Research Article

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Biochemistry laboratory errors and patient safety: Turkey data

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Abstract

Objectives: Our aim in this study is to provide information about the rate of errors in the process of the biochemistry laboratories in the hospitals in Turkey with the “Indicators”.

Methods: The hospitals calculate their own data according to the indicator cards defined by the Ministry of Health of Turkey and enter into the system once in a year. In this study we examined the quality indicators related to the disruptions in the biochemistry laboratory of hospitals for the year of 2018.

Results: All indicators except “Non-timely reported result rate in biochemistry laboratory” are found to be significantly higher in university hospitals. This indicator is found to be significantly higher in private hospitals ($p:0.030$) “Lost sample rate in biochemistry laboratory” is found to be significantly higher in Eastern Anatolia Region ($p:0.000$) and “Non-timely reported result rate in biochemistry laboratory” is found to be significantly higher in Aegean Region ($p:0.008$).

Conclusions: The ratio of non-timely reported result rate is the most seen disruption in biochemistry laboratories. It

may be due to lots of reasons; lack of biochemistry equipment, lack of staff, problems in transportation, etc. The management of hospitals and the staff should take measures and regulations about problems.

Keywords: biochemistry; hospitals; laboratories; medical error; quality control.

Introduction

The error is a planned series of mental or physical activities cannot achieve the desired goal and result [1]. The Institute of Medicine defines the medical error as “a planned action does not result in its intended purpose or the usage of a wrong plan to achieve a goal” [2, 3].

All errors in healthcare delivery can lead to adverse events and injuries, regardless of patients’ underlying conditions [4].

The studies have reported that 10% of hospitalized patients are affected by medical errors [5, 6] and 61% of the side effects caused by the human factor could be prevented [7].

Reducing errors and increasing patient safety are the most important parts of healthcare service quality [8]. Any mistake made in healthcare can threaten human health. For this reason, zero error should be targeted. Laboratories are the important parts of the healthcare system. An error made in a laboratory may cause complete change of diagnosis and treatment process and harm that patient. Therefore, the quality of service should be kept at the highest level. In “Healthcare Quality Standards (HQS) Hospital” set, the standards related to the Biochemistry laboratories are specified in Table 1. The Department of Healthcare Quality, Accreditation and Employee Rights organized expert groups and these standards were prepared with the participation of experts in their field. Five of them are the basic standards and are as follows:

- Pre-analytical process regarding biochemistry laboratory tests should be kept under control.
- Processes for the acceptance of samples to the laboratory and preparation for analysis should be checked.

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- Internal quality control studies for laboratory tests should be carried out.
- External quality assessment studies should be conducted for laboratory tests.
- Timely and effective notification of critical values should be ensured [9].

These 5 standards are indispensable. Basic standards are also important in scoring the Hospital Quality Score. Hospital Quality Score 5 for each basic standard not met point are reduced. If the number of basic standards not met is six or above, the Hospital Quality Score will be reduced by 30 points.

If laboratory errors are classified simply, they occur in pre-analytical, analytical and postanalytical phases. Pre-analytical phase; is a stage before the test, outside the laboratory and until the analysis in the laboratory. Analytical phase; is a stage which the test or measurement is made. The postanalytical phase is a stage where the test result is transferred to a patient's test report and clinician making the request using a patient's test result for the benefit of patient or individual [10–12]. The studies showed that the vast majority of the laboratory errors occur in the pre-analytical and postanalytical phases [13]. pre-analytical errors are generally observed at a higher rate. Because the process is generally not managed by the medical laboratory and the laboratory can intervene in the preanalytic process only when it reaches the sample laboratory limits [14]. It is equally important to measure and evaluate the effectiveness of every service that forms part of this system, as well as the establishment of a modern healthcare system focused on providing qualified health care services. Surely, each system must firstly collect

information about the activities it performs in order to determine the extent to which its service achieves its purpose. In other words, it should make measurements, try to reach some results and decisions by making use of measurement results and use these results as a guide for future studies. Accordingly, “Indicators” have been created in order to measure service processes and effectiveness of the service in health institutions. The indicator card defines the indicator name, indicator code, and definition and calculation method. Also these indicators were prepared with the participation of experts in their field too. The indicators created for the “Biochemistry Laboratory” in the “Indicator Management Guide” are as follow [15]:

