etkin bir hesaplama yöntemi olarak son yıllarda Friedewald formülünün kullanımı kabul görmüştür. Trigliserit (TG) ≤400 mg/dL olan hastalarda bu formül yerine direkt-düşük yoğunluklu lipoprotein (LDL) kiti kullanılarak yapılan ölçümlerin laboratuvarlara gereksiz test maliyeti getirdiği söylenebilir.

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Öz

Yöntem: Çalışmamızda 01.01.2022-31.12.2022 tarihleri arasında kayıtlı poliklinik hastalarının test istemleri incelenmiş olup, total kolesterol (TK), HDL, TG ve direkt LDL veya bunlardan en az birisinin ölçümü olan 112.649 hasta sonucu elde edildi. TK, TG, HDL ve direkt LDL testleri beraber istenmeyen hasta sonuçları; TK değeri >400 mg/dL olan sonuçlar ve test sonuçları numerik olmayan sonuçlar çalışma dışı bırakıldığında 720 hasta sonucu çalışmaya dahil edildi. Gereksiz test istem maliyetinin, SUT paket (poliklinik) geri ödeme bedeli ve muayene ücreti dışı paket ücretine oranı hesaplandı.

Bulgular: Çalışmaya dahil edilen 720 hasta sonucundan en çok gereksiz direkt LDL istemi, 261 (%36,25) adet ile dahiliye polikliniğine aitken en az istem birer adet (%0,14) ile dermatoloji, göğüs hastalıkları, hematoloji ve psikiyatri polikliniklerine aittir. Direkt LDL testinin birim test başına ihale bedeli 4,75 TL ve sabit olduğundan gereksiz test maliyet oranı meblağ olarak istem sayısıyla orantılı ve sırasıyla %36,25 ve %0,14'tür.

Sonuç: Bu çalışma ile risk faktörü bulunan ve ilk kez karşılanan bireylerde lipid profili istenirken direkt LDL test istemi yerine hesaplamalı LDL testinin kullanılmasının, daha sonra ise hedefe yönelik test isteminin yapılmasının kurumlar ve ülke ekonomisi açısından daha maliyet etkin olduğu söylenebilir.

Anahtar Kelimeler: Düşük dansiteli lipoprotein, maliyet etkinlik, klinik laboratuvar teknikleri

Introduction

The medium-term program was published in Official Gazette no. 30541 dated September 20, 2018, with Presidential Decree No. 108. In this context, it has been decided to establish the Public Finance Transformation and Change Office within the Ministry of Treasury and Finance to use public resources efficiently, reduce costs and expenditures, and increase the quality of revenues. The savings and revenue enhancement program (SREP) to be prepared and monitored by this office aims to make permanent improvements in public finance.

The SREP, which is also implemented by the Ministry of Health, is an action plan that seeks to prevent unnecessary expenditures of central and provincial institutions by taking necessary measures and, where possible, increasing their revenues.

Medical biochemistry laboratories are units that positively affect the revenues of hospitals, even if they do not have direct income. In this sense, significant savings can be made in laboratory test costs by organizing the tests within the scope of rational laboratory practices in accordance with current medical science.

In patients at cardiovascular risk, clinical status is associated with low-density lipoprotein (LDL) levels. Therefore, LDL levels are one of the most important target parameters in cholesterol-lowering treatment regimens worldwide. In biochemistry laboratory practice, LDL is usually a member of a group of tests called the "lipid profile". Other tests in this panel are total cholesterol (TC), triglycerides (TG), and high-density lipoprotein (HDL).

Medical laboratories are units that adopt the principle of cost-effective operation and fast and accurate delivery of test results. Scientists have begun to develop new laboratory tests and methods for many reasons, especially increasing health expenditures. Since it was developed in 1972 by Friedewald, the LDL calculation equation [LDL=TC-(HDL+TG/5)] has been widely used in clinical practice for several decades[1]. Recently, many new formulas have entered the literature that have been shown to calculate more successfully than the Friedewald formula, especially at low LDL levels. Although the calculation methods developed by Martin-Hopkins and Sampson et al.[2] have been used in many centers, the most widely used formula is still the Friedewald formula[3]. Therefore, it can be said that measurements using a direct-LDL kit in patients with TG ≤400 mg/dL in hospitals incur unnecessary testing costs to laboratories.

In today's health policies, cost-effectiveness is another consideration for laboratories trying to respond appropriately to expanded test panels and increasing patient populations. Therefore, reflex testing practices and test panels programed together with clinicians may be a good first step to have a positive impact on health expenditures[4]. "Reflex testing" refers to the ordering and running of a new test based on the result of the first test if the criteria are provided[5]. A reflex test can be created according to the criteria set at the beginning in accordance with the needs of the hospital and laboratory. With reflex testing, unnecessary test ordering may be avoided because not all tests are ordered at the first time but only when needed according to the algorithms. Therefore, reflex testing has become an important tool that provides timely, cost-effective, and quality care to patients. When the literature is reviewed, many publications can be noticed regarding the positive effect of reflex testing in laboratories[6,7].

Thus, we aimed to reveal the cost to the laboratory of not performing the direct LDL test as a "reflex test" in a training and research hospital with a capacity of 910 beds.

Materials and Methods

Data Collection and Formation of Groups

In our study, we obtained the results of 112,649 outpatients registered in the Hospital Information Management System (HIMS) of University of Health Sciences Turkey, İzmir Tepecik Education and Research Hospital between 01.01.2022 and 31.12.2022, who had TC, HDL, TG, and direct LDL test orders (at least one of which was available). According to the Social Security Institution reimbursement regulation, the results of patients admitted to emergency, oncology and hematology outpatient clinics whose reimbursement conditions differed from those of other outpatient clinics; results of patients who did not want TC, TG, HDL and direct LDL tests together; results with TC value >400 mg/dL and non-numeric test results were excluded from the study. After the exclusion criteria, 720 patient results, including duplicate test results, were included in the study.

Statistical Analysis

This study was planned as a retrospective descriptive study. The ratio of unnecessary test ordering cost to the SUT (health practice regulations in Turkey) package (outpatient clinic) reimbursement fee and outpatient package fee was calculated. Calculations and statistics were performed using Microsoft Excel© 2019 (USA) program.

Ethics Committee Approval

Our study was initiated with the permission of the Ethics Committee of University of Health Sciences Turkey, İzmir Tepecik Education and Research Hospital (ethics committee permission date and number: 06/06/2023-2023/05-17).

Cost Analysis of Unnecessary Direct LDL Orders

The LDL test results were calculated using the Friedewald formula from test results with TG levels ≤400 mg/dL. Therefore, the number of patients included in the study and the distribution of the ordering clinics was calculated. The additional cost of this test was calculated by determining the number of unnecessary tests ordered, the tender test price valid on the relevant dates, and the social security institution (SSI) reimbursement amount (SUT Annex-2b). The percentile of the amount paid for direct LDL and the other three parameters in outpatients was calculated according to the package fee. In addition, the percentage expression of the changed cost if computed LDL was used instead of the unnecessary direct LDL test was calculated.

Measurement Principles for Related Tests

All lipid profile parameters were measured on Beckman Coulter AU 5800 (Brea, California, USA) automated chemistry analyzers in the biochemistry laboratory of the hospital. TC was calculated using the enzymatic cholesterol esterase/oxidase method, and TG was calculated using the enzymatic glycerol phosphate oxidase method. HDL was measured by direct homogeneous assays without precipitation, and LDL was measured by a direct homogeneous assay using a selective preservative to separate LDL from chylomicrons, HDL, and VLDL and then calculated by the cholesterol esterase/oxidase method. All assays were performed using Beckman Coulter AU reagents and calibrators and Bio-Rad© (California, USA) internal quality control material.

Results

In the "Biochemistry Service Procurement for Results" tender dated and numbered 2021/202539 for our hospital, the HDL test purchase cost was determined as 4.704 TL, the TG test purchase cost as 3.535 TL, the TC test purchase cost as 3.227 TL, and the direct LDL test purchase cost as 4.75 TL. The SUT reimbursement costs of these tests were 3.98, 2.99, 3.0, and 6.23 TL, respectively. Outpatient clinic package fees were obtained from the SUT Annex-2A list. When the results of 720 patients included in the study were analyzed, the highest number of unnecessary direct LDL orders belonged to internal medicine outpatient clinic with 261 (36.25%), while the lowest number of orders belonged to dermatology, pulmonology, hematology, and psychiatry outpatient clinics with one order each (0.14%). Since the tender price per unit of direct LDL test was 4.75 TL and fixed, the unnecessary test cost ratio between 2022 and 2023 was proportional to the number of claims in terms of amount and was 36.25% and 0.14%, respectively.

