RESEARCH ARTICLE

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# Impact of Rational Laboratory Practice on Hospital Procedure Costs Based on Evidence-Based Medicine: Case Study in a University Hospital

**ABSTRACT**

**Objective:** By integrating the rational laboratory system into hospital processes with evidence-based medicine applications, it is ensured that hospital resources are used more effectively and efficiently by preventing unnecessary test requests and reducing laboratory operation costs.

**Methods:** The data in this qualitative study are the primary data and were obtained through document review and focus group (physician) interviews. The data in question were analyzed comparatively before the Rational Laboratory Application (RLA) (between 01.06.2018-31.12.2018) and after the RLA (between 01.06.2019-31.12.2019). The universe of the study consists of all the data in the laboratory of Düzce University Health Application and Research Center Hospital (DUHARCH). In this universe, the data evaluated for rational laboratory application constitute the sample of the research.

**Results:** Before the RLA, a total of 446,300 test requests were made in the seven months (in 2018) and the cost of these tests was determined to be 1,591,063 ₺ ($ 330,782.33). After the RLA, a total of 475,585 test requests were made in the seven months (in 2019), and the cost of these tests was determined to be 1,537,903 ₺ ($ 271,235.10). It was found that after RLA, there was a 6.56% increase in the number of examination requests compared to before RLA, but as an amount, costs fell by 3.34% on a ₺ basis and 22% on a $ basis. In the unit-based analysis, it was seen that successful units were surgical, and unsuccessful units were internal units that requested more tests.

**Conclusions:** It was concluded that the rational laboratory system based on evidence-based medicine reduces hospital processing costs, provided that patient safety is protected, so this method can be a tool for more effective and efficient use of hospital resources.

**Keywords:** Evidence-Based Medicine, Rational Laboratory Application, Hospital Costs, Cost Management.

# Kanıta Dayalı Tıp Ekseninde Akılcı Laboratuvar Uygulamasının Hastane İşlem Maliyetleri Üzerindeki Etkisi: Bir Üniversite Hastanesinde Vaka Çalışması

**ÖZET**

**Amaç:** Kanıta dayalı tıp uygulamalarıyla akılcı laboratuvar sistemini hastane süreçlerine entegre ederek gereksiz tetkik istemlerini engelleyip laboratuvar işlem maliyetlerini düşürerek hastane kaynaklarının daha etkin ve verimli kullanılmasını sağlamaktır.

**Gereç ve Yöntem:** Nitel bir araştırma olan bu çalışmadaki veriler birincil veri niteliğini taşımakta olup doküman incelemesi ve odak grup (hekim) görüşmeleriyle elde edilmiştir. Söz konusu veriler, Akılcı Laboratuvar Uygulaması (ALU) öncesi (01.06.2018-31.12.2018 tarihleri arası) ve ALU sonrası (01.06.2019-31.12.2019 tarihleri arası) karşılaştırmalı olarak analiz edilmiştir. Çalışmanın evreni Düzce Üniversitesi Sağlık Uygulama ve Araştırma Merkezi (Hastanesi)'nin laboratuvardaki tüm verilerden oluşurken bu evren içerisinde akılcı laboratuvar uygulaması için değerlendirilen veriler ise araştırmanın örneklemini oluşturmaktadır.

**Bulgular:** ALU öncesi 2018/7 aylık dönemde toplam 446.300 adet tetkik istemi yapılmış ve bu tetkiklerin maliyeti 1.591.063 ₺ ($ 330,782.33) olarak tespit edilmiştir. ALU sonrası 2019/7 aylık dönemde ise toplam 475.585 adet tetkik istemi yapılmış ve bu tetkiklerin maliyeti 1.537.903 ₺ ($ 271,235.10) olarak tespit edilmiştir. ALU sonrası, ALU öncesine göre tetkik istem sayılarında %6.56 artışın olduğu, fakat tutar olarak ise ₺ bazında %3.34, $ bazında %22 oranında maliyetlerin düştüğü tespit edilmiştir. Birim bazında yapılan analizde başarılı birimlerin cerrahi, başarısız birimlerin ise daha çok tetkik isteminde bulunan dâhili birimlerin olduğu görülmüştür.

**Sonuç:** Hasta güvenliğini korumak şartıyla kanıta dayalı tıp ekseninde uygulanan akılcı laboratuvar sisteminin hastane işlem maliyetlerini azalttığı bu nedenle bu yöntemin hastane kaynaklarının daha etkin ve verimli kullanılabilmesinde bir araç olabileceği sonucuna varılmıştır.

**Anahtar Kelimeler:** Kanıta Dayalı Tıp, Akılcı Laboratuvar Uygulaması, Hastane Maliyetleri, Maliyet Yönetimi.

## INTRODUCTION

Rational use applications, which have become increasingly important especially in recent years, have become a system that encourages the presence of more logical, reliable, reasonable, and conscientious medical systems. Rational laboratory use practice based on evidence aims to reduce the high health expenses by preventing unnecessary test requests. In this respect, rational laboratory use means the rational use of laboratory services to provide an accurate diagnosis, to prevent unnecessary tests, and to reduce costs (1).

When a physician requests any test, he or she must evaluate the suitability, effectiveness, reliability, and cost of the test in advance. If the test is necessary, it is useful to show scientific evidence and to demonstrate the necessity in the light of this scientific evidence (2).

Evidence-based medicine is quickly making clinical application more scientifically and empirically based to provide practical evidence depended on the best evidence research summaries. Evidence-based medicine thus involves building implementation strategies that are committed to providing safer, more consistent, and less costly care (3-4).

Rational laboratory use can be defined as effective and correct laboratory use by making the most accurate test request in the light of correct clinical questions and evidence-based information, taking into account patient-employee safety and cost-effectiveness (5).

In general, non-rational drug, laboratory, radiology, pathology, biochemistry, tissue typing, and microbiology laboratories applications, and rational billing procedures are among the most fundamental problems of health organizations. Such problems reach greater dimensions especially in developing countries and underdeveloped countries. Rational applications have started to show their effectiveness gradually to eliminate these problems, which are a huge financial burden for health organizations.

To increase the clinical usefulness of test results in our country, to ensure the correct diagnosis of the patient, to prevent unnecessary test requests, to ensure that test requests can be maintained cost-effectively, the "Rational Laboratory Use Project", which covers medical microbiology, medical biochemistry, tissue typing, and medical pathology laboratories were first handled by Ministry of Health, General Directorate of Health Services (Inspection and Diagnostic Services Department) in 2016 (6-7-8).

Unnecessary requests, unnecessary intervention, unnecessary tests, and unnecessary treatments are the most important factors that threaten the health of patients in healthcare and cause an increase in care costs. In this respect, the necessity of rational use is needed (9).

The main purpose of this study is to integrate the rational laboratory system into the hospital processes, to protect patient safety and to prevent unnecessary test requests, to reduce procedures and costs by developing rational strategies, and to ensure effective and efficient management of health expenditures.

For this purpose, the transition process to the application related to the recommendations of the Ministry of Health has been started at the (DUHARCH). The effect of this process on hospital costs was analyzed following the problem and purpose of this study.

## MATERIAL AND METHODS

To start RLA, it was decided to establish a commission consisting of representatives of microbiology, medical biochemistry, infection industry experts, information processing, and hospital administration by DUHARCH. In the studies carried out by the commission, within the scope of the Rational Laboratory Use Project, the use of microbiology and medical biochemistry tests in outpatient applications was determined as the first step. At the same time, departments were asked by the commission to make suggestions for the RLA system. By the scientific evidence-based suggestions from the departments, it was decided to make arrangements in the tests that are not within the scope of rational laboratories. As a result, it was put into practice with the decision to be implemented and to observe the process in March 2019.