- GBBL01 Rejected sample rate in biochemistry laboratory tests
- GBBL02 Lost sample rate in the biochemistry laboratory
- GBBL03 The number of the nonconformities in the biochemistry laboratory internal quality control studies
- GBBL04 The number of the nonconformities in the biochemistry laboratory external quality control studies
- GBBL05 Non-timely reported result rate in biochemistry laboratory (see Table 2)

Our purpose in this study is to provide information about the rate of errors in the process of the biochemistry laboratories in the hospitals in Turkey with the “Indicators”.

Materials and methods

The approval for the study was obtained from the Republic of Turkey, Ministry of Health General Directorate of Health Services, Department of Healthcare Quality, Accreditation and Employee Rights.

Table 1: HQS – the hospital biochemistry laboratory standards.

SBL01	In order to manage biochemistry services effectively and reliably outside of laboratory processes, relevant healthcare professionals should be informed.
SBL02	Pre-analysis processes regarding biochemistry laboratory tests should be kept under control.
SBL03	Processes for the acceptance of samples to the laboratory and preparation for analysis should be checked.
SBL04	Working processes should be defined on a test basis.
SBL05	Control and safe usage of materials, devices and equipments in the laboratory should be ensured.
SBL06	Internal quality control studies of laboratory tests should be carried out.
SBL07	External quality control studies of laboratory tests should be carried out.
SBL08	<i>Optional method validation/verification should be done.</i>
SBL09	<i>Measurement uncertainty for optional quantitative tests should be evaluated.</i>
SBL10	Arrangements should be made for patient result reports.
SBL11	Test result times should be determined.
SBL12	Timely and effective notification of panic values should be ensured.
SBL13	The rules for archiving the test samples with completed test procedures, test data and the results should be determined.
SBL14	Traceability of processes related to laboratory tests should be ensured.
SBL15	Errors occurring in the laboratory processes and “close-call” events should be coded according to the laboratory error classification system (LHSSTR).

*The bold written standards are basic standards.*The italic written standards are optional standard.

Table 2: Indicator cards.

Rejected sample rate in biochemistry laboratory tests	
Indicator name	Sample rate rejected in biochemistry Laboratory tests
Indicator code	GBBL01
Definition	It refers to the percentage of the rejected samples in the samples sent to the clinical laboratory.
Calculation method	In the relevant period; (number of samples rejected/Total number of samples sent to the laboratory) x 100
Lost sample rate in biochemistry Laboratory	
Indicator name	Sample rate lost in biochemistry laboratory
Indicator code	GBBL02
Definition	It refers to the percentage of the lost samples to be sent to the laboratory in the samples sent to the clinical laboratory.
Calculation method	In the relevant period; (number of lost samples/Total number of samples taken) x 100
Number of nonconformities in biochemistry Laboratory internal quality control studies	
Indicator name	Number of nonconformities in internal quality control studies
Indicator code	GBBL03
Definition	It is a measurement tool used to monitor nonconformities that occur in laboratory internal quality control studies.
Calculation method	In the relevant period; number of nonconformities on the basis of test in internal quality control studies
Number of nonconformities in biochemistry Laboratory external quality control studies	
Indicator name	Number of nonconformities in external quality control studies
Indicator code	GBBL04
Definition	It is a measurement tool used to monitor nonconformities that occur in laboratory external quality control studies.
Calculation method	In the relevant period; number of nonconformities on the basis of test in external quality control studies
Non-timely reported result rate in biochemistry Laboratory	
Indicator name	Non-timely reported result rate
Indicator code	GBBL05
Definition	It is a measurement tool used for the purpose of determination and monitoring of the results that cannot be given within the given test times in clinical laboratories.
Calculation method	In the relevant period; (number of results not delivered on time/Total number of results given) x 100

TUR-GOS (Turkey Healthcare Quality Indicators System) is an indicator management system designed to evaluate the quality of health service, developed by the Republic of Turkey, Ministry of Health. The hospitals calculate their data according to the indicator cards determined by the Ministry of Health. Then the results are entered into the system and sent to the Ministry once a year.