Dermatology and anesthesia had lower SSI reimbursement outpatient clinic package fees than other outpatient clinics and had the highest unnecessary order cost/polyclinic package fee ratio (5.16%) as their examination fees were fixed at 31.75 TL for each outpatient clinic. Therefore, 7.88% of the amounts allocated for examinations in these two branches were allocated to unnecessary test orders. Among the tests that include lipid profile, direct LDL accounts for 41% of the cost of this test. Among outpatient clinics that ordered unnecessary LDL, anesthesia and dermatology outpatient clinics had the lowest package fee (TL 92.0), while cardiology outpatient clinic had the highest package fee with TL 146.00 (Table 1). Package fees defined for radiology and nuclear

Table 1. Distribution of tests in lipid panel according to polyclinics and cost analysis

Polyclinic	Number of LDL orders	% Distribution according to polyclinics	Lipid profile total tender price (Tl)	Direct LDL total cost (Tl)	Polyclinic SSI package fee (Tl)	Direct LDL cost/ package ratio (%)	SSI examination fee (Tl)	Lipid panel cost/ examination budget ratio (%)	Direct LDL cost/ examination budget ratio (%)
Internal medicine	**261**	**36.25**	11.51	**1239.75**	123.00	3.86	31.75	12.61	5.21
Endocrinology	79	10.97	11.51	375.25	122.00	3.89	31.75	12.75	5.26
Pediatrics	71	9.86	11.51	337.25	101.00	4.70	31.75	16.62	6.86
Gastroenterology	57	7.92	11.51	270.75	122.00	3.89	31.75	12.75	5.26
General surgery	54	7.50	11.51	256.50	122.00	3.89	31.75	12.75	5.26
Cardiology	53	7.36	11.51	251.75	146.00	3.25	31.75	10.07	4.16
Obstetric	44	6.11	11.51	209.00	132.00	3.60	31.75	11.48	4.74
Family medicine	31	4.31	11.51	147.25	99.00	4.80	31.75	17.12	7.06
Radiology	14	1.94	11.51	66.50	99.00	4.80	0.00	11.63	4.80
Eye diseases	7	0.97	11.51	33.25	96.00	4.95	31.75	17.91	7.39
Neurology	6	0.83	11.51	28.50	112.00	4.24	31.75	14.34	5.92
Urology	6	0.83	11.51	28.50	122.00	3.89	31.75	12.75	5.26
Infectious disease	6	0.83	11.51	28.50	122.00	3.89	31.75	12.75	5.26
Nephrology	6	0.83	11.51	28.50	123.00	3.86	31.75	12.61	5.21
Neurosurgery	5	0.69	11.51	23.75	122.00	3.89	31.75	12.75	5.26
Otolaryngology	5	0.69	11.51	23.75	96.00	4.95	31.75	17.91	7.39
Orthopedics	4	0.56	11.51	19.00	109.00	4.36	31.75	14.90	6.15
Anesthesiology	3	0.42	11.51	14.25	**92.00**	**5.16**	**31.75**	**19.10**	**7.88**
Genetics	2	0.28	11.51	9.50	99.00	4.80	31.75	17.12	7.06
Nuclear medicine	2	0.28	11.51	9.50	99.00	4.80	0.00	11.63	4.80
Dermatology	1	0.14	11.51	4.75	**92.00**	**5.16**	**31.75**	**19.10**	**7.88**
Pulmonology	1	0.14	11.51	4.75	109.00	4.36	31.75	14.90	6.15
Hematology	1	0.14	11.51	4.75	123.00	3.86	31.75	12.61	5.21
Psychiatry	1	0.14	11.51	4.75	109.00	4.36	31.75	14.90	6.15
Mean					**112.13**	**4.30**	**29.10**	**14.30**	**5.90**
Total	**720**	**100**		**3420**					

LDL: Low density lipoprotein, SSI: Social security institution

medicine units were reimbursed only if interventional procedures were performed.

Discussion

When our study results were analyzed, it was observed that the use of direct LDL measurements together with lipid parameters as reflex tests unnecessarily increased laboratory costs. Internal medicine specialists ranked first and endocrinology specialists ranked second with the highest number of unnecessary direct LDL orders. This ranking is not surprising when considering the patient profiles of the clinics and SSI reimbursement.

Two of the most important steps in the prevention of coronary heart disease are lifestyle modification and identification of risk factors. The most important risk factors are hypertension and hypercholesterolemia[8]. Cardiology, cardiovascular surgery, and endocrine and metabolism specialists are mainly involved in the detection and treatment of these risks. In addition to these disciplines, it should not be forgotten that hypercholesterolemia treatment can be arranged by

all specialist physicians in terms of preventive medicine. In parallel with this situation, the reimbursement conditions of the drugs to be used for treating hypercholesterolemia are periodically updated in the SUT. The latest drug reimbursement conditions are as follows:

According to the SUT dated 08/01/2019, all specialist physicians can issue a low-dose statin group (<40 mg for atorvastatin, <20 mg for rosuvastatin) drug report.

1. According to the SUT dated 24/06/2020, atorvastatin ≥40 mg and rosuvastatin ≥20 mg doses can be reported by cardiology, cardiovascular surgery, endocrinology, geriatrics, and neurology specialists in adults and pediatric metabolism, pediatric endocrinology, and pediatric cardiology specialists in children.

2. According to the SUT dated 18/05/2018, drugs with active ingredients fenofibrate and gemfibrozil can be reported by cardiology, cardiovascular surgery, endocrinology, internal medicine, and neurology physicians.

It is quite natural for physicians in these specialties to order lipid panel tests in the health centers where they work and thus to make erroneous orders. Similarly, in our study, the highest number of erroneous orders were made by internal medicine physicians. Endocrinology specialists ranked second. It can be said that patients cannot be examined directly by subspecialty physicians because of the health policies in our country; therefore, the data in our study are compatible with the results of the current health policies. Another factor contributing to the relatively lower number of erroneous orders by subspecialists specialized in treatment might be that patients whose lipid profile had been ordered by internal medicine were then referred to subspecialists, and these physicians had focused on the treatment of patients with elevated lipid profile tests (frequently LDL and TG) that were already estimated.

Of the 112,649 patient results obtained at the beginning of the study, only 720 patient results remained after the exclusion criteria. There may be several reasons for this situation. Because patients with hypercholesterolemia are frequently followed up by specialist family physicians at family health centers or secondary health care institutions, patients admitted to our hospital for treatment are mostly complicated cases (patients with acute coronary syndrome on the background of hypercholesterolemia, etc.). Because lipid profiles are often included in the periodic controls of these patients performed in external centers, only the elevated lipid parameter may have been requested. In addition, because our hospital is a hospital with A1 group training and research status, it is expected that the relevant clinics apply rational test ordering procedures in their test requests because they are training clinics and closely follow the current treatment guidelines. The fact that the number of test orders per patient was 4.01 tests between 2022 and 2023 in our hospital could be considered as an indicator of the success of this practice.

Unnecessary test requests are one of the most important reasons for increasing laboratory and therefore institutional resources to be used more than necessary[9]. These unnecessary requests are usually due to the physician's concern that the diagnosis may be overlooked or the desire to present the diagnosis/condition in uncertain situations[10]. In particular, training clinics that order LDL and organize the treatment of hypercholesterolemia should focus more on rational test ordering, which may provide significant savings in hospital costs. In emergency services (yellow and red areas) and oncology services, which were not included in the study, tests are charged outside the package when appropriate conditions are provided. While the cost per direct LDL test is 4.75 TL, the SUT reimbursement is 6.23 TL. Although the return to the hospital per test is +1.48 TL, it costs the social security institution -6.23 TL/test in real terms.

In addition, the use of machine learning algorithms from artificial intelligence technologies is increasing. These algorithms are particularly used to help predict the result of a target laboratory test using other laboratory tests. There are studies that have achieved successful results in predicting the LDL test, which is the subject of our article[11,12]. In the future, the costs of producing more accurate results can be further minimized by calculating the results from other parameters using classical methods or artificial intelligence instead of analyzing the tests.

Study Limitations

The limitations of this study include the inability to compare the reduction in the number of unnecessary test requests and costs with the reflex test application established according to certain rules compared with the previous situation.

Conclusion

As a result of this study, it can be said that the use of computational LDL test (Friedewald, Martin-Hopkins, Sampson, etc. formulas) instead of direct LDL test ordering

when requesting lipid profile in individuals with risk factors and who are provided for the first time, and then targeted test ordering (TG for hypertriglyceridemic patients and/or direct LDL for hypercholesterolemic patients) is more cost-effective in terms of institutions and national economy.

Ethics

Ethics Committee Approval: Our study was initiated with the permission of the Ethics Committee of University of Health Sciences Turkey, İzmir Tepecik Education and Research Hospital (ethics committee permission date and number: 06/06/2023-2023/05-17).

Informed Consent: No specific patient or patient results were used. Only test order numbers were received from clinics.

Authorship Contributions

Concept: F.D., Design: F.D., M.Z.K., Data Collection or Processing: F.D., M.A., Analysis or Interpretation: F.D., M.A., M.Z.K., Literature Search: F.D., Writing: F.D.

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