In March 2019, it was decided that some changes should be made to the Hospital Information Management System (HIMS) by The Rational Laboratory Commission to start implementation. To initiate the application under its purpose, software improvements were made in HIMS for obstructive restrictions such as test repeat constraint, branch constraint, day constraint, request number constraint, and not re-requesting the same test without the result of the previous request, and the arrangement made was announced to all hospital staff.

In this context, a change would be revealed before and after RLA by analyzing the data available in the hospital database for test requests in-hospital processes.

This research, which aims to adopt a cost-effective approach to practice by avoiding unnecessary test requests in the process of integrating a rational laboratory system into hospital processes, is a descriptive type of research with a screening model. The reason why this research is with a screening model is that the data is not reproduced by the researcher as in the trial model. The data from the study was obtained from the database and attended meetings like the screening model.

DUHARCH's entire database and healthcare professionals constitute the general universe of the research. The study universe of the study is composed of the rational laboratory data available in the DUHARCH database and the healthcare professionals involved in this study. As a result of the information provided, the universe of this study was determined in one category. This is formed according to the document analysis technique, which is the method of collecting research data. Accordingly, DUHARCH's database formed the universe of work on document analysis techniques. In this universe, the data evaluated for rational laboratory application constitute the sample of the research.

## RESULTS

The evidence-based medicine pyramid levels of the studies related to the analyzed tests were determined as follows (Table 1), taking into account the codes in the Health Implementation Communique (HIC).

**Table 1.** Evidence-based medicine pyramid levels of studies related to the tests analyzed

| Evidence-Based Medicine Pyramid Levels of Studies Related to Analyzed Investigations | | | | | | | |
|---|---|---|---|---|---|---|---|
| **R.Nu** | **Assay Name** | **HIC Code** | **Request Unit Constraint (On)** | **Request Unit Constraint (Closed)** | **Scientific Evidence Level** | **Source** | **RLA Test Request Time (Days)** |
| 1 | 25-Hydroxy Vitamin D | 900130 | Child Health and Diseases, Physical Medicine and Rehabilitation, Pediatric Endocrinology, Orthopedics and Traumatology, Neonatology, Pediatric Nephrology, Pediatric Surgery, Gynecology and Obstetrics, Pediatric Cardiology, Nephrology, Child and Adolescent Mental Health and Diseases, Pediatric Endocrinology, Neurology, Internal Medicine | Forensic Medicine, Family Medicine, Anesthesiology and Reanimation, Brain and Nerve Surgery, Skin and Venereal Diseases, Endocrinology and Metabolism Diseases, Infectious Diseases, Gastroenterology, General Surgery, Thoracic Surgery, Chest Diseases, Ophthalmology, Hematology, Hemodialysis, Cardiovascular Surgery , Cardiology, Ear-Nose-Throat Diseases, Mental Health and Diseases. | Article: Retrospective analysis KP: Case control studies Level 3 | (10) | 30 |
| 2 | Folate (Serum / Plasma) | 901240 | Child Health and Diseases, Physical Medicine and Rehabilitation, Pediatric Endocrinology and Metabolic Diseases, Anesthesiology and Reanimation, Mental Health and Diseases, Medical Oncology, Orthopedics and Traumatology, Neonatology, Pediatric Nephrology, Pediatric Surgery, Gynecology and Obstetrics, Pediatric Cardiology, Gastroenterology, , Nephrology, Child and Adolescent Mental Health and Diseases, Endocrinology and Metabolic Diseases, Dermatology and Venereal Diseases, Hematology, Hemodialysis, Neurology, Internal Medicine. | Forensic Medicine, Family Medicine, Brain and Nerve Surgery, Infectious Diseases, General Surgery, Thoracic Surgery, Chest Diseases, Eye Diseases, Cardiovascular Surgery, Cardiology, Ear-Nose-Throat Diseases, Urology. | Article: Retrospective analysis KP: Case control studies Level 3 | (11-12-13-14) | 42 |
| 3 | PSA (Prostate specific antigen) | 903220 | Anesthesiology and Reanimation, Medical Oncology, Family Medicine, Gastroenterology, Nephrology, Endocrinology and Metabolic Diseases, Dermatology and Venereal Diseases, Urology, Internal Medicine | Brain and Nerve Surgery, Pediatric Surgery, Pediatric Endocrinology, Pediatric Cardiology, Pediatric Nephrology, Infectious Diseases, Physical Medicine and Rehabilitation, General Surgery, Thoracic Surgery, Chest Diseases, Ophthalmology, Hematology, Hemodialysis, Gynecology and Obstetrics, Cardiovascular Surgery , Cardiology, Ear-Nose-Throat Diseases, Neonatology, Neurology, Orthopedics and Traumatology, Mental Health and Diseases. | Article: Retrospective analysis KP: Case control studies Level 3 | (15) | 28 |
| 4 | Free T3 | 903470 | Child Health and Diseases, Pediatric Endocrinology, Medical Oncology, Neonatology, Pediatric Nephrology, Pediatric Surgery, Gynecology and Obstetrics, Family Medicine, Pediatric Cardiology, Gastroenterology, General Surgery, Nephrology, Pediatric and Adolescent Mental Health and Diseases, Forensic Medicine, Pediatric Endocrinology , Endocrinology and Metabolic Diseases, Hematology, Hemodialysis, Neurology, Internal Medicine. | Anesthesiology and Reanimation, Brain and Nerve Surgery, Skin and Venereal Diseases, Infectious Diseases, Physical Medicine and Rehabilitation, Thoracic Surgery, Chest Diseases, Eye Diseases, Cardiovascular Surgery, Cardiology, Ear-Nose-Throat Diseases, Orthopedics and Traumatology, Mental Health and Diseases, Urology. | Article: Retrospective analysis KP: Case control studies Level 3 | (16-17-18-19) | 13 |
| 5 | Free T4 | 903480 | Child Health and Diseases, Medical Oncology, Neonatology, Pediatric Nephrology, Pediatric Surgery, Gynecology and Obstetrics, Family Medicine, Pediatric Cardiology, Gastroenterology, General Surgery, Nephrology, Child and Adolescent Mental Health and Diseases, Forensic Medicine, Pediatric Endocrinology, Endocrinology and Metabolic Diseases, Hemodialysis, Neurology, Internal Medicine. | Anesthesiology and Reanimation, Brain and Nerve Surgery, Skin and Venereal Diseases, Infectious Diseases, Physical Medicine and Rehabilitation, Thoracic Surgery, Chest Diseases, Eye Diseases, Cardiovascular Surgery, Cardiology, Ear-Nose-Throat Diseases, Orthopedics and Traumatology, Mental Health and Diseases, Urology, | 1.2.3.4. Article: Retrospective analysis KP: Case control studies Level 3 | (16-17-18-19) | 13 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6 | Vitamin B12 | 904150 | Child Health and Diseases, Physical Medicine and Rehabilitation, Pediatric Endocrinology and Metabolic Diseases, Anesthesiology and Reanimation, Mental Health and Diseases, Medical Oncology, Orthopedics and Traumatology, Neonatology, Pediatric Nephrology, Pediatric Surgery, Gynecology and Obstetrics, Pediatric Cardiology, Gastroenterology, Nephrology, Child and Adolescent Mental Health and Diseases, Child Endocrinology, Endocrinology and Metabolic Diseases, Dermatology and Venereal Diseases, Hematology, Hemodialysis, Neurology, Internal Medicine. | Forensic Medicine, Family Medicine, Brain and Nerve Surgery, Infectious Diseases, General Surgery, Thoracic Surgery, Chest Diseases, Eye Diseases, Cardiovascular Surgery, Cardiology, Ear-Nose-Throat Diseases, Urology. | Article 1: Retrospective analysis 1.KP: Case control studies Level 3 | (14-20) | 30 |
| 7 | Anti CMV IgG (Microparticle immune assay-MEIA or similar) | 906360 | Child Health and Diseases, Pediatric Endocrinology and Metabolic Diseases, Neonatology, Pediatric Nephrology, Pediatric Surgery, Pediatric Cardiology, Child and Adolescent Mental Health and Diseases, Pediatric Endocrinology, Infectious Diseases, Internal Medicine | Forensic Medicine, Family Medicine, Anesthesiology and Reanimation, Brain and Nerve Surgery, Skin and Venereal Diseases, Endocrinology and Metabolic Diseases, Physical Medicine and Rehabilitation, Gastroenterology, General Surgery, Thoracic Surgery, Chest Diseases, Ophthalmology, Hematology, Hemodialysis, Gynecology and Obstetrics, Cardiovascular Surgery, Cardiology, Ear-Nose-Throat Diseases, Nephrology, Neurology, Orthopedics and Traumatology, Mental Health and Diseases, Medical Oncology, Urology. | Article: Retrospective analysis KP: Case control studies KP: Systematic Review (23) Level 1, Level 3 | (21-22-23-24-25) | On the same day the test is not repeated. |
| 8 | Anti CMV IgM (Microparticle immune assay-MEIA or similar) | 906370 | Child Health and Diseases, Pediatric Endocrinology and Metabolic Diseases, Neonatology, Pediatric Nephrology, Pediatric Surgery, Pediatric Cardiology, Gastroenterology, Pediatric Endocrinology, Infectious Diseases, Internal Medicine. | Forensic Medicine, Family Medicine, Anesthesiology and Reanimation, Brain and Nerve Surgery, Child and Adolescent Mental Health, Dermatology and Venereal Diseases, Endocrinology and Metabolism Diseases, Physical Medicine and Rehabilitation, General Surgery, Thoracic Surgery, Chest Diseases, Eye Diseases, Hematology, Hemodialysis, Gynecology and Obstetrics, Cardiovascular Surgery, Cardiology, Ear-Nose-Throat Diseases, Nephrology, Neurology, Orthopedics and Traumatology, Mental Health and Diseases, Medical Oncology, Medical Urology. | Article: Retrospective analysis KP: Case control studies KP: Systematic Review (23) Level 1, Level 3 | (21-22-23-24-25) | On the same day the test is not repeated. |
| 9 | Anti HAV IgG (Microparticle immune assay-MEIA or similar) | 906510 | Pediatric Health and Diseases, Pediatric Endocrinology and Metabolic Diseases, Anesthesiology and Reanimation, Neonatology, Pediatric Nephrology, Pediatric Surgery, Gastroenterology, Pediatric Cardiology, Nephrology, Pediatric Endocrinology, Dermatology and Venereal Diseases, Hematology, Infectious Diseases and Clinical Microbiology, Internal Medicine | Forensic Medicine, Family Medicine, Brain and Nerve Surgery, Child and Adolescent Mental Health, Endocrinology and Metabolic Diseases, Physical Medicine and Rehabilitation, General Surgery, Thoracic Surgery, Chest Diseases, Eye Diseases, Hemodialysis, Gynecology and Obstetrics, Cardiovascular Surgery , Cardiology, Ear-Nose-Throat Diseases, Neurology, Orthopedics and Traumatology, Mental Health and Diseases, Medical Oncology, Urology. | Article: Retrospective analysis KP: Case control studies KP: Systematic Review (23) Level 1, Level 3 | (21-22-23-24-25) | On the same day the test is not repeated |
| 10 | Anti HAV IgM (Microparticle immune assay-MEIA or similar) | 906530 | Pediatric Health and Diseases, Pediatric Endocrinology and Metabolic Diseases, Anesthesiology and Reanimation, Neonatology, Pediatric Nephrology, Pediatric Surgery, Pediatric Cardiology, Gastroenterology, Nephrology, Pediatric Endocrinology, Dermatology and Venereal Diseases, Hematology, Infectious Diseases and Clinical Microbiology, Internal Medicine | Forensic Medicine, Family Medicine, Brain and Nerve Surgery, nChild and Adolescent Mental Health, Endocrinology and Metabolic Diseases, Physical Medicine and Rehabilitation, General Surgery, Thoracic Surgery, Chest Diseases, Eye Diseases, Hemodialysis, Gynecology and Obstetrics, Cardiovascular Surgery , Cardiology, Ear-Nose-Throat Diseases, Neurology, Orthopedics and Traumatology, Mental Health and Diseases, Medical Oncology, Urology. | Article: Retrospective analysis KP: Case control studies KP: Systematic Review (23) Level 1, Level 3 | (21-22-23-24-25) | On the same day the test is not repeated. |
| 11 | Anti Hbc IgG (Microparticle immune assay-MEIA or similar) | 906560 | Pediatric Health and Diseases, Pediatric Endocrinology and Metabolic Diseases, Anesthesiology and Reanimation, Medical Oncology, Neonatology, Pediatric Nephrology, Pediatric Surgery, Pediatric Cardiology, Gastroenterology, Nephrology, Child and Adolescent Mental Health and Diseases, Pediatric Endocrinology, Pediatric, Endocrinology and Metabolism Diseases, Skin and Venereal Diseases, Hematology, Infectious Diseases and Clinical Microbiology, Internal Medicine. | Forensic Medicine, Family Medicine, Brain and Nerve Surgery, Physical Medicine and Rehabilitation, General Surgery, Thoracic Surgery, Chest Diseases, Eye Diseases, Hemodialysis, Gynecology and Obstetrics, Cardiovascular Surgery, Cardiology, Ear-Nose-Throat Diseases, Neurology Orthopedics and Traumatology, Mental Health and Diseases, Urology. | Article: Retrospective analysis KP: Case control studies KP: Systematic Review (23) Level 1, Level 3 | (21-22-23-24-25) | 365 |

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|---|---|---|---|---|---|---|---|
| 12 | Anti HBc IgM (Microparticle immune assay-MEIA or similar) | 906580 | Pediatric Health and Diseases, Pediatric Endocrinology and Metabolic Diseases, Anesthesiology and Reanimation, Medical Oncology, Neonatology, Pediatric Nephrology, Pediatric Surgery, Pediatric Cardiology, Gastroenterology, Nephrology, Pediatric Endocrinology, Endocrinology and Metabolic Diseases, Dermatology and Venereal Diseases, Hematology and Clinical Microbiology, Internal Medicine. | Forensic Medicine, Family Medicine, Brain and Nerve Surgery, Child and Adolescent Mental Health, Physical Medicine and Rehabilitation, General Surgery, Thoracic Surgery, Chest Diseases, Eye Diseases, Hemodialysis, Gynecology and Obstetrics, Cardiovascular Surgery, Cardiology, Ear-Nose and Throat Diseases, Neurology, Orthopedics and Traumatology, Mental Health and Diseases, Urology, | Article: Retrospective analysis KP: Case control studies KP: Systematic Review (23) Level 1, Level 3 | (21-22-23-24-25) | 365 |
| 13 | Anti HBe (Microparticle immune assay-MEIA or similar) | 906600 | Child Health and Diseases, Pediatric Endocrinology and Metabolic Diseases, Anesthesiology and Reanimation, Neonatology, Pediatric Nephrology, Pediatric Surgery, Pediatric Cardiology, Gastroenterology, Nephrology, Pediatric Endocrinology, Endocrinology and Metabolic Diseases, Hematology, Infectious Diseases and Clinical Microbiology | Forensic Medicine, Family Medicine, Brain and Nerve Surgery, Child and Adolescent Mental Health, Skin and Venereal Diseases, Physical Medicine and Rehabilitation, General Surgery, Thoracic Surgery, Chest Diseases, Ophthalmology, Hemodialysis, Gynecology and Obstetrics, Cardiovascular Surgery , Cardiology, Ear-Nose-Throat Diseases, Neurology, Orthopedics and Traumatology, Mental Health and Diseases, Medical Oncology, Urology. | Article: Retrospective analysis KP: Case control studies KP: Systematic Review (23) Level 1, Level 3 | (21-22-23-24-25) | 365 |
| 14 | Anti rubella IgG (Chemiluminescence or similar) | 906820 | Pediatric Health and Diseases, Pediatric Endocrinology and Metabolic Diseases, Neonatology, Pediatric Nephrology, Pediatric Surgery, Gastroenterology, Pediatric Cardiology, Pediatric Endocrinology, Infectious Diseases and Clinical Microbiology, Internal Medicine. | Forensic Medicine, Family Medicine, Anesthesiology and Reanimation, Brain and Nerve Surgery, Child and Adolescent Mental Health, Dermatology and Venereal Diseases, Endocrinology and Metabolism Diseases, Physical Medicine and Rehabilitation, General Surgery, Thoracic Surgery, Chest Diseases, Eye Diseases, Hematology, Hemodialysis, Gynecology and Obstetrics, Cardiovascular Surgery, Cardiology, Ear-Nose-Throat Diseases, Nephrology, Neurology, Orthopedics and Traumatology, Mental Health and Diseases, Medical Oncology, Urology. | Article: Retrospective analysis KP: Case control studies KP: Systematic Review (23) Level 1, Level 3 | (21-22-23-24-25) | On the same day the test is not repeated |
| 15 | Anti rubella IgM (Chemiluminescence or similar) | 906840 | Pediatric Health and Diseases, Pediatric Endocrinology and Metabolic Diseases, Neonatology, Pediatric Nephrology, Pediatric Surgery, Pediatric Cardiology, Gastroenterology, Pediatric Endocrinology, Infectious Diseases and Clinical Microbiology, Internal Medicine. | Forensic Medicine, Family Medicine, Anesthesiology and Reanimation, Brain and Nerve Surgery, Child and Adolescent Mental Health, Dermatology and Venereal Diseases, Endocrinology and Metabolism Diseases, Physical Medicine and Rehabilitation, Hematology, Hemodialysis, Gynecology and Obstetrics, Cardiovascular Surgery, Cardiology, Ear-Nose-Throat Diseases, Nephrology, Neurology, Orthopedics and Traumatology, Mental Health and Diseases, Medical Oncology, Urology. | Article: Retrospective analysis KP: Case control studies KP: Systematic Review (23) Level 1, Level 3 | (21-22-23-24-25) | On the same day the test is not repeated |
| 16 | Anti toxoplasma IgG (Chemiluminescence or similar) | 906910 | Pediatric Health and Diseases, Pediatric Endocrinology and Metabolic Diseases, Neonatology, Pediatric Nephrology, Pediatric Surgery, Pediatric Cardiology, Gastroenterology, Pediatric Endocrinology, Infectious Diseases and Clinical Microbiology, Internal Medicine. | Forensic Medicine, Family Medicine, Anesthesiology and Reanimation, Brain and Nerve Surgery, Child and Adolescent Mental Health, Dermatology and Venereal Diseases, Endocrinology and Metabolism Diseases, Physical Medicine and Rehabilitation, General Surgery, Thoracic Surgery, Chest Diseases, Eye Diseases,, Hematology Hemodialysis, Gynecology and Obstetrics, Cardiovascular Surgery, Cardiology, Ear-Nose-Throat Diseases, Nephrology, Neurology, Orthopedics and Traumatology, Mental Health and Diseases, Medical Oncology, Urology. | Article: Retrospective analysis KP: Case control studies KP: Systematic Review (23) Level 1, Level 3 | (21-22-23-24-25) | On the same day the test is not repeated. |
| 17 | Anti toxoplasma IgM (Chemiluminescence or similar) | 906930 | Child Health and Diseases, Neonatology, Pediatric Nephrology, Gastroenterology, Infectious Diseases and Clinical Microbiology. | Forensic Medicine, Family Medicine, Anesthesiology and Reanimation, Brain and Nerve Surgery, Pediatric Surgery, Pediatric Endocrinology, Pediatric Endocrinology, Pediatric Cardiology, Child and Adolescent Mental Health, Dermatology and Venereal Diseases, Endocrinology and Metabolic Diseases, Physical Medicine and Rehabilitation, General Surgery , Thoracic Surgery, Chest Diseases, Eye Diseases, Hematology, Hemodialysis, Internal Diseases, Gynecology and Obstetrics, Cardiovascular Surgery, Cardiology, Ear-Nose-Throat Diseases, Nephrology, Neurology, Orthopedics and Traumatology, Mental Health and Diseases, Medical Oncology, Urology. | Article: Retrospective analysis KP: Case control studies KP: Systematic Review (23) Level 1, Level 3 | (21-22-23-24-25) | On the same day the test is not repeated |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 18 | HBeAg Qual (Chemoluminescence or similar) | 907420 | Pediatric Health and Diseases, Pediatric Endocrinology and Metabolic Diseases, Anesthesiology and Reanimation, Neonatology, Pediatric Nephrology, Pediatric Surgery, Pediatric Cardiology, Gastroenterology, Nephrology, Pediatric Endocrinology, Endocrinology and Metabolic Diseases, Hematology, Hemodialysis, Infectious Diseases and Clinical Microbiology . | Forensic Medicine, Family Medicine, Brain and Nerve Surgery, Child and Adolescent Mental Health, Skin and Venereal Diseases, Physical Medicine and Rehabilitation, General Surgery, Thoracic Surgery, Chest Diseases, Eye Diseases, Gynecology and Obstetrics, Cardiovascular Surgery, Cardiology , Ear-Nose-Throat Diseases, Neurology, Orthopedics and Traumatology, Mental Health and Diseases, Medical Oncology, Urology. | Article: Retrospective analysis KP: Case control studies KP: Systematic Review (23) Level 1, Level 3 | (21-22-23-24-25) | 365 |

Evidence-based levels (Table 1) were determined for 18 tests, which are the most demand and cost included in the Ministry of Health's rational laboratory test request procedure. Thus, a rational approach was developed for the units that resist the branch constraint. In other words, the scientific basis of the restriction was supported by the most up-to-date scientific studies for the interlocutors. Thus, it was shown that the objectors are contrary to current scientific literature. It was observed that those who supported their objections with evidence-based medical articles removed the restriction in the process. Therefore, the process is liberated from the naturalistic structure. At the end of the dynamic and interactive process, cost analyzes were made for 18 tests. It was observed that both the cost and the number of test requests of the 18 analysis of which evidence levels were determined decreased (Table 3).

At the unit-based findings stage of the RLA's created as a result of studies on evidence-based medicine, analyzes (Table 2) for each polyclinic were made as follows.

**Table 2.** Pre and post-RLA change rates for units

| **Outpatient Application** | **Before RLA (01.06.2018 - 31.12.2018)** | | | **After RLA (01.06.2019 - 31.12.2019)** | | | **(a-d)/a *100** | **(b-e)/b *100** | **f-c** | **((a/b)* 100) - ((d/e) *100)** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Units** | **(a) Application Numb. (Piece)** | **(b) RLA Number of Assays (Piece)** | **(c) RLA Assay Amount (₺)** | **(d) Application Numb. (Piece)** | **(e) RLA Number of Assays (Piece)** | **(f) RLA Assay Amount (₺)** | **Application Number of Change Rate (%)** | **RLA Number of Test Change Rate (%)** | **RLA Assay Amount Difference (₺)** | **Applic. Average Analysis Request.Differ.** |
| Forensic Medicine | 45 | 140 | 789 | 58 | 163 | 821 | 28,89 | 16,43 | 33 | 3,44 |
| Family Medicine | 4.047 | 34.883 | 126.822 | 4.563 | 32.220 | 74.396 | 12,75 | -7,63 | -52.426 | 2,56 |
| Anesthesiology and Reanimation | 121 | 474 | 1.640 | 164 | 590 | 2.039 | 35,54 | 24,47 | 399 | 2,27 |
| Brain and Nerve Surgery | 370 | 3.050 | 11.198 | 342 | 1.943 | 5.880 | -7,57 | -36,30 | -5.317 | 5,47 |
| Pediatric Surgery | 105 | 252 | 898 | 92 | 274 | 910 | -12,38 | 8,73 | 12 | -8,09 |
| Children's Endocrinology | 2.768 | 15.012 | 58.548 | 3.059 | 18.405 | 76.547 | 10,51 | 22,60 | 17.999 | -1,82 |
| Child Nephrology | 0 | 0 | 0 | 2.113 | 12.050 | 29.910 | - | - | 29.910 | 0,00 |
| Child Neurology | 0 | 0 | 0 | 172 | 1.235 | 6.383 | - | - | 6.383 | 0,00 |
| Child Health and Diseases | 7.148 | 41.188 | 147.032 | 4.330 | 26.437 | 96.743 | -39,42 | -35,81 | -50.289 | -0,98 |
| Child and Adolescent Mental Health and Diseases | 537 | 4.518 | 15.708 | 598 | 5.873 | 20.958 | 11,36 | 29,99 | 5.250 | -1,70 |
| Skin and Venereal Diseases | 1.643 | 8.613 | 27.782 | 2.295 | 13.011 | 43.929 | 39,68 | 51,06 | 16.147 | -1,44 |
| Endocrinology and Metabolic Diseases | 0 | 0 | 0 | 1 | 12 | 28 | - | - | 28 | 0,00 |
| Infectious Diseases and Clinical Microbiology | 2.545 | 16.191 | 76.396 | 3.200 | 18.140 | 74.148 | 25,74 | 12,04 | -2.248 | 1,92 |
| Physical Medicine and Rehabilitation | 1.992 | 15.279 | 66.474 | 3.715 | 29.945 | 109.767 | 86,50 | 95,99 | 43.292 | -0,63 |
| Gastroenterology | 1.820 | 14.056 | 49.699 | 1.386 | 9.761 | 34.475 | -23,85 | -30,56 | -15.224 | 1,25 |
| General Surgery | 2.329 | 15.469 | 58.469 | 3.056 | 18.355 | 56.820 | 31,22 | 18,66 | -1.649 | 1,59 |
| Thoracic Surgery | 511 | 1.382 | 4.804 | 534 | 1.230 | 3.615 | 4,50 | -11,00 | -1.188 | 6,44 |
| Chest Diseases | 2.993 | 8.495 | 22.416 | 2.586 | 8.631 | 17.949 | -13,60 | 1,60 | -4.468 | -5,27 |
| Eye diseases | 452 | 1.477 | 8.623 | 198 | 731 | 2.744 | -56,19 | -50,51 | -5.880 | -3,52 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Hematology | 2.155 | 17.571 | 58.913 | 272 | 1.829 | 5.343 | -87,38 | -89,59 | -53.570 | 2,61 |
| Internal diseases | 8.059 | 81.448 | 294.512 | 9.721 | 93.669 | 330.898 | 20,62 | 15,00 | 36.386 | 0,48 |
| Gynecology and Obstetrics | 6.339 | 31.509 | 125.490 | 8.532 | 38.973 | 130.523 | 34,60 | 23,69 | 5.033 | 1,77 |
| Cardiac surgery | 97 | 431 | 1.042 | 90 | 440 | 859 | -7,22 | 2,09 | -183 | -2,05 |
| Cardiology | 3.750 | 24.363 | 56.378 | 4.562 | 26.209 | 43.393 | 21,65 | 7,58 | -12.985 | 2,01 |
| Ear-Nose-Throat Diseases | 950 | 8.376 | 38.805 | 727 | 4.767 | 12.224 | -23,47 | -43,09 | -26.582 | 3,91 |
| Nephrology | 4.171 | 44.618 | 135.029 | 6.213 | 67.352 | 232.864 | 48,96 | 50,95 | 97.836 | -0,12 |
| Neonatology | 254 | 857 | 1.016 | 181 | 628 | 809 | -28,74 | -26,72 | -208 | -0,82 |
| neurology | 2.118 | 19.320 | 74.921 | 1.580 | 12.233 | 34.611 | -25,40 | -36,68 | -40.310 | 1,95 |
| Orthopedics and Traumatology | 1.339 | 9.517 | 37.304 | 1.310 | 6.398 | 19.075 | -2,17 | -32,77 | -18.229 | 6,41 |
| Mental Health and Diseases | 199 | 1.373 | 5.763 | 93 | 566 | 1.565 | -53,27 | -58,78 | -4.198 | 1,94 |
| Medical Oncology | 2.187 | 10.678 | 29.618 | 2.260 | 11.901 | 31.331 | 3,34 | 11,45 | 1.713 | -1,49 |
| Urology | 4.498 | 15.760 | 54.974 | 3.524 | 11.614 | 36.348 | -21,65 | -26,31 | -18.626 | 1,80 |
| **Total** | **65,542** | **446,300** | **1,591,063** | **71,527** | **475,585** | **1,537,903** | **-9,13** | **-6,56** | **-53.160** | **-0,35** |

Among the 33 units evaluated within the scope of RLA, when the number of applications is listed in ascending order in terms of change rate, it is seen that 14 units succeeded in reducing the number of applications. Among these units, the first three units that reduce the number of applicants the most are hematology (87.38%), eye diseases (56.19), and mental health and diseases (53.27%). The first three units that reduced the minimum number of applications were found to be brain and neurosurgery (7.5%), cardiovascular surgery (7.2%), and orthopedics and traumatology (2.17%) (Table 2).

As a result of studies conducted based on evidence-based medicine, 75 different tests were evaluated within the scope of RLA, and the request amounts and prices of these tests before and after RLA are shown (Table 3).

**Table 3.** Pre-and post-RLA findings based on test

| R.Nu | HIC price | RLA Assay Name | Before RLA (01.06.2018-31.12.2018) | | After RLA (01.06.2019-31.12.2019) | | Assay Difference (Piece) (d-b) (e ) | Amount Difference (₺) (c-d) (f) | Assay Change Rate e/b*100 or f/c*100 |
|---|---|---|---|---|---|---|---|---|---|
| | | | RLA Test amount (₺) (HIC) (a) | RLA Number of tests (pieces) (b) | RLA Test amount (₺) (HIC) (c) | RLA Number of tests (pieces) (d) | | | |
| 1 | 19,13 | 25-Hydroxy Vitamin D | 220.511,25 | 11.530 | 197.025,75 | 10.302 | -1.228 | -23.485,50 | -10,65 |
| 2 | 14,25 | Aldosterone | 99,75 | 7 | 0,00 | 0 | -7 | -99,75 | -100,00 |
| 3 | 6,18 | Alpha-Fetoprotein (AFP) (Serum / Plasma) (Triple Scan) (D) | 8.892,00 | 1.440 | 9.077,25 | 1.470 | 30 | 185,25 | 2,08 |
| 4 | 9,69 | Copper, urine (24 Hours) | 19,38 | 2 | 0,00 | 0 | -2 | -19,38 | -100,00 |
| 5 | 8,08 | Growth Hormone 0, 30, 60, 90, 120 min | 1.340,45 | 166 | 1.485,80 | 184 | 18 | 145,35 | 10,84 |
| 6 | 7,60 | CA 125 (Serum / Plasma) | 5.867,20 | 772 | 9.652,00 | 1.270 | 498 | 3.784,80 | 64,51 |
| 7 | 7,60 | CA 15-3 (Serum / Plasma) | 5.867,20 | 772 | 10.374,00 | 1.365 | 593 | 4.506,80 | 76,81 |
| 8 | 7,60 | CA 19-9 (Serum / Plasma) | 6.581,60 | 866 | 10.640,00 | 1.400 | 534 | 4.058,40 | 61,66 |
| 9 | 2,38 | CRP (Turbidimetric) | 0,00 | 0 | 8.298,25 | 3.494 | 3.494 | 8.298,25 | - |
| 10 | 4,28 | CRP (Nephelometric) | 83.443,73 | 19.519 | 79.959,60 | 18.704 | -815 | -3.484,13 | -4,18 |
| 11 | 9,69 | Zinc | 48,45 | 5 | 0,00 | 0 | -5 | -48,45 | -100,00 |
| 12 | 1,05 | Iron (Serum / Plasma) | 18.064,92 | 17.287 | 18.522,63 | 17.725 | 438 | 457,71 | 2,53 |
| 13 | 5,70 | Estradiol (E2) (Serum / Plasma) | 11.628,00 | 2.040 | 14.677,50 | 2.575 | 535 | 3.049,50 | 26,23 |
| 14 | 4,75 | Ferritin (Serum / Plasma) | 90.539,75 | 19.061 | 84.056,00 | 17.696 | -1.365 | -6.483,75 | -7,16 |
| 15 | 6,18 | Folate (Serum / Plasma) | 95.101,18 | 15.401 | 81.102,45 | 13.134 | -2.267 | -13.998,73 | -14,72 |
| 16 | 5,70 | FSH | 13.583,10 | 2.383 | 17.288,10 | 3.033 | 650 | 3.705,00 | 27,28 |
| 17 | 1,52 | HDL cholesterol | 19.650,56 | 12.928 | 25.669,76 | 16.888 | 3.960 | 6.019,20 | 30,63 |
| 18 | 19,00 | Homocysteine | 114,00 | 6 | 0,00 | 0 | -6 | -114,00 | -100,00 |
| 19 | 4,75 | Complete Urine Examination | 88.996,00 | 18.736 | 119.823,50 | 25.226 | 6.490 | 30.827,50 | 34,64 |
| 20 | 1,05 | Urea + BUN (Peritoneal Fluid / 24 hours / Spot urine / Serum / Plasma) | 85.136,15 | 81.470 | 95.452,39 | 91.342 | 9.872 | 10.316,24 | 12,12 |
| 21 | 6,65 | Carcinoembryonic antigen (CEA) (Serum / Plasma) | 6.098,05 | 917 | 10.906,00 | 1.640 | 723 | 4.807,95 | 78,84 |
| 22 | 1,05 | Cholesterol (Serum / Plasma) | 14.403,24 | 13.783 | 19.005,42 | 18.187 | 4.404 | 4.602,18 | 31,95 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 23 | 1,05 | Creatinine (Peritoneal Fluid / Serum / Plasma / Spot urine) | 56.355,81 | 53.929 | 64.127,47 | 61.366 | 7.437 | 7.771,66 | 13,79 |
| 24 | 2,38 | LDL Cholesterol | 32.516,13 | 13.691 | 33.544,50 | 14.124 | 433 | 1.028,38 | 3,16 |
| 25 | 4,85 | Lipoprotein a | 29,07 | 6 | 0,00 | 0 | -6 | -29,07 | -100,00 |
| 26 | 5,70 | LH | 13.167,00 | 2.310 | 17.082,90 | 2.997 | 687 | 3.915,90 | 29,74 |
| 27 | 6,65 | Parathormone (PTH) (Serum / Plasma) | 17.662,40 | 2.656 | 23.507,75 | 3.535 | 879 | 5.845,35 | 33,09 |
| 28 | 6,65 | Progesterone | 1.589,35 | 239 | 1.562,75 | 235 | -4 | -26,60 | -1,67 |
| 29 | 6,65 | Prolactin | 15.501,15 | 2.331 | 19.218,50 | 2.890 | 559 | 3.717,35 | 23,98 |
| 30 | 6,18 | PSA (Prostate specific antigen) | 11.510,20 | 1.864 | 9.392,18 | 1.521 | -343 | -2.118,03 | -18,40 |
| 31 | 10,55 | Protein Electrophoresis (Serum and Body Fluids / urine / spot urine) | 369,08 | 35 | 0,00 | 0 | -35 | -369,08 | -100,00 |
| 32 | 12,16 | Renin | 109,44 | 9 | 0,00 | 0 | -9 | -109,44 | -100,00 |
| 33 | 2,38 | Rheumatoid factor (RF) (Turbidimetric) | 0,00 | 0 | 361,00 | 152 | 152 | 361,00 | - |
| 34 | 4,28 | Rheumatoid factor (RF) (Nephelometric) | 4.420,35 | 1.034 | 7.618,05 | 1.782 | 748 | 3.197,70 | 72,34 |
| 35 | 4,28 | Free T3 | 43.220,25 | 10.110 | 38.923,88 | 9.105 | -1.005 | -4.296,38 | -9,94 |
| 36 | 4,28 | Free T4 | 106.263,68 | 24.857 | 91.104,53 | 21.311 | -3.546 | -15.159,15 | -14,27 |
| 37 | 8,08 | Serum ACE level | 32,30 | 4 | 0,00 | 0 | -4 | -32,30 | -100,00 |
| 38 | 8,55 | Total IgE | 6.327,00 | 740 | 4.847,85 | 567 | -173 | -1.479,15 | -23,38 |
| 39 | 4,75 | Total Testosterone | 4.137,25 | 871 | 4.830,75 | 1.017 | 146 | 693,50 | 16,76 |
| 40 | 1,14 | Triglyceride (Peritoneal Fluid / Serum / Plasma) | 15.604,32 | 13.688 | 20.634,00 | 18.100 | 4.412 | 5.029,68 | 32,23 |
| 41 | 4,28 | TSH | 128.899,80 | 30.152 | 141.335,78 | 33.061 | 2.909 | 12.435,98 | 9,65 |
| 42 | 1,05 | Uric acid (24-hour urine / Serum / Plasma / Synovial Fluid / Spot urine) | 9.673,57 | 9.257 | 16.065,83 | 15.374 | 6.117 | 6.392,27 | 66,08 |
| 43 | 4,75 | Vitamin B12 | 104.001,25 | 21.895 | 86.397,75 | 18.189 | -3.706 | -17.603,50 | -16,93 |
| 44 | 36,29 | Protein C | 435,48 | 12 | 0,00 | 0 | -12 | -435,48 | -100,00 |
| 45 | 36,29 | Protein S | 471,77 | 13 | 0,00 | 0 | -13 | -471,77 | -100,00 |
| 46 | 2,38 | Urine Culture | 14.744,00 | 6.208 | 16.411,25 | 6.910 | 702 | 1.667,25 | 11,31 |
| 47 | 2,85 | Stool Culture | 1.861,05 | 653 | 1.883,85 | 661 | 8 | 22,80 | 1,23 |
| 48 | 2,38 | Sputum Culture | 584,25 | 246 | 370,50 | 156 | -90 | -213,75 | -36,59 |
| 49 | 7,60 | Anti CMV IgG (Microparticle immune assay-MEIA or similar) | 3.389,60 | 446 | 1.831,60 | 241 | -205 | -1.558,00 | -45,96 |
| 50 | 7,60 | Anti CMV IgM (Microparticle immune assay-MEIA or similar) | 3.496,00 | 460 | 2.143,20 | 282 | -178 | -1.352,80 | -38,70 |
| 51 | 7,60 | Anti HAV IgG (Microparticle immune assay-MEIA or similar) | 10.434,80 | 1.373 | 6.232,00 | 820 | -553 | -4.202,80 | -40,28 |
| 52 | 7,60 | Anti HAV IgM (Microparticle immune assay-MEIA or similar) | 3.541,60 | 466 | 1.915,20 | 252 | -214 | -1.626,40 | -45,92 |
| 53 | 7,60 | Anti Hbc IgG (Microparticle immune assay-MEIA or similar) | 25.672,80 | 3.378 | 15.899,20 | 2.092 | -1.286 | -9.773,60 | -38,07 |
| 54 | 7,60 | Anti HBc IgM (Microparticle immune assay-MEIA or similar) | 15.450,80 | 2.033 | 6.642,40 | 874 | -1.159 | -8.808,40 | -57,01 |
| 55 | 7,60 | Anti HBe (Microparticle immune assay-MEIA or similar) | 9.963,60 | 1.311 | 6.916,00 | 910 | -401 | -3.047,60 | -30,59 |
| 56 | 7,60 | Anti HBs (Microparticle immune assay-MEIA or similar) | 53.314,00 | 7.015 | 34.131,60 | 4.491 | -2.524 | -19.182,40 | -35,98 |
| 57 | 7,60 | Anti HCV (Microparticle immune assay-MEIA or similar) | 67.108,00 | 8.830 | 29.982,00 | 3.945 | -4.885 | -37.126,00 | -55,32 |
| 58 | 7,13 | Anti rubella IgG (Chemiluminescence or similar) | 7.972,88 | 1.119 | 2.921,25 | 410 | -709 | -5.051,63 | -63,36 |
| 59 | 7,13 | Anti rubella IgM (Chemiluminescence or similar) | 2.657,63 | 373 | 1.524,75 | 214 | -159 | -1.132,88 | -42,63 |
| 60 | 7,13 | Anti toxoplasma IgG (Chemiluminescence or similar) | 2.493,75 | 350 | 1.581,75 | 222 | -128 | -912,00 | -36,57 |
| 61 | 7,13 | Anti toxoplasma IgM (Chemiluminescence or similar) | 2.614,88 | 367 | 1.104,38 | 155 | -212 | -1.510,50 | -57,77 |
| 62 | 15,39 | CMV IgG avidity | 230,85 | 15 | 323,19 | 21 | 6 | 92,34 | 40,00 |
| 63 | 8,08 | Delta Antibody | 444,13 | 55 | 2.067,20 | 256 | 201 | 1.623,08 | 365,45 |
| 64 | 7,13 | HBeAg Qual (Chemoluminescence or similar) | 7.823,25 | 1.098 | 4.332,00 | 608 | -490 | -3.491,25 | -44,63 |
| 65 | 11,31 | Herpes simplex type 1 IgG | 192,19 | 17 | 0,00 | 0 | -17 | -192,19 | -100,00 |
| 66 | 11,31 | Herpes Simplex Type 2 IgG | 192,19 | 17 | 0,00 | 0 | -17 | -192,19 | -100,00 |
| 67 | 4,75 | IgA (Nephelometric) | 2.892,75 | 609 | 1.615,00 | 340 | -269 | -1.277,75 | -44,17 |
| 68 | 2,38 | IgA (Turbidimetric) | 0,00 | 0 | 87,88 | 37 | 37 | 87,88 | - |
| 69 | 4,75 | IgG (Nephelometric) | 2.289,50 | 482 | 1.401,25 | 295 | -187 | -888,25 | -38,80 |
| 70 | 2,38 | IgG (Turbidimetric) | 0,00 | 0 | 78,38 | 33 | 33 | 78,38 | - |
| 71 | 4,75 | Immunglobulin IgM (Nephelometric) | 2.256,25 | 475 | 959,50 | 202 | -273 | -1.296,75 | -57,47 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 72 | 2,38 | IgM (Turbidimetric) | 0,00 | 0 | 73,63 | 31 | 31 | 73,63 | - |
| 73 | 14,54 | Rubella IgG avidity | 29,07 | 2 | 377,91 | 26 | 24 | 348,84 | 1.200,00 |
| 74 | 16,15 | Toxoplasma IgG avidity | 209,95 | 13 | 419,90 | 26 | 13 | 209,95 | 100,00 |
| 75 | 9,69 | Treponema pallidum hemagglutination (TPHA) | 920,55 | 95 | 1.104,66 | 114 | 19 | 184,11 | 20,00 |
| **TOTAL** | | | **1,591,062.86** | **446,300** | **1,537,903.25** | **475,585** | **29,285** | **-53,159.61** | |

Among the 75 tests conducted based on evidence-based medicine and evaluated within the framework of RLA, 40 types of tests that were successful in reducing the number of requests. The first three tests with the highest number of requests are Anti HCV (Microparticle immune assay-MEIA or similar) (4.885 piece), Vitamin B12 (3.706 piece), and Free T4 (3.546 piece). The least successful tests are Serum ACE level (4 piece), Progesterone (4 piece), and copper urine test (24-hour) (2 piece) (Table 3).

Numerically, the first three tests are Urea + BUN (Peritoneal Fluid / 24-hour / Spot urine / Serum / Plasma) (9.876 piece), Creatinine (Peritoneal Fluid / Serum / Plasma / Spot urine) (7.437 piece) and Complete Urine Test (6.490 piece) that are against RLA by increasing more test requests compared to the pre-RLA period. The first three tests that increase the number of requests at least are Toxoplasma IgG avidity (13 piece), Stool Culture (8 piece), and CMV IgG avidity (6 piece) (Table 3).

In terms of price differences, the first three test types that cause the most cost reduction are Anti HCV (Microparticle Immune Assay-MEIA or similar) (37.126 ₺), 25-Hydroxy Vitamin D (23.485 ₺) and Anti HBs (Microparticle Immune Assay-MEIA or similar) (19.182 ₺). The least cost-saving assay types were determined as Lipoproteina (29,07 ₺), Progesterone (26,6 ₺), and copper urine test (24 Hours) (19,38 ₺ pieces)(Table 3).

In terms of price differences, the most contrary to the RLA are the first three types of test: Full Urine Test (30.827 ₺), TSH (12.435 (₺)) and Urea + BUN (Peritoneal Fluid / 24 hours / Spot urine / Serum / Plasma) (10.316 (₺)). The first three tests that caused the least cost increase were determined as IgG (Turbidimetric) (78.37 ₺), IgM (Turbidimetric) (73.62 ₺), and Stool Culture (22.8 ₺) (Table 3).

40 tests were identified that can provide cost savings as required by RLA. The remaining 35 tests, on the other hand, obtained results that were not suitable for RLA.

**DISCUSSION**

June-December 2018 is the period when there is no RLA and June-December 2019 is the period when RLA began and was used. In this process, the decrease in the number of some of the tests was evaluated in the sense that RLA was successful.

In the study titled "Reducing unnecessary laboratory testing using health informatics applications: a case study on a tertiary care hospital" conducted by Khalifa and Khalid (26), it was determined that more than 11% of the requested tests were repeated as the frequency of requests for laboratory tests and that they were overused.

In the study titled "An automated minimum retest interval rejection rule reduces repeat C-reactive protein (CRP) workload and expenditure, and influences clinician-requesting behavior" by Waldron et al. (27), a decrease of 7.0% and 12.3% was achieved in CRP demands for 1 year. Annual savings of £ 10,500 in general costs and £ 3,000 in consumable costs were reported.

In the study titled "An Educational and Administrative Intervention to Promote rational laboratory test ordering on an academic general medicine service" by Wertheim et al. (28), some rules were developed to reduce the number of laboratory test requests in a controlled manner. It was stated that as a result of the interventions, a 9% reduction in total laboratory use was achieved.

In this study, it was determined that the total amount of tests in June-December 2018 before RLA (HIC price x number of tests) was 1,591,063 ₺ ($ 330,782.32). After RLA, the total test amount (HIC price x number of tests) for June-December 2019 was 1.537.903 ₺ ($ 271,235.10) (Table 2 and Table 3). In other words, the economic gain provided by the Rational laboratory application to the hospital was determined to be 50,163.00 ₺ (3.34%).

Since the hospital where the study was conducted was established in 2006 and is a relatively new university hospital, the constantly growing laboratory facilities, newly opened branches and the acceptance of more applications by the physicians who started working for these branches result in the demand for more tests. As of the end of 2018, there were 109 academic personnel and 177 research assistants. As of the end of 2019, the number of academic personnel increased by 8% to 118, and the number of research assistants increased by 6% to 188. In the last 5 years, an average of 10% of the number of hospital admissions is observed. For all these reasons, between 2018 and 2019, when the study was conducted, the number of patient applications already increased by 10% of the number of laboratory tests. Consequently, the decrease in the number of tests and even the demand increase of less than 10% between 2018 and 2019 can be assumed that RLA is successful.

Tests performed in lower quantities are routine analyzes that are not specific to any

particular branch and can be requested by all doctors. Therefore, the increase in the number of personnel and newly opened branches were effective in the increase in the number of routine tests. It was also observed that the average number of requests per application before RLA was 6.81, and the average number of requests per application after RLA was 6.65.

While evaluating thyroid functions, Free T4 and Free T3 are frequently requested in addition to TSH analysis, which is a screening test. To prevent this situation with RLA, it is aimed to request only TSH first and then T3 and T4 if there is an abnormality in TSH. As expected in the results, the expected reduction in Free T4 was achieved without a significant reduction in TSH. While the increase in TSH was minimal, the decrease in the amount of Free T4 was much more prominent. This shows that unnecessary demands targeted in thyroid function tests are avoided (Table 3).

When the units are examined in terms of the number of test requests, it is seen that 13 out of 32 units (40.63%) are successful by decreasing the number of requests. The number of test requests increased contrary to expectations and the number of unsuccessful units was 17 (53.13%). The number of units without pre-RLA test request was determined as 2 (6.25%) (Table 1). When the pre- and post-RLA periods were compared in terms of the number of tests, the rate of successful units (13/30) was 43.33% and the rate of unsuccessful units (17/30) was 56.67%.

When the units are evaluated in terms of test costs, it is seen that 18 out of 32 units (56.25%) are successful by decreasing costs. The number of unsuccessful units by increasing their costs contrary to expectations is 12 (37.50%). The number of units without pre-RLA test request was determined as 2 (6.25%) (Table 1). When the pre-RLA and post-RLA periods were compared in terms of costs, it was concluded that the ratio of successful units (18/30) was 60%, and the rate of unsuccessful units (12/30) was 40%.

## CONCLUSION

In the study, a total of 446,300 test requests were made in the 7 months of 2018 before RLA, and the cost of these tests was found to be 1,591,063 ₺ ($ 330,782.32). In the 7 months after RLA, 475,585 test requests were made in total and the cost of these tests was determined to be 1,537,903 ₺ ($ 271,235.10). When the number of test requests before and after RLA was compared, it was seen that there was an increase of 6.56%. Although the number of patients increased by 10% compared to the previous period, the rate of test requests decreased. On the other hand, it was determined that the costs decreased by 3.34% in ₺ and 22% in terms of $. Although the number of test requests increased, the reason for the decrease in the test amount was found to be that the tests with an increased number of requests have low prices and the prices of tests with a decreased number of requests are high. Considering that the Central Bank Exchange Rate was an average of $ 1 = 4.81 ₺ in 2018, an average of $ 1 = 5.67 ₺ in 2019, and an 18% increase in foreign currency, it was determined that the costs decreased by 22%.

According to the findings in this study, it was concluded that the successful units are mainly surgical, and the unsuccessful units are internal units that require more analysis due to the nature of the work.

According to the results of the study, the following recommendations were made:

Diagnostic algorithms should be established together with stakeholders such as the Ministry of Health (HM), Social Security Institution (SSI), Clinical Specialist Associations. Physicians should be ensured to comply with diagnostic algorithms. The order of priority of tests should be determined and remuneration should be made to those who comply with this order. The tests and prescriptions that do not go through the diagnostic process should not be paid, and costs should be reduced by preventing unnecessary test requests with diagnostic algorithms.

HM and SSI should cooperate in evidence-based medicine and RLA's. Test request time and branch restrictions should be made by the HM and it should be ensured that the reimbursement should be controlled by the SSI if these restrictions are exceeded. Hospitals that have switched to RLA should be given a greater share of the global budget set by the SSI. Additional points should be given to hospitals that have switched to RLA in the quality assessment process every year.

RLA should be further developed by healthcare professionals and put into daily practice. Healthcare professionals should be given feedback and the process should be dynamic. Awareness training should be given to the person who requests the test. Planning should be made about the kits. For the sustainability of RLA processes, the importance of support in the process should be explained by the hospital management. Besides, the evidence-based Audit levels of all existing tests should be determined by the SB. The number of tests within the scope of rational laboratories should be increased and leading work must be done with quality control cards to decide whether the process can be interfered with.

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