In this study, the negativities that occurred in the biochemistry laboratories of the hospitals in 2018 were evaluated using the TUR-GOS data. The evaluated indicators are:

- GBBL01 Rejected sample rate in biochemistry laboratory tests
- GBBL02 Lost sample rate in biochemistry laboratory
- GBBL03 The number of the nonconformities in the biochemistry laboratory internal quality control studies
- GBBL04 The number of the nonconformities in the biochemistry laboratory external quality control studies
- GBBL05 Non-timely reported result rate in biochemistry laboratory

The results were presented on the average on the basis of public, private and university hospitals' data. Also the hospitals were classified due to geographic regions and the indicators results' were compared due to geographic regions.

Statistical evaluation was performed using the SPSS (Statistical Packet for the Social Science) 23.0 package program. In the evaluation of the data obtained; continuous variables in the study were

expressed as mean $\pm$ standard deviation or median (minimum-maximum) values. Kruskal Wallis test was used for intergroup comparisons of these parameters. Comparison of categorical variables was made using the chi-square test. $p < 0.05$ was considered as statistically significant.

Results

The number of the hospitals that sent data for each indicator is as follows:

Rejected sample rate in biochemistry laboratory tests (GBBL01): 1,115 (State hospitals: 595, Private hospitals: 398, University hospitals: 122).

Lost sample rate in biochemistry laboratory (GBBL02): 1,111 (State hospitals: 594, Private hospitals: 398, University hospitals: 119).

The number of the nonconformities in the biochemistry laboratory internal quality control studies (GBBL03): 1,096 (State hospitals: 591, Private hospitals: 385, University hospitals: 120).

Table 3: The indicator rates by hospitals.

	Indicator parameters	N	Mean	Std. Deviation	Mini mum	Maximum
STATE HOSPITALS	Number of samples rejected	595	1,410.0975	2,842.29759	0.00	36,572.00
	Total number of samples sent to the laboratory	595	322,384.4992	1,072,597.42383	0.00	21,323,820.00
	Sample rate rejected in biochemistry laboratory tests	562	0.6270	1.14793	0.00	20.69
	Number of lost samples	594	274.6380	3,930.30580	0.00	86,108.00
	Total number of samples taken	594	285,336.9562	631,425.50046	0.00	11,550,835.00
	Sample rate lost in biochemistry laboratory	554	0.0526	0.36332	0.00	7.28
	Number of results not delivered on time	589	13,326.4822	57,486.70947	0.00	873,157.00
	Total number of results given	589	677,780.2513	1,671,521.28489	0.00	21,322,435.00
	Non-timely reported result rate	552	2.0375	3.39085	0.00	26.16
	Number of nonconformities in external quality control studies	588	55.6956	853.51949	0.00	20,666.00
	Number of nonconformities in internal quality control studies	591	629.5854	3,780.07144	0.00	81,747.00
PRIVATE HOSPITALS	Number of samples rejected	398	484.4849	877.91960	0.00	8,144.00
	Total number of samples sent to the laboratory	398	203,761.2312	811,118.57791	0.00	15,323,925.00
	Sample rate rejected in biochemistry laboratory tests	353	0.4625	0.60787	0.00	3.95
	Number of lost samples	398	13.2764	197.87501	0.00	3,723.00
	Total number of samples taken	398	235,200.8568	1,511,435.38400	0.00	29,786,225.00
	Sample rate lost in biochemistry laboratory	348	0.0060	0.06647	0.00	1.18
	Number of results not delivered on time	392	8,984.3989	33,675.48312	0.00	338,542.00
	Total number of results given	392	362,420.6939	998,975.18705	0.00	15,323,925.00
	Non-timely reported result rate	346	3.2365	12.74210	0.00	205.00
	Number of nonconformities in external quality control studies	387	8.4548	19.60530	0.00	228.00
	Number of nonconformities in internal quality control studies	385	360.4390	2035.82402	0.00	26,520.00
UNIVERSITY HOSPITALS	Number of samples rejected	122	9,581.7049	12,672.09926	0.00	86,368.00
	Total number of samples sent to the laboratory	122	1,142,759.3197	1,347,988.01680	0.00	7,694,690.00
	Sample rate rejected in biochemistry laboratory tests	114	1.0990	1.41120	0.01	11.48
	Number of lost samples	119	837.7479	6,286.09682	0.00	65,202.00
	Total number of samples taken	119	995,003.0588	1,064,024.25924	0.00	5,716,137.00
	Sample rate Lost in biochemistry laboratory	110	0.0612	0.24630	0.00	1.76
	Number of results not delivered on time	121	50,595.3388	132,037.69521	0.00	1,055,662.00
	Total number of results given	121	1,805,562.0496	2,241,555.87662	0.00	10,048,591.00
	Non-timely reported result rate	110	3.0502	5.34272	0.00	38.87
	Number of nonconformities in external quality control studies	120	56.4750	120.41043	0.00	1,143.00
	Number of nonconformities in internal quality control studies	120	1886.7000	6,672.86414	0.00	57,653.00
Total	Number of samples rejected	1,115	1973.8126	5,415.28375	0.00	86,368.00
	Total number of samples sent to the laboratory	1,115	369,804.8287	1,059,129.15856	0.00	21,323,820.00
	Sample rate rejected in biochemistry laboratory tests	1,029	0.6229	1.04811	0.00	20.69
	Number of lost samples	1,111	241.3240	3,539.00471	0.00	86,108.00
	Total number of samples taken	1,111	343,389.2502	1,096,320.89744	0.00	29,786,225.00
	Sample rate Lost in biochemistry laboratory	1,012	0.0375	0.28423	0.00	7.28
	Number of results not delivered on time	1,102	15,874.0639	64,966.72270	0.00	1,055,662.00
	Total number of results given	1,102	689,432.3848	1,602,888.03590	0.00	21,322,435.00
	Non-timely reported result rate	1,008	2.5596	8.08328	0.00	205.00
	Number of nonconformities in external quality control studies	1,095	39.0849	626.98474	0.00	20,666.00
	Number of nonconformities in internal quality control studies	1,096	672.6807	3,766.73910	0.00	81,747.00

The number of the nonconformities in the biochemistry laboratory external quality control studies (GBBL04):1,095 (State hospitals:588, Private hospitals:387, University hospitals: 120).

Non-timely reported result rate in biochemistry laboratory (GBBL05): 1,102 (State hospitals: 589, Private hospitals: 392, University hospitals: 121).

The mean value of the rejected sample rate in biochemistry laboratory tests in the state hospitals: 0.6270%, in the private hospitals: 0.4625% and in the university hospitals: 1.0990%.

The mean value of the lost sample rate in the biochemistry laboratory in the state hospitals: 0.526%, in the private hospitals: 0.0060% and in the university hospitals: 0.612%.

The mean value of the number of the nonconformities in the biochemistry laboratory internal quality control studies in the state hospitals: 629.5854, in the private hospitals: 360.4390, and in the university hospitals: 1886.70

The mean value of the number of the nonconformities in the biochemistry laboratory external quality control studies in the state hospitals: 55.6956, in the private hospitals: 8.4548 and in the university hospitals: 56.475.

The mean value of the non-timely reported result rate in the biochemistry laboratory, in the state hospitals: 2.0375%, in the private hospitals: 3.2365%, and in the university hospitals: 3.0502% (see Table 3).

All indicators except GBBL05 are found to be significantly higher in university hospitals. GBBL05 is found to be significantly higher in private hospitals ($p:0.030$) (see Table 4).

While the most data were sent by the hospitals in the Marmara region, the least data were sent by the hospitals in the Eastern Anatolia and Southeastern Anatolia region (see Table 5). GBBL02 is found to be significantly higher in Eastern Anatolia Region ($p:0.000$) and GBBL05 is found to be significantly higher in Aegean Region ($p:0.008$) (see Table 6).

Discussion

Errors in biochemistry laboratories in the hospitals in our country are coded with the error classification systems according to the Security Reporting System (SRS) infrastructure. Since most of the laboratory information systems are integrated with SRS, all error applications are sent directly to the national system. Unlike analytical and postanalytical processes, the pre-analytical process covers a large number of units that are difficult to keep under control by the laboratory team in the healthcare facilities such as clinics, emergency services, polyclinics. Therefore,

the error rate may be higher in the pre-analytical phase. In the studies conducted, it was reported that the errors were made in the pre-analytical phase, and the second most errors were made in the postanalytical phase [13, 14]. However, in our study, the “non-timely reported result rate in biochemistry laboratory” belonging to the post-analytical phase was higher. The analytical process errors were found to be low in accordance with the literature.

In the study carried out by Oz et al. in Kayseri Training and Research Hospital, sample rejection rates were 0.6% for hematological tests and 0.3% for biochemical tests [16]. In the study carried out by Ozcan et al. in Corum State Hospital, the frequency of preanalytic error was stated as 0.77% [17].

In another study conducted in a state hospital in Ankara, 0.81% of the samples sent to the central laboratory and 0.69% of the samples sent to the emergency laboratory were rejected [18]. The results are consistent with our study data. In the studies, the most common causes of pre-analytical errors were clotted sample, insufficient sampling and contamination [16–18].

In the study conducted with 30 health institutions in the USA, pre-analytical laboratory errors were reported as the most common errors with 81.1%. Among these errors, the most common errors are those that arise from not labeling the sample taken, incorrect labeling of the sample

Table 4: Comparison of indicators by hospital types **Kruskal-Wallis Test.**

Test statistics ^{a,b}			
	Chi-square	df	Asymp. Sig.
Number of samples rejected	186.488	2	0.000
Total number of samples sent to the laboratory	146.760	2	0.000
Sample rate rejected in biochemistry laboratory tests	70.729	2	0.000
Number of lost samples	56.131	2	0.000
Total number of samples taken	132.316	2	0.000
Sample rate lost in biochemistry laboratory	45.663	2	0.000
Number of results not delivered on time	39.221	2	0.000
Total number of results given	93.907	2	0.000
Non-timely reported result rate	6.984	2	0.030
Number of nonconformities in external quality control studies	91.225	2	0.000
Number of nonconformities in internal quality control studies	14.450	2	0.001

^aKruskal Wallis Test. ^bGrouping Variable: Hospital type. The significance level based on the asymptotic distribution of a test statistic. Typically, a value of less than 0.05 is considered significant. The asymptotic significance is based on the assumption that the data set is large. If the data set is small or poorly distributed, this may not be a good indication of significance.

Table 5: The indicators by geographic regions.

Geographic reagon		N	Mean	Std. Deviation	Minimum	Maximum
Aegean region	Number of samples rejected	151	1791.5166	3,903.09858	0.00	24,670.00
	Total number of samples sent to the laboratory	151	309,218.1258	390,762.28971	0.00	1,977,014.00
	Sample rate rejected in biochemistry laboratory tests	138	0.5174	0.54498	0.00	3.13
	Number of lost samples	150	580.3533	7,030.25817	0.00	86,108.00
	Total number of samples taken	150	326,483.0600	459,036.59558	0.00	3,303,429.00
	Sample rate lost in biochemistry laboratory	137	0.0103	0.07489	0.00	0.83
	Number of results not delivered on time	146	21,898.6738	85,277.09047	0.00	705,185.00
	Total number of results given	146	631,513.9589	1,135,644.16782	0.00	8,955,186.00
	Non-timely reported result rate	134	4.3036	18.75770	0.00	205.00
	Number of nonconformities in external quality control studies	149	21.7718	35.03996	0.00	239.00
	Number of nonconformities in internal quality control studies	148	429.6554	1,055.85696	0.00	8,531.00
Mediterranean Region	Number of samples rejected	129	1,596.7907	3,932.83223	0.00	26,330.00
	Total number of samples sent to the laboratory	129	405,693.5349	1,133,030.15418	0.00	11,630,835.00
	Sample rate rejected in biochemistry laboratory tests	116	0.5339	1.05881	0.00	10.57
	Number of lost samples	126	415.6667	3,704.40542	0.00	41,126.00
	Total number of samples taken	126	410,886.5238	1,183,856.98259	0.00	1,155,083.00
	Sample rate lost in biochemistry laboratory	113	0.0832	0.68889	0.00	7.28
	Number of results not delivered on time	129	15,377.7984	56,775.27712	00	427,843.00
	Total number of results given	129	728,909.6279	1,804,225.41410	0.00	1,197,557.00
	Non-timely reported result rate	116	2.4876	4.60681	0.00	26.16
	Number of nonconformities in external quality control studies	124	19.8952	39.25771	0.00	267.00
	Number of nonconformities in internal quality control studies	125	516.8400	1,318.82351	0.00	10,399.00
Blacksea region	Number of samples rejected	145	1,597.6414	7,296.12582	0.00	86,368.00
	Total number of samples sent to the laboratory	145	231,287.9931	284,271.85166	0.00	1,560,799.00
	Sample rate rejected in biochemistry laboratory tests	138	0.5475	1.03156	0.00	11.48
	Number of lost samples	145	63.1862	381.37232	0.00	3,913.00
	Total number of samples taken	145	218,997.5241	269,688.23188	0.00	1,798,240.00
	Sample rate lost in biochemistry laboratory	136	0.0534	0.25266	0.00	1.76
	Number of results not delivered on time	144	6,758.5139	15,830.42924	0.00	108,451.00
	Total number of results given	144	516,187.0764	962,451.27419	0.00	7,105,637.00
	Non-timely reported result rate	135	1.9434	3.08003	0.00	18.47
	Number of nonconformities in external quality control studies	144	28.4097	104.58017	00	1,143.00
	Number of nonconformities in internal quality control studies	144	771.0764	4,966.20546	0.00	57,653.00
Central anatolia region	Number of samples rejected	172	2,231.8605	5,795.55297	0.00	41,989.00
	Total number of samples sent to the laboratory	172	378,819.9186	790,606.54006	0.00	7,694,690.00
	Sample rate rejected in biochemistry laboratory tests	157	0.5649	0.82262	0.00	6.99
	Number of lost samples	170	155.0000	1,653.72879	0.00	21,507.00
	Total number of samples taken	170	329,324.6765	506,856.66180	0.00	3,049,747.00
	Sample rate lost in biochemistry laboratory	154	0.0224	0.10840	0.00	0.83
	Number of results not delivered on time	170	13,588.8059	69,814.42544	0.00	873,157.00
	Total number of results given	170	758,747.4176	1,740,893.01152	0.00	12,573,236.00

Table 5: (continued)

Geographic reagon		N	Mean	Std. Deviation	Minimum	Maximum
Marmara region	Non-timely reported result rate	153	1.8255	3.05604	0.00	21.40
	Number of nonconformities in external quality control studies	168	148.1429	1,595.79513	0.00	20,666.00
	Number of nonconformities in internal quality control studies	168	1,052.8690	7,050.66196	0.00	81,747.00
	Number of samples rejected	330	2,187.2697	5,827.89320	0.00	65,594.00
	Total number of samples sent to the laboratory	330	376,048.7424	1,037,857.56017	0.00	15,323,925.00
	Sample rate rejected in biochemistry laboratory tests	310	0.6333	0.74911	0.00	4.28
	Number of lost samples	331	206.5378	3,584.37006	0.00	65,202.00
	Total number of samples taken	331	415,306.2387	1,743,033.59773	0.00	29,786,225.00
	Sample rate lost in biochemistry laboratory	307	0.0083	0.07635	0.00	1.14
	Number of results not delivered on time	329	19,008.8784	74,297.63932	0.00	1,055,662.00
	Total number of results given	329	675,079.9392	1,556,682.66916	0.00	15,323,925.00
	Non-timely reported result rate	305	2.8297	5.97185	0.00	57.86
	Number of nonconformities in external quality control studies	329	15.5046	31.67538	0.00	246.00
	Number of nonconformities in internal quality control studies	329	828.5593	3,105.27085	0.00	30,089.00
Eastern anatolia region	Number of samples rejected	92	1917.3043	4,640.69791	0.00	28,981.00
	Total number of samples sent to the laboratory	92	610,002.6630	2,410,457.98317	0.00	21,323,820.00
	Sample rate rejected in biochemistry laboratory tests	86	0.7697	0.98135	0.00	5.49
	Number of lost samples	92	64.6522	380.71565	0.00	3,553.00
	Total number of samples taken	92	253,570.4130	432,767.38170	0.00	2,228,647.00
	Sample rate lost in biochemistry laboratory	82	0.0956	0.34537	0.00	2.62
	Number of results not delivered on time	89	5,368.4831	13,615.40209	0.00	76,114.00
	Total number of results given	89	862,099.1124	2,629,649.27173	0.00	21,322,435.00
	Non-timely reported result rate	81	1.4076	3.67539	0.00	25.68
	Number of nonconformities in external quality control studies	91	14.8901	25.78434	0.00	143.00
	Number of nonconformities in internal quality control studies	91	217.6484	620.73131	0.00	4,908.00
Southeastern anatolia region	Number of samples rejected	96	2,193.4062	4,334.53969	0.00	30,355.00
	Total number of samples sent to the laboratory	96	358,290.2708	739,258.44517	0.00	5,869,369.00
	Sample rate rejected in biochemistry laboratory tests	84	0.9623	2.29649	0.00	20.69
	Number of lost samples	97	194.4330	765.03138	0.00	5,060.00
	Total number of samples taken	97	332,233.1649	711,922.51014	0.00	5,537,204.00
	Sample rate lost in biochemistry laboratory	83	0.0724	0.24331	0.00	1.32
	Number of results not delivered on time	95	24,181.4421	69,621.39405	0.00	493,391.00
	Total number of results given	95	751,347.2316	1,337,465.09665	0.00	6,401,608.00
	Non-timely reported result rate	84	2.3341	3.91327	0.00	22.43
	Number of nonconformities in external quality control studies	90	18.3556	30.42335	0.00	165.00
	Number of nonconformities in internal quality control studies	91	315.8791	778.79332	0.00	5,091.00
Total	Number of samples rejected	1,115	1973.8126	5,415.28375	0.00	86,368.00
	Total number of samples sent to the laboratory	1,115	369,804.8287	1,059,129.15856	0.00	21,323,820.00
	Sample rate rejected in biochemistry laboratory tests	1,029	0.6229	1.04811	0.00	20.69
	Number of lost samples	1,111	241.3240	3,539.00471	0.00	86,108.00

Table 5: (continued)

Geographic reagon	N	Mean	Std. Deviation	Minimum	Maximum
Total number of samples taken	1,111	343,389.2502	1,096,320.89744	0.00	29,786,225.00
Sample rate lost in biochemistry laboratory	1,012	0.0375	0.28423	0.00	7.28
Number of results not delivered on time	1,102	15,874.0639	64,966.72270	0.00	1,055,662.00
Total number of results given	1,102	689,432.3848	1,602,888.03590	0.00	21,322,435.00
Non-timely reported result rate	1,008	2.5596	8.08328	0.00	205.00
Number of nonconformities in external quality control studies	1,095	39.0849	626.98474	0.00	20,666.00
Number of nonconformities in internal quality control studies	1,096	672.6807	3,766.73910	0.00	81,747.00

Table 6: Comparison of indicators by geographic regions Kruskal-Wallis Test.

Test statistics ^{a,b}			
	Chi-square	Df	Asymp. Sig.
Nmber of samples rejected	5.310	6	0.505
Total number of samples sent to the laboratory	6.190	6	0.402
Sample rate rejected in biochemistry laboratory tests	12.006	6	0.062
Number of lost samples	35.997	6	0.000
Total number of samples taken	8.044	6	0.235
Sample rate Lost in biochemistry laboratory	45.181	6	0.000
Number of results not delivered on time	12.224	6	0.057
Total number of results given	4.302	6	0.636
Non-timely reported result rate	17.259	6	0.008
Number of nonconformities in external quality control studies	12.420	6	0.053
Number of nonconformities in internal quality control studies	4.951	6	0.550

^aKruskal Wallis Test. ^bGrouping Variable: Hospital type. The significance level based on the asymptotic distribution of a test statistic. Typically, a value of less than 0.05 is considered significant. The asymptotic significance is based on the assumption that the data set is large. If the data set is small or poorly distributed, this may not be a good indication of significance.

and improper sample collection [19]. In the same study, it was stated that most of the pre-analytical laboratory errors result in consequences that do not harm the patient or only cause temporary harm, while postanalytic laboratory errors are more likely to harm the patient [19].

In the study of Hickner et al., which analyzed 590 laboratory errors, 18% of the patients experienced some damages such as financial loss, delay in diagnosis, delay in care and negative clinical results [20]. Another study suggested that an error occurring in the testing process was effective on patient care in 27% of patients [21].

In the literature, there are studies showing that staff working in all clinics that take samples and laboratory technicians are regularly trained on pre-analytical errors before and during the task, thereby contributing to the prevention of labor and economic losses due to pre-analytical errors in laboratory services [22–24].

Number of nonconformities in biochemistry laboratory internal/external quality control studies are calculated as “In the relevant period; number of nonconformities on the basis of test in internal/external quality control studies” So it is not correct to make comparisons between hospitals because it does not give a ratio. The most important thing is to carry out and continue the necessary studies and maintenance on the devices for the tests that are inappropriate in internal and external quality control studies until the tests become suitable.

“Non-timely reported result rate in biochemistry laboratory” is one of the important indicators showing the quality of the postanalytical process. It has been determined that this indicator had the highest rate. The reasons for this situation may include wrong patient protocol, late reporting of panic results, late approval of the report, and transition errors between the laboratory information system and the hospital information system.

In our study, the most common error rate except “Non-timely reported result rate in biochemistry laboratory” was seen in university hospitals. When we searched for literature, we could not find a study comparing the hospital types. In the university hospitals various tests are carried out, so different types of test tubes and devices are used. So it can be difficult to master.

Although we had expected the biochemistry laboratory error rates to be higher in the Marmara region as the number of hospitals were the highest when we compared the indicators according to regions the highest “Non-timely reported result rate in biochemistry laboratory” was in Aegean region and the lowest rate was in Eastern Anatolia region. However the highest “Lost sample rate

in biochemistry laboratory” was seen also in Eastern Anatolia region.

Our study represents an important contribution to the literature with comparing the hospitals types and presenting the general data in Turkey.

Conclusion

The non-timely reported result rate is the most common adversity. In addition, the error rates in the university hospitals are higher than public and private hospitals. The root cause needs to be analyzed well and necessary measures must be taken by those responsible.

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