Archives of Current Medical Research
Arch Curr Med Res 2023;4(3):153-177

Received: 28 July 2023
Revised: 26 August 2023
Acccepted: 25 September 2023
DOI: 10.47482/acmr.1333906

ORIGINAL ARTICLE

# Determining the turnaround time in a newly established biochemistry laboratory

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## Abstract

**Background:** The aim of our study was to compare the turnaround times at the central biochemistry laboratory of Etlik City Hospital in terms of time and between clinics and to reveal the reasons for the variations in these times.

**Methods:** The time of acceptance of the samples to Etlik City Hospital Central Biochemistry Laboratory and the time of confirmation of the results were noted and the difference between these two times was calculated.

**Results:** Delay rates were significantly different between patients hospitalized in October, November and December 2022 (P<0.001). Delay rates for troponin tubes were significantly different between patients hospitalized in October, November and December (P<0.001). In the emergency department, the highest delay rate was 73.8% for troponin and the lowest was 12.1% for hormone, regardless of time. The highest and the lowest delay rate in the outpatient clinic was observed for biochemistry (43.2%) and complete blood count (3.7%), respectively. When the tubes were compared for inpatient clinic, the highest delay rate in the emergency department was observed for troponin.

**Conclusions:** The expected benefits of our study are to clearly demonstrate the rapid turnaround times of newly established biochemistry laboratories in large hospitals and centers, to show the variations of these times between clinics, to increase clinicians' satisfaction with the laboratory, to reduce costs by shortening hospital stays and to develop measures that can be adopted.

**Keywords:** Turnaround Time, City Hospital, Laboratory, Efficiency.

***Cite this article as:*** *Öztürk A, Demirci G. Determining the turnaround time in a newly established biochemistry laboratory. Arch Curr Med Res. 2023;4(3):153-177*

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## INTRODUCTION

Laboratory turnaround time (LRT) is the time between the acceptance of a sample in the laboratory and the availability of an approved report. However, the definition of TAT is different between various studies and scientific institutions. The clinician considers TAT as the time between an order and approval of the specialist. On the other hand, laboratory specialists consider TAT as the time between the acceptance of the sample and the opinion of the specialist (1). Clinicians often use TAT when evaluating laboratory performance. The reason for this is that clinicians need fast turnaround times to diagnose their patients quickly, administer the right treatment within the shortest possible time and discharge their inpatient clinic as soon as possible. Another benefit of faster TAT times is to reduce costs by shortening hospitalization and length of stay. Prolonged turnaround times also increase the laboratory workload. For patient satisfaction and laboratory quality, it is important to frequently evaluate TAT times and implement appropriate measures (2-4).

There are many parameters that affect TAT and are beyond the authority of the laboratory. Such non-analytical delays can be responsible for up to 96% of total TAT (5-7). Clinical laboratories classically have limited analytical and technical quality debates and focus on uncertainty and inaccuracy targets. At the same time, clinicians evaluate the "quality of the laboratory" for fast, reliable and efficient service delivered at low cost. To illustrate this, timeliness is one of the key attributes prepared to be assessed as one of the key quality steps. The TAT times described above are also one of the most important indicators (8-11).

TAT is a laboratory service that is used by many clinicians to assess the quality of the laboratory. According to Lundberg, which evaluates the total testing cycle, the following steps need to be completed for a test to be performed in the laboratory: ordering, identification, processing, preparation, analysis, reporting, interpretation and action (12-15). Due to the limitations and difficulties of controlling all the steps mentioned above, most laboratories assess TAT with in-laboratory activities.

Delays in turnaround times and complaints of patients and clinicians increase the workload of the laboratory and the work stress of laboratory staff. However, identifying the causes of these delays can lead to problem solving and efficient workflow, ultimately increasing the satisfaction and motivation of patients, clinicians and laboratory staff.

The aim of our study was to compare the turnaround times on a daily, weekly and monthly basis and between clinics (emergency department, inpatient, outpatient) in the newly established central biochemistry laboratory of Etlik City Hospital, which was recently opened and serves as a large center, and to reveal the reasons for the variations between these times. We also believe that our study will contribute to the development of solutions that can further shorten TAT times.

## MATERIALS AND METHODS

### Patients

No specific disease group was included in our study. All samples for which test order and result times were determined were included in the study. The acceptance times and the approval times of the results of the samples that were accepted to the Central Biochemistry Laboratory of Etlik City Hospital were noted and the difference between these two times was calculated. These times were evaluated separately according to time and clinics. The TAT of the samples studied in October, November and December 2022 were calculated. The reason for choosing these first 3 months is that our laboratory is in its early stages of establishment and we want to be able to clearly observe both positive and negative rapid changes in TAT. No test results were analyzed except for the timing of the samples. Our study is a retrospective observational study.

### Laboratory analysis

Tests for biochemistry, hormones and troponin tubes are performed on the Roche Cobas c 702 (Roche Diagnostics GmbH, Mannheim, Germany) (up to 2,000 tests/hour) and Roche Cobas c 801 (Roche Diagnostics GmbH, Mannheim, Germany) (up to 300 tests/hour), complete blood count analysis on the XN-1000 (Sysmex corp. Kobe, Japan) (up to 100 tests/hour) and urinalysis studies are performed on the Roche cobas 6500 (Roche Diagnostics GmbH, Mannheim, Germany) urine analyzer series (cobas u 601 urine analyzer system cobas u 701 microscopy) (up to 240 samples per hour). Table 1 shows the target times used in our laboratory.

**Table 1. Our target times according to type of tubes and clinics**

| Tube type | Emergency (minutes) | Outpatient-Inpatient (minutes) |
|---|---|---|
| Biochemistry | 90 | 180 |
| Complete blood count | 45 | 120 |
| Hormone | 120 | 240 |
| Coagulation | 60 | 120 |
| Urınalysis | 45 | 90 |
| Troponin | 60 | 120 |

### Inclusion criteria

Inclusion criteria include that the test is requested by the clinician at Etlik City Hospital, accepted by our laboratory and confirmed by the biochemist after performing the test. Therefore, we do not have a specific age range or gender criteria.

### Exclusion criteria

Samples that were requested by the clinician but not accepted, samples that were not analysed even if accepted and samples that were not approved by the biochemist even if analysed were excluded from our study.

### Statistical analysis

Statistical analyses of the data obtained in the study were performed using the SPSS (Version 22.0, Spss Inc, Chicago, IL, USA) package program. Descriptive statistics of categorical variables were reported using number (n) and percentage (%). Descriptive statistics of numerical data were reported using mean, standard deviation (SD), median and quartiles: first quarter (Q1) and third quarter (Q3). The chi-square test was used to compare proportions of categorical variables between study groups and to investigate associations based on sample sizes in cross-tabulations. The level of statistical significance was set at $P<0.05$.

## RESULTS

The statistical analyses were performed according to months (October, November, December), service type (emergency, outpatient, inpatient) and tube types (biochemistry, complete blood count, hormone, coagulation, complete urinalysis, troponin) and the rates of deviation from the target values were compared according to months, service type and tube types.

Table 2, Table 3 and Table 4 present the descriptive statistics of turnaround times according to tube types in the emergency department, outpatient clinic and inpatient clinic in October, November and December, respectively. For each procedure, all turnaround times were subtracted from the target times to determine if there were delays, and the rates were statistically compared according to months, service type and tube types.

**Table 2. Descriptive statistics of turnaround times according to the types of tubes in the Emergency, İnpatient clinic and Outpatient clinic in October**

| Service type | Tube | N | Mean (minutes) | SD | Q1 | Median | Q3 |
|---|---|---|---|---|---|---|---|
| **Emergency** | **Biochemistry** | 6767 | 96.05 | 525.55 | 48 | 66 | 99 |
| | **Complete blood count** | 6473 | 32.96 | 517.09 | 11 | 19 | 31 |
| | **Hormone** | 739 | 76.96 | 40.47 | 52 | 66 | 90 |
| | **Coagulation** | 2347 | 62.92 | 420.07 | 36 | 47 | 64 |
| | **Urinalysis** | 3184 | 54.36 | 62.97 | 28 | 44 | 66 |
| | **Troponin** | 391 | 184.50 | 1833.9 | 55 | 71 | 94 |
| **Outpatient** | **Biochemistry** | 23073 | 248.73 | 1104.4 | 121 | 169 | 233 |
| | **Complete blood count** | 17274 | 77.46 | 782.75 | 30 | 47 | 73 |
| | **Hormone** | 16699 | 465.79 | 1804.8 | 153 | 223 | 341 |
| | **Coagulation** | 4703 | 105.73 | 645.65 | 62 | 84 | 113 |
| | **Urinalysis** | 6667 | 121.32 | 653.03 | 63 | 92 | 127 |
| | **Troponin** | 5165 | 142.56 | 514.37 | 92 | 119 | 159 |
| **Inpatient** | **Biochemistry** | 10340 | 240.83 | 1369.8 | 69 | 109 | 188 |
| | **Complete blood count** | 9335 | 68.26 | 1149.1 | 20 | 32 | 52 |
| | **Hormone** | 1729 | 770.85 | 3154.6 | 146.5 | 274 | 556.5 |
| | **Coagulation** | 4198 | 74.89 | 51.77 | 47 | 63 | 90 |
| | **Urinalysis** | 1479 | 113.42 | 1323 | 32 | 54 | 86 |
| | **Troponin** | 1368 | 115.75 | 167.22 | 64 | 87.5 | 129 |

**Table 3. Descriptive statistics of turnaround times according to the types of tubes in the Emergency, İnpatient clinic and Outpatient clinic in November**

| Service type | Tube | N | Mean (minutes) | SD | Q1 | Median | Q3 |
|---|---|---|---|---|---|---|---|
| Emergency | Biochemistry | 13178 | 98.75 | 102.62 | 58 | 82 | 117 |
| | Complete blood count | 12238 | 36.61 | 275.94 | 15 | 26 | 42 |
| | Hormone | 1999 | 85.76 | 51.62 | 57 | 74 | 102 |
| | Coagulation | 5345 | 60.51 | 47.11 | 36 | 50 | 71 |
| | Urinalysis | 5759 | 56.54 | 161.17 | 29 | 44 | 68 |
| | Troponin | 1001 | 170.25 | 863.21 | 63 | 84 | 116 |
| Outpatient | Biochemistry | 44309 | 240.19 | 690.45 | 119 | 168 | 240 |
| | Complete blood count | 35902 | 48.90 | 222.83 | 25 | 37 | 57 |
| | Hormone | 32998 | 448.25 | 1260.2 | 132 | 188 | 277 |
| | Coagulation | 9065 | 93.88 | 282.91 | 57 | 74 | 99 |
| | Urinalysis | 14043 | 75.68 | 279.09 | 44 | 61 | 85 |
| | Troponin | 10151 | 125.79 | 294.26 | 86 | 108 | 135 |
| Inpatient | Biochemistry | 23509 | 239.55 | 947.75 | 86 | 130 | 202 |
| | Complete blood count | 21519 | 57.60 | 277.04 | 27 | 44 | 67 |
| | Hormone | 3909 | 760.04 | 1902.1 | 124 | 220 | 425.5 |
| | Coagulation | 9573 | 80.24 | 77.83 | 49 | 68 | 94 |
| | Urinalysis | 2991 | 62.88 | 225.42 | 31 | 49 | 75 |
| | Troponin | 2877 | 176.18 | 858.30 | 85 | 110 | 148 |

**Table 4. Descriptive statistics of turnaround times according to the types of tubes in the Emergency, İnpatient clinic and Outpatient clinic in December**

| Service type | Tube | N | Mean (minutes) | SD | Q1 | Median | Q3 |
|---|---|---|---|---|---|---|---|
| Emergency | Biochemistry | 14653 | 89.84 | 346.9 | 51 | 67 | 94 |
| | Complete blood count | 14527 | 35.98 | 239.88 | 17 | 28 | 43 |
| | Hormone | 2218 | 79.55 | 65.35 | 56 | 70 | 90 |
| | Coagulation | 6874 | 59.23 | 48.82 | 36 | 48 | 67 |
| | Urinalysis | 6520 | 47.58 | 28.84 | 27 | 41 | 62 |
| | Troponin | 1233 | 116.64 | 742.86 | 60 | 80 | 107 |
| Outpatient | Biochemistry | 50866 | 213.12 | 448.96 | 119 | 164 | 225 |
| | Complete blood count | 42946 | 43.84 | 72.91 | 23 | 33 | 52 |
| | Hormone | 39550 | 402.5 | 1148.8 | 128 | 172 | 241 |
| | Coagulation | 10763 | 76.72 | 68.29 | 55 | 68 | 90 |
| | Urinalysis | 15925 | 63 | 143.74 | 41 | 55 | 75 |
| | Troponin | 12073 | 101.85 | 94.14 | 73 | 91 | 115 |
| Inpatient | Biochemistry | 26518 | 194.04 | 654.08 | 73 | 110 | 180 |
| | Complete blood count | 26625 | 53.16 | 153.2 | 28 | 41 | 63 |
| | Hormone | 4911 | 431.2 | 1537.6 | 86 | 138 | 231 |
| | Coagulation | 12508 | 84.55 | 101.67 | 50 | 66 | 95 |
| | Urinalysis | 3321 | 53.36 | 74.32 | 30 | 46 | 67 |
| | Troponin | 3659 | 138.04 | 520.66 | 82 | 103 | 132 |

Statistical findings regarding the comparison of delay rates in the emergency, outpatient and inpatient clinics in October, November and December for all tubes are presented in Table 5. Delay rates differed significantly among inpatient clinic in October, November and December (P<0.001). In October, the highest delay rate was observed in samples from outpatient clinics and the lowest delay rate was observed in samples from inpatient clinic. In November, the highest delay rate was observed in samples from emergency departments and the lowest delay rate was observed in samples from inpatient clinic. In December, the highest delay rate was observed in samples from emergency departments and the lowest delay rate was observed in samples from inpatient clinic.

**Table 5. Statistical findings on the comparison of the delay rates experienced in the Emergency Department, Outpatient clinic and İnpatient clinic in October, November and December for all departments**

| | | | Delay | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| **October** | **Emergency** | n | 14592 | 5309 | 19901 | <0.001 |
| | | % | 73.3 | 26.7 | 100 | |
| | **Outpatient Clinic** | n | 47807 | 25774 | 73581 | |
| | | % | 65,0 | 35.0 | 100 | |
| | **Inpatient** | n | 23214 | 5235 | 28449 | |
| | | % | 81.6 | 18.4 | 100 | |
| | **Total** | n | 85613 | 36318 | 121931 | - |
| | | % | 70.2 | 29.8 | 100 | |
| **November** | **Emergency** | n | 25639 | 13881 | 39520 | <0.001 |
| | | % | 64.9 | 35.1 | 100 | |
| | **Outpatient Clinic** | n | 106598 | 39870 | 146468 | |
| | | % | 72.8 | 27.2 | 100 | |
| | **Inpatient** | n | 51518 | 12860 | 64378 | |
| | | % | 80.0 | 20.0 | 100 | |
| | **Total** | n | 183755 | 66611 | 250366 | - |
| | | % | 73.4 | 26.6 | 100 | |
| **December** | **Emergency** | n | 32677 | 13348 | 46025 | <0.001 |
| | | % | 71.0 | 29.0 | 100 | |
| | **Outpatient Clinic** | n | 134223 | 37900 | 172123 | |
| | | % | 78.0 | 22.0 | 100 | |
| | **Inpatient** | n | 65270 | 12272 | 77542 | |
| | | % | 84.2 | 15.8 | 100 | |
| | **Total** | n | 232170 | 63520 | 295690 | - |
| | | % | 78.5 | 21.5 | 100 | |

Statistical findings that compare the delay rates in October, November and December for all inpatient clinic are presented in Table 6. The delay rates in October, November and December are significantly different according to tube types (P<0.001). In October, the highest delay rate was observed for Complete Urinalysis and the lowest delay rate was observed for Complete Blood Count. In November, the highest delay rate was found for biochemistry and troponin, while the lowest delay rate was for complete blood count. In December, the highest delay rate was for biochemistry and the lowest for complete blood count.

**Table 6. Statistical findings for the comparison of delay rates in October, November and December for all tubes**

| | | | Delay | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| October | Biochemistry | n | 25236 | 14944 | 40180 | <0.001 |
| | | % | 62.8 | 37.2 | 100 | |
| | Complete blood count | n | 30869 | 2213 | 33082 | |
| | | % | 93.3 | 6.7 | 100 | |
| | Hormone | n | 10603 | 8564 | 19167 | |
| | | % | 55.3 | 44.7 | 100 | |
| | Coagulation | n | 9100 | 2148 | 11248 | |
| | | % | 80.9 | 19.1 | 100 | |
| | Urinalysis | n | 6077 | 5253 | 11330 | |
| | | % | 53.6 | 46.4 | 100 | |
| | Troponin | n | 3728 | 3196 | 6924 | |
| | | % | 53.8 | 46.2 | 100 | |
| | Total | n | 85613 | 36318 | 121931 | - |
| | | % | 70.2 | 29.8 | 100 | |
| November | Biochemistry | n | 48644 | 32352 | 80996 | <0.001 |
| | | % | 60.1 | 39.9 | 100 | |
| | Complete blood count | n | 64796 | 4863 | 69659 | |
| | | % | 93.0 | 7.0 | 100 | |
| | Hormone | n | 25714 | 13192 | 38906 | |
| | | % | 66.1 | 33.9 | 100 | |
| | Coagulation | n | 19585 | 4398 | 23983 | |
| | | % | 81.7 | 18.3 | 100 | |
| | Urinalysis | n | 16581 | 6212 | 22793 | |
| | | % | 72.7 | 27.3 | 100 | |
| | Troponin | n | 8435 | 5594 | 14029 | |
| | | % | 60.1 | 39.9 | 100 | |
| | Total | n | 183755 | 66611 | 250366 | - |
| | | % | 73.4 | 26.6 | 100 | |
| December | Biochemistry | n | 60090 | 31947 | 92037 | <0.001 |
| | | % | 65.3 | 34.7 | 100 | |
| | Complete blood count | n | 78707 | 5391 | 84098 | |
| | | % | 93.6 | 6.4 | 100 | |
| | Hormone | n | 35374 | 11305 | 46679 | |
| | | % | 75.8 | 24.2 | 100 | |
| | Coagulation | n | 25120 | 5025 | 30145 | |
| | | % | 83.3 | 16.7 | 100 | |
| | Urinalysis | n | 20621 | 5145 | 25766 | |
| | | % | 80.0 | 20.0 | 100 | |
| | Troponin | n | 12258 | 4707 | 16965 | |
| | | % | 72.3 | 27.7 | 100 | |
| | Total | n | 232170 | 63520 | 295690 | - |
| | | % | 78.5 | 21.5 | 100 | |

Statistical findings regarding the comparison of delay rates according to tube types in October, November and December at the emergency department are presented in Table 7. Delay rates according to tube types were significantly different in October, November and December at the emergency department (P<0.001). In October, the highest delay rate was observed for troponin and the lowest delay rate was observed for complete blood count. In November, the highest delay rate was seen for troponin and the lowest delay rate was seen for hormone. In December, the highest delay rate was seen for troponin and the lowest delay rate was seen for hormones.

**Table 7. Statistical findings for the comparison of delay rates according to the type tubes in October, November and December for the emergency department**

| | | | Delay | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| October | Biochemistry | n | 4747 | 2020 | 6767 | <0.001 |
| | | % | 70.1 | 29.9 | 100 | |
| | Complete blood count | n | 5725 | 748 | 6473 | |
| | | % | 88.4 | 11.6 | 100 | |
| | Hormone | n | 652 | 87 | 739 | |
| | | % | