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Reprocessing Cost Analysis of Specimens Rejected in Laboratory: Results from the Perspective of the Costs to the Hospital

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ABSTRACT

Objective: The objective of the study is to analyze the additional costs of reprocessing the specimens rejected in the laboratory to the hospital.

Methods: The data is acquired from the Düzce University Medical Application and Research Hospital (DUMARH) laboratories. 5-year (2015-2019) data was retrospectively reviewed and subjected to document analysis.

Results: The rate of the total rejected specimens has increased throughout the years. (2015, 0.88% – 2019, 2.12%). The most prominent rejection reasons are hemolysis specimen (32.9%), insufficient specimen (17.25%), clotted specimen (15.4%) and inaccurate examination request (10.64%). While the reprocessing cost of specimens was 12.085 dollars in 2015, it increased to 51.132 dollars in 2019. It is seen that the rejection rate has increased as the specimen number increased and the reprocessing costs have increased since the inflation in Turkey increased and the purchasing power of the hospital has decreased throughout the years.

Conclusion: In order to decrease and prevent the rejected specimen, there is a need for phlebotomy training, especially for nursing and other healthcare professionals, and strict quality control and standard operating procedures for the pre-analytical phase. These are the critical approaches that will improve the service quality of laboratories and patient safety.

Keywords: Laboratory, Rejected Specimen, Reprocessing, Cost Analysis.

1. INTRODUCTION

Today, diagnoses are mostly made by resorting to laboratory tests and depending on their results (1). Laboratory services play an important role in patient care, and laboratory data is estimated to affect 60-70% of the most important decisions regarding acceptance, discharge and medication. (2). Considering that approximately 80-90% of the diagnoses that doctors make to their patients are made according to laboratory tests, it is obvious that errors in the laboratory will decrease the chance of correct diagnosis. In addition, such mistakes increase adverse events and lead to an increase in costs (3).

Performing a laboratory test consists of three phases named as pre-analytical, analytical and post-analytical phases. The pre-analytical phase covers the process from the request of the test until the specimen is ready for analysis, the analytical phase includes the analysis process of the specimen, and the post-analytical phase covers the reporting and interpreting the test result (4).

Laboratory error is expressed as any defect that occurs during the entire testing process, from ordering tests to reporting results and in any way affecting the quality of laboratory services (4,5). One of the elements that make up the laboratory errors is the rejected samples.

Many studies in the last decade show that about 70% of errors causing rejected specimens occurred before the laboratory tests, that is, in the pre-analytical phase, and 30% in the analytical and post-analytical phase (6,7). In Turkey, it is found that the 96.33% of laboratory errors occur in the pre-analytical phase (8).

Most of the pre-analysis errors are caused by system defects and insufficient supervision of staff involved in sampling and processing. This results in an unacceptable number of unsuitable specimens due to hemolysis, clotting, insufficient volume, wrong container, misidentification and contamination (9). Patient specimens must be appropriate for laboratory results to be accurate and precise. Inappropriate specimens must be evaluated in the pre-analytical phase and faulty specimens must be rejected (10,11).

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During laboratory analysis, laboratory errors occur due to improper collection of specimens, carelessness, an unnecessary retake of samples and prolonged corrective-preventive actions and the test results are delayed. All of these errors result in the rejection of samples and repetition of the whole process for a rejected sample which causes a waste of time and resources in the laboratory (12).

In addition, these errors cause additional costs as they may require retaking of specimens, retesting and further investigation by laboratory staff. Also, erroneous results may cause many problems such as unnecessary treatment, complications of treatment, lack of proper treatment, delay incorrect diagnosis, and the remaking of additional and unnecessary diagnostic tests. These results lead to increased costs and inadequate patient outcomes due to time loss and staff effort.

It can be seen that costs are calculated in several ways when the studies about the costs of rejected specimens are examined: calculation according to the parameters determined by the health economy specialist (4), calculation by multiplying the numbers obtained from the hospital automation program with the material costs (13) calculation with a global survey taken from several countries (14), cost study made by calculating only the hourly wages of employees (15) and cost study only for a particular type of assay (such as INR…) (16) are the studies for major calculation techniques. The studies conducted for the reprocessing of rejected specimens that take strategic cost analysis tools, cost elements, cost distribution stages and key into account, could not be identified in PubMed, Scopus and Web of Science databases. The most original part of this study is the calculation of costs by using cost distribution keys in the process of direct raw materials and supplies, direct labor and general service production cost distribution in the reprocessing of rejected specimens.

The aim of the study is to provide useful information to the hospital management on taking the necessary precautions by calculating the number of specimens rejected for some reason in DUMARH* laboratories for the last 5 years (2015, 2016, 2017, 2018 and 2019), the cost of reprocessing of them for the hospital, by revealing the reasons for their rejections. With this study, useful information will be provided to the management to take necessary measures to eliminate the reprocessing costs of rejected specimens from activities that do not create added value to ensure efficient and effective use of hospital resources. In addition, this study aims to determine the reasons for the rejected samples, to reveal in which units they occur, and to contribute to taking the necessary administrative measures.

2. METHODS

The data of the study includes the 5 years (2015-2019) of specimen data from the Medical Biochemistry, Medical Microbiology, and Transfusion Center Blood Grouping (including lined and scuba) laboratories of Düzce University Medical Application and Research Hospital which is a tertiary 316-bed healthcare center located in Düzce, Turkey.

The research population consists of all the specimens coming to the laboratory of the hospital in question. Specimens coming to the laboratory are evaluated in terms of whether they are suitable for analysis or not and the ones that are not suitable are rejected by entering the reason for rejection in the hospital automation system. All specimens that were rejected for various reasons were studied.

Information about specimens accepted and rejected in the laboratory was obtained retrospectively through hospital automation and laboratory information management system. The financial data of the study were obtained from the managers and personnel working in the hospital's enterprise resource planning, administrative/financial affairs, accounting, and information processing departments and they are factual and primary data. Document analysis was performed during the data acquisition and cost analysis.

3. RESULTS

The total number of specimens, rejection rate, number of rejected specimens, reasons for rejection, rejection rates of each unit and reprocessing costs in the three laboratories belong to DUMARH (Medical Biochemistry, Medical Microbiology and Transfusion Center Blood Grouping laboratory) were examined in a way that will cover 2015-2019 (last 5 years). The tests such as Emergency-Routine Biochemistry Tests, Immunoassay Tests, Blood Gases, Urine, Fecal, Blood Count, Sedimentation, Coagulation, aCPT, Medical Microbiology and Transfusion Center Blood Grouping are all included in the analysis.

3.1. Data on Rejected Specimens

According to Table 1, the rejected total specimen rejection rates were determined to be lowest with 0.88% in 2015 and highest with 2.12% in 2019. It is remarkable to see that although the total number of samples increased by 5% in 2019 compared to the previous year, the rate of rejected samples increased by 14%.

According to Table 2, it is seen that among the most common reasons for rejection, hemolysis, insufficient specimen, clotted specimen and incorrect examination request have come to the fore especially in the last three years, although it varies according to years.

According to Table 3, Emergency Medicine (Adult) (33,1%) and Internal Diseases (13.84) have the most rejected specimen units when the units are examined separately. The rates of other units correspond to very small rates.

* Düzce University Medical Application and Research Hospital

Table 1. *Total specimens rejected and percentage of rejection*

Type	2015	2016	2017	2018	2019
Number of Rejected Specimens(including lined and scuba) (pieces)	41.390	62.180	107.613	122.754	139.706
Total Number of Specimens (pieces)	4.729.623	5.121.959	5.451.590	6.275.950	6.578.502
Rejection Rate (%)	0.88	1.21	1.97	1.96	2.12

Table 2. *Number and percentage of specimens rejected according to their reasons*

Reason of Rejection	2015		2016		2017		2018		2019	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Hemolysis specimen	1502	15.36	1346	9.31	3462	**21.66**	4858	**25.76**	7703	**32.19**
Insufficient specimen	3001	**30.7**	3649	**25.24**	3232	20.22	3858	20.45	4128	17.25
Clotted specimen	1839	18.81	3218	22.26	2998	18.76	3576	18.96	3686	15.4
Inaccurate examination request	30	0.3	1326	9.17	1489	9.31	2289	12.13	2547	10.64
Wrong tube specimen	697	7.13	833	5.76	796	4.98	897	4.75	869	3.63
Inappropriate specimen	378	3.86	665	4.6	560	3.5	769	4.07	726	3.03
Excess specimen	501	5.12	343	2.37	43	0.26	64	0.33	64	0.2
Specimen that did not come to the laboratory	44	0.45	1	0.006	301	1.88	8	0.04	7	0.02
Other reasons	1783	18.24	3071	21.24	3096	19.37	2538	13.45	4196	17.53
TOTAL	9775	100	14452	100	15977	100	18857	100	23926	100

Table 3. *Number and percentage of rejected samples by requested units*

Units	2015		2016		2017		2018		2019	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Emergency Medicine (Adult)	3354	34,48	3897	27,1	5382	33,78	6647	35,34	7892	33,1
Internal Diseases	1595	16,39	3041	21,15	2765	17,35	2645	14,0	3302	13,84
Nephrology, Urology, Dermatology, Orthopedics – Trav. and ENT Diseases	387	3,97	1147	7,97	1498	9,40	2284	12,14	2683	11,25
Obstetrics and Gynecology and Neon.	766	7,87	843	5,86	909	5,70	1.420	7,54	1813	7,6
Pediatry	607	6,24	1236	8,59	1219	7,65	1445	7,68	1636	6,86
Anesthesiology, Physical Medicine, Hematology, Hemodialysis	594	6,10	1175	8,17	1292	8,10	1190	6,32	1403	5,88
General Surgery, Gastroenterology and Endocrinology	286	2,94	612	4,25	525	3,29	505	2,68	905	3,79
Neurology and Neurosurgery	516	5,30	774	5,38	659	4,13	675	3,58	818	3,43
Chest Diseases and Surgery	245	2,51	342	2,37	545	3,42	608	3,23	742	3,11
Cardiology and Cardiovascular Surgery	305	3,13	389	2,70	432	2,71	678	3,6	751	3,14
Intensive Care and Infection Disease	937	9,63	595	4,13	343	2,15	316	1,68	402	1,68
Other Specializations	183	1,38	401	2,27	444	2,27	444	2,1	1579	6,27
TOTAL	9775	100	14452	100	15977	100	18857	100	23926	100

3.2. Cost Analysis Regarding the Reprocessing of Rejected Specimens

In determining the cost information of the study, all cost elements of the Dxxxxx Central-Emergency Laboratory for the last 5 years (2015-2019) were examined and cost analyzes were made. Unit costs are determined by calculating direct raw materials and supplies, direct labor and general service production expenses.

Costs are divided into two parts as direct and indirect according to the way they are loaded into the service costs. Since direct costs are the costs directly related to the laboratory unit, they are loaded without using the allocation key. Indirect costs such as general service production expenses were allocated with the help of various allocation keys according to their qualities.

Cost elements are allocated to the primary service production expense places, auxiliary service production expense places, auxiliary service expense places and operating expense places as the I. allocation. Then, as the second distribution, the costs collected in the auxiliary expense places are distributed to the main service production expense places according to various distribution methods (simple, graded, math and cross-distribution methods). As a final distribution, the costs collected in the main service production cost centers are calculated as unit cost according to the service quality measurement units (patient, day, number of examinations, minutes, etc.). In the laboratory unit cost distribution, auxiliary service is considered as production cost centers.

The dollar is used as the currency in cost calculations by taking the annual average exchange rate published by Central Bank of the Turkey Republic into account. Accordingly, the calculations were made taking the currency exchanges as 1 ₺= $2,72 in 2015, 1 ₺= $3,02 in 2016, 1 ₺=$3,65 in 2017, 1 ₺=$4,82 in 2018 and 1 ₺=$5,67 in 2019.

The list and price of the materials purchased by the Hospital's Revolving Fund Directorate, under the Public Procurement Law No. 4734; the gross salary, additional payment, revolving fund and duty fee expenses of the personnel working in the Central-Emergency Laboratory of the hospital and general service production expenses incurred in the researched laboratory are shown in Table 4.

Table 4. *Direct raw materials and supplies expenses, direct labor costs and general service production expenses ($-cent)*

Direct raw materials and supplies expenses ($-cent)						
Material Type		**2015**	**2016**	**2017**	**2018**	**2019**
Injector (5 cc, 10cc,20cc,50cc)		0.037	0.040	0.038	0.068	0.092
Edta/ gel tube/ Plastic Sterile Container		0.037	0.066	0.068	0.077	0.106
Glove		0.018	0.023	0.025	0.025	0.037
TOTAL MATERIAL EXPENSES PER UNIT ($)		0.092	0.129	0.132	0.170	0.235
Direct labor costs ($-cent)						
Direct Labor Elements		**2015 (11 people)**	**2016 (11 people)**	**2017 (14 people)**	**2018 (20 people)**	**2019 (20 people)**
Salary		93,156.57	92,303.98	101,847.45	78,129.07	73,209.75
Supplementary payment		37,770.26	40,794.43	43,184.56	37,819.80	36,470.90
Revolving Funds Payment		25,947.02	23,627.62	27,790.80	23,510.04	22,320.99
Duty fee		0.00	0.00	16,216.53	13,677.43	12,633.51
TOTAL FEE		156,873.86	156,726.03	189,039.33	153,136.35	144,635.15
FEES PER UNIT ($)		0.033	0.031	0.035	0.024	0.022
General service production expenses ($-cent)						
General Service Expense Items		**2015**	**2016**	**2017**	**2018**	**2019**
Indirect Personnel Expenses (Cleaning etc.)		1,100.00	1,288.08	1,144.11	987.58	1,075.84
Cleaning Material Expense		951.10	978,81	1,273.97	1,089.03	1,386.24
Hospital Automation Expense		2,786.63	2,885.31	3,660.52	3,083.00	2,749.56
Electricity Expense		9,502.25	9,164.14	8,579.05	6,753.11	6,095.59
Various Expenses		1,308.82	1,307.95	1,232.90	10,031.06	938.27
Accumulated Depreciation (Fixtures)		6,341.91	6,192.05	5,835.62	5,517.60	5,379.19
License, Document Editing and Licensing Expenses		3,583.27	3,414.24	1,949.86	1,839.23	2,833.42
Medical Waste Disposal and Transport Service Purchase Expenses		3,198.53	3,152.32	2,913.70	1,425.47	1,437.39
External Benefits and Services	Autoanalizer and HBA1C Kits	9,607.35	82,507.28	45,698.63	0.00	0.00
	Device for Microbiology and Sterilization Consumables and Kit	375,497.43	379,629.14	845,019.45	514,352.17	561,689.47
	Device for Biochemistry, Hormone Blood Gas and Urine Strip Kit	293,811.21	356,280.35	75,835.62	154,850.93	134,274.25
TOTAL ($)		789,688.51	846,799.67	993,143.43	699,929.18	717,859.23
GENERAL SERVICE PRODUCTION EXPENSE PER UNIT ($)		0.167	0.165	0.182	0.112	0.109

According to Table 4, despite the highest number of staff per unit (20 people) according to the total specimen, it is seen that the lowest labor expense was $ 0.022 in 2019 due to the lowest salary payment, and the highest with $0.035 in 2017 due to the highest salary payment. Despite the increase in the number of staff in 2018 and 2019 compared to previous years, the reason for the low salary per unit is the provision of employment based on personnel based outsourcing services in these years.

The examination of the specimens in the aforementioned laboratory is carried out by service procurement by tender through outsourcing. The service procurement subject to the tender is to purchase services in return for the results of the emergency-routine biochemistry test, immunoassay tests, blood gases, urine, stool, blood count, sedimentation, coagulation, aCPT, medical microbiology and Transfusion center blood grouping tests to be performed in the medical biochemistry, medical microbiology and transfusion center blood grouping laboratories of the hospital. These, the purchase of equipment in exchange for the kit, all calibrators for quality control, control, consumables, maintenance and spare parts costs of the devices, (in case of periodic or malfunction) belong to the company receiving the tender.

On the other hand, laboratory tests and cleaning are carried out by hospital staff. Materials for all disinfection processes (surface and hand etc.) related to cleaning, personal cleaning materials (paper towels, toilet paper, hand disinfectant, hand soap, etc.), all medical and domestic waste bags, cutting-piercing tools, medical waste buckets are covered by the hospital.

According to Table 5, when the reprocessing cost elements of the rejected specimens were analyzed by years, it was seen that although the common service production expenses were the most in 2015, 2016 and 2017, the direct raw materials and supplies expenses were the most in 2018 and 2019.

According to Table 6, during the period between 2015 and 2019, the unit costs of the samples increased by 26% in total, the rejected specimens increased by 151% and the total costs increased by 183%. The number of rejected specimens mostly increased by 73% in 2017, the total number of specimens mostly increased by 15% in 2018, unit costs mostly increased by 20% in 2019 and reprocessing costs increased by 85% in 2017, directly proportional to the highest number of rejected specimens.

According to Table 7, while the share of laboratory income in total revenue is 13% in 2015, 14% in 2016 and 2017, 12% in 2018, it decreased to 10% in 2019. Although the share of reprocessing cost in total revenue was 0.06% in 2015, 0.10% in 2016, 0.21% in 2017, 0.22% in 2018, this rate increased to 0.31% in 2019.

Table 5. *Reprocessing cost of rejected specimens*

Cost Elements	2015	2016	2017	2018	2019
Direct Raw Materials and Supplies Expenses	0.092	0.129	0.132	0.170	0.235
Direct Labor Expenses	0.033	0.031	0.035	0.024	0.022
General Service Production Expenses	0.167	0.165	0.182	0.112	0.109
TOTAL EXPENSES PER UNIT ($)	0,292	0,325	0,349	0,306	0,366
Rejected Specimen Number	41.390	62.180	107.613	122.754	139.706
REPROCESSING COST OF REJECTED SPECİMENS ($)	12,085.88	20,208.50	37,556.94	37,562.72	51,132.40

Table 6. *Change index of rejected specimens and costs compared to the previous year*

	2015		2016		2017		2018		2019	
	Unit	Change	Unit	Change	Unit	Change	Unit	Change	Unit	Change
Number of Rejected Specimens (pieces)	41.390	1	62.180	**0.50**	107.613	**0.73**	122.754	**0.14**	139,706	**0.14**
Total Number of Specimens (pieces)	4.729.623	1	5.121.959	**0.08**	5.451.590	**0.06**	6.275.950	**0.15**	6.578.502	**0.05**
Unit Cost ($)	0,292	1	0,325	**0.11**	0,349	**0.07**	0,306	**-0.12**	0,366	**0.20**
Reprocessing Cost ($)	12,085.88	1	20,208.50	**0.67**	37,556.94	**0.85**	37,562.72	**0.00**	51,132.40	**0.36**

Table 7. *The share of reprocessing costs in total income and expense*

Total Revenue ($)	**2015**	**2016**	**2017**	**2018**	**2019**
Reprocessing Cost	12.085,88	20.208,50	37.556,94	37.562,72	51.132,40
Revenue acquired from the Laboratory (SSI and Total Invoice Amount Including Paid)	2.663.528,38	2.820.884,05	2.556.195,46	2.149.564,05	1.581.053,16
Laboratory Total Cost of Production of Services	1.381.270,37	1.664.970,74	1.899.104,19	1.918.547,72	2.405.599,78
Laboratory Profitability	1.282.258,01	1.155.913,31	657.091,27	231.016,33	-824.546,62
Total Expenses of the Hospital	24.107.894,26	24.314.074,74	22.198.930,50	20.257.794,82	21.242.908,57
Total Revenue of the Hospital	20.500.785,56	19.942.879,45	18.113.571,04	17.254.345,34	16.524.800,34
Share of Laboratory Income in Total Revenue	0,13	0,14	0,14	0,12	0,10
Share of Reprocessing Cost in Total Revenue	0,0006	0,0010	0,0021	0,0022	0,0031
Share of Reprocessing Cost in Total Expense	0,0005	0,0008	0,0017	0,0019	0,0024

4. DISCUSSION

In the literature, there are many studies aimed at detecting faulty and rejected specimen rates in the laboratory. Association of Public Health Laboratories (17) set a specimen rejection rate of 2% or less as a monthly quality indicator. In similar studies on the subject, the specimen rejection rate was determined to be between 0.1% and 3.49% (17, 20). In this study, specimen rejection rates were determined to be between 0.08% and 2.12% between the years 2015 and 2019. On the other hand, although there is no standard threshold value in the world specified as an acceptable specimen rejection rate, the American College of Pathologists (CAP-College of American Pathologists) recommends each institution to compare its rejected specimen rates with references from multiple institutional studies (22). In a study on the reasons for rejection of laboratory specimens (12), improper packaging of specimens (84.2%), coagulation (15.8%), non-centrifuged specimens (46.9%), hemolysis specimens (19.8%) and wrong tube use (17.7 %) were found as the main reasons for rejection. In a similar study (3), the most common cause encountered was found to be the clotting of the sample with a rate of 43.8%, insufficient volume with 24% and hemolysis with 18%. In a study by Da Rin (2009) (2), the rate of inappropriate test request, sample collection and transport inadequate, misidentification of the patient, labelling errors was between 46-68.2% and the rate of equipment malfunction and sample mix-ups/interference was between 7-13% in the pre-analytical (outside&within the laboratory) phase. Besides the rate of failure in reporting and improper data entry was between 18.5-47% in the post-analytical phase.

Among the rejected specimens, although they vary by years, the most common reasons for rejection are hemolysis specimen, insufficient specimen and clotted specimen in general. In similar studies, the most common reasons for rejection in line with our findings with differences in the ranking. Insufficient specimen, hemolysis specimen and clotted specimen were reported as the reasons (19, 22).

When specimen rejection rates were evaluated on the basis of units, the highest rejection rate was determined in the adult emergency unit (34.48%; 27.1%; 33.78%; 35.34%; 33.1%) during the years subject to the study. This finding is in line with similar studies in the literature. When the reasons are examined, emergency services among all units stand out as the units where the number of patients is quite high and that require urgent intervention due to emergencies. Therefore, the risk of making mistakes and specimen rejects are more likely than other units (23,24).

Another issue is reprocessing costs. The share of these costs in the total expenses of the hospital increased for 0.05% – 0.08% – 0.17% – 0.19% and 0.24% during the 5-year period (Table 6). These rates are partially compatible with the literature. Indeed, in similar studies, reprocessing costs are estimated to represent 0.2% to 1.2% of total hospital costs. This is estimated to be approximately $ 1,199,122 per year for a 650-bed US hospital (4,15).

According to the results of the study conducted by Erdal et al. (2017) (14) at the global level in 2016 to determine the economic impact of rejected samples, the average annual cost (10,000 per tube; labour/materials included) of reprocessing laboratory-induced errors varies between $ 117 – $ 147 per year (Turkey), $ 32 – $ 67 (UK) and $ 294 – $ 417 (Italy). Again, in a similar study on this subject, the reprocessing cost per specimen 837,862 tubes was determined as $ 43,210 and the average cost as $ 21.9 (13). In our study, the total reprocessing cost was calculated as $ 12,058 for 2015 and $ 51,132 for 2019.

When the reprocessing costs are analyzed by years, it increased significantly by 67% in 2016 compared to the previous year and by 85% in 2017 compared to the previous year. The main reason for this increase, including the 7% increase in unit cost amount in 2017, is that there has been a serious increase in sample rejection rates such as 73% (Table 6).

In the study, it was determined that the number of rejected samples and unit costs affected the reprocessing cost of

rejected samples. In order to reduce the number of rejected samples, especially in the preanalytical stage, training of personnel, lean and six sigma methodology can be applied (26). In addition, in order to reduce the number of rejections, it is necessary to implement quality requirements, provide information, in-service training, share changing technological developments and increase communication (27).

Considering the unit cost factors, it has been determined that the general service production expenses were the biggest expenditure item until 2018, and as of 2018, raw materials and supplies expenses are the largest expenditure item in the laboratory expenses. Direct labour was observed as the smallest expense item (Table 5). Although the total specimen amount showed a steady increase between 2015-2019, the increase in rejected specimen amount was found to be disproportionate and irregular. Again, the rejected specimen amount, which increased at high levels until 2018, shows a smaller and regular increase as of 2018 (Table 6).

Although the total number of specimens of the hospital increased in 2019 compared to the previous year (5%), the number of rejected specimens (14%) increased more (9%). In addition, it was determined that there was a decrease of $ 568,510.89 in the income obtained from the laboratory in 2019 compared to the previous year (Table 6). Despite this decrease in revenues, there was an increase of 20% in unit costs and 36% in total costs (Table 6). In the same year, a 36% increase in costs, despite the 20.30% inflation in Turkey shows that the purchasing power of the hospital is not strong.

It can be also said that the total cost of reprocessing continues to increase every year as a result of the increase in unit cost. When investigated, the reasons for this situation can be determined as, inflation is being higher in the inputs of the health sector since 2018 although it has been 11% in Turkey over the years, movements in exchange rates and depreciation of the domestic currency against the dollar and the Euro. In addition, importing some of the devices and kits used in the laboratory causes prices to be highly affected by inflation and foreign exchange movements. Another reason for the increase in unit costs has been determined that the prolonged purchase times with the suppliers due to the decrease in the purchasing power of the hospital caused the increase in the purchase price levels due to the maturity differences.

The income from the laboratory has a considerable place in the total revenue of the hospital. In fact, in 2015, 2016 and 2017, laboratory revenues tended to increase in total revenue. The reason for this is that total specimen numbers increase year by year and there is no serious increase in unit costs. In 2018, however, it can be seen that although the revenue from the laboratory increased, the share of this income in total hospital revenue decreased (12%) (Table 7). The most important incomes of the hospital consist of invoice revenues issued in accordance with the Social Security Institution (SSI) in Health Implementation Communiqué (HIC). Despite the decrease in the purchasing power of the hospital, the fact that the HIC prices were not increased by the SSI caused a decrease in the total revenue of the hospital.

4.1. Limitations

In this study, cost items for the following items were not calculated. Cost for the re-examination of the patient due to rejected specimens, cost of improper treatments, the cost of prolonged hospital stay, deaths due to specimen errors and their costs, potential income losses due to dissatisfaction with health services were not included in the analysis. In addition, labor costs in the units where the specimens were taken again were not calculated. Labor costs in the laboratory, which is the unit where only reprocessing takes place, have not been calculated.

5. CONCLUSION

Due to the negative effects on patient safety and increased hospital costs, specimen rejections are an issue that must be considered regardless of their reason or ratio. The important thing is to eliminate these errors with minimum resources without compromising patient health. Laboratory tests, which are an important factor in patient diagnosis and treatment, need to be rejected and reprocessed due to some errors. Such errors and delays have the potential to endanger the health of patients, as well as to increase health care costs both directly and indirectly as they can also increase the length of hospital stay of patients. Considering the macro scale, sample rejections are a significant financial burden on hospitals and therefore on the state in terms of health economics.

In the face of these increasing costs, no additional payment is made to the hospitals by both SSI and patients for the samples that are reprocessed. Therefore, it is important to reduce the number of rejected samples and cost factors in the reprocessing of rejected samples. In order to reduce reprocessing costs, rejection rates must first be reduced. For this purpose, some preventive activities should be carried out by regularly monitoring sample rejection rates in hospitals. These activities include options such as phlebotomy training for nurses and other healthcare professionals, creation of a technological registration system, applying strict quality control and regular working procedures to laboratory workers in pre-analytical, analytical and post-analytical phases and regular inspections. In order to reduce unit costs, some measures can be taken such as finding alternative suppliers, using personnel more efficiently, actively using the financial resources allocated to the hospital and reducing borrowing costs due to maturity.

REFERENCES

[1] T.C Sağlık Bakanlığı Sağlık Hizmetleri Genel Müdürlüğü. Klinik Mikrobiyoloji Laboratuvarları Kalite Yönetimi Rehberi. 2014. https://dosyahastane.saglik.gov.tr/

Eklenti/52175,25-klinik-mikrobiyoloji-laboratuvari-kalite-yonetimi-rehberi-02012014pdf.pdf?0. Accessed 24 April 2020 (Turkish).

[2] Da Rin G. Pre-analytical workstations: A tool for reducing laboratory errors. Clin Chim Acta 2009; 404(1): 68–74.

[3] Guimarães AC, Wolfart M, Brisolara MLL, Dani C. Causes of rejection of blood samples handled in the clinical laboratory of a university hospital in Porto Alegre. Clin Biochem 2012; 45(1-2): 123–126.

[4] Green SF. The cost of poor blood specimen quality and errors in preanalytical processes. Clin Biochem. 2013; 46(13-14): 1175–1179.

[5] Goldschmidt H, Lent R. Gross errors and work flow analysis in the clinical laboratory. Klin Biochem Metab 1995; (3): 131–140.

[6] Plebani M, Lippi G. To err is human. To misdiagnose might be deadly. Clin Biochem 2010; 43(1-2): 1–3.

[7] ECRI Ins. PSO monthly brief from the ECRI institute PSO deep dive: An examination of "Lab" errors check out ECRI institute. 2014. https://www.ecri.org/EmailResources/PSO_Monthly_Brief/2014/PSO_Brief_May14.pdf. Accessed 22 April 2020.

[8] T.C Sağlık Bakanlığı. Güvenlik raporlama sistemi 2016 yılı istatistik ve analiz raporu 2018. www.grs.saglik.gov.tr. Accessed 24 April 2020 (Turkish).

[9] Lippi G, Guidi GC. Risk management in the preanalytical phase of laboratory testing. Clin Chem Lab Med 2007; 45(6): 720–727.

[10] Howanitz PJ. Errors in laboratory medicine: Practical lessons to improve patient safety. Arch Pathol Lab Med 2005; 129(10): 1252–1261.

[11] Güvenç Y. Poliklinik, servis ve acil kanlarında numune red analizi: Eğitim ve yeni yaklaşımlar. Türk Klin Biyokim Derg 2017; 15(3): 119–128 (Turkish).

[12] Shiferaw MB, Yismaw G, Getachew H. Specimen rejections among referred specimens through referral network to the Amhara Public Health Institute for laboratory testing, Bahir Dar, Ethiopia. BMC Res Notes. 2018. Report No: 781.

[13] Cao L, Chen M, Phipps RA, Del Guidice RE, Handy BC, Wagar EA, Meng QH. Causes and impact of specimen rejection in a clinical chemistry laboratory. Clin Chim Acta 2016; 458: 154–158.

[14] Erdal EP, Mitra D, Khangulov VS, Church S, Plokhoy E. The economic impact of poor sample quality in clinical chemistry laboratories: results from a global survey. Ann Clin Biochem 2017; 54(2): 230–239.

[15] Maul P, Phelan M, Reineks E, Bontempo A, Green S. Quantifying the economic impact of poor quality (hemolyzed) blood samples from the emergency department. J Health Care Finance 2019; 45(4): 1–9.

[16] Kulkarni S, Piraino D, Strauss R, Proctor E, Waldman S, King J, Selby R. The cost of pre-analytical errors in inr testing at a tertiary-care hospital laboratory: Potential for significant cost savings. Lab Med 2020; 51(3): 1–5.

[17] APHL. Best practice guidance: specimen and specimen-product storage and retention. 2016.https://www.aphl.org/aboutAPHL/publications/Documents/ID_Specimen_Storage_0216.pdf. Accessed 28 April 2020.

[18] Tapper MA, Pethick JC, Dilworth LL, McGrowder DA. Pre-analytical errors at the chemical pathology laboratory of a teaching hospital. J Clin Diagnostic Res 2017; 11(8): BC16-BC16.

[19] Atay A, Demir L, Cuhadar S, Saglam G, Unal H, Aksun S, Arslan B, Ozkan A, Sutcu R. Clinical biochemistry laboratory rejection rates due to various types of preanalytical errors. Biochem Medica. 2014; 24(3): 376–382 (Turkish).

[20] Jandial S, Gosai V. Sample rejection rate in clinical biochemistry laboratory of a tertiary care centre. Int J Res Med. 2017; 5(4): 127-131.

[21] Forest SK, Shirazi M, Wu-Gall C, Stotler, BA. The impact of an electronic ordering system on blood bank specimen rejection rates. Am J Clin Pathol. 2017; 147(1): 105–109.

[22] Rooper L, Carter J, Hargrove J, Hoffmann S, Riedel S. Targeting rejection: Analysis of specimen acceptability and rejection, and framework for ıdentifying ınterventions in a single tertiary healthcare facility. J Clin Lab Anal 2017; 31(3): e22060.

[23] Chawla R, Goswami B, Tayal D, Mallika V. Identification of the types of preanalytical errors in the clinical chemistry laboratory: 1-year study at G.B. Pant Hospital. Lab Med 2010; 41(2): 89–92.

[24] Stark A, Jones BA, Chapman D, Well K, Krajenta R, Meier FA, Zarbo RJ. Clinical laboratory specimen rejection – Association with the site of patient care and patients' characteristics: Findings from a single health care organization. Arch Pathol Lab Med 2007; 131(4): 588–592.

[25] Fordyce J, Blank FSJ, Pekow P, Smithline HA, Ritter G, Gehlbach S, Benjamin E, Henneman PL. Errors in a busy emergency department. Ann Emerg Med 2003; 42(3): 324–333.

[26] Green S. Improvıng the preanalytıcal process: the focus on specımen qualıty. JMB 2008; 27(3): 343-347.

[27] Aykal G, Yeğin A, Aydın Ö, Yılmaz N, Ellidağ HY. Preanalitik süreçteki ret oranlarının azalmasında eğitimin önemi. Turk J Biochem 2014; 39(4):562-566 (Turkish).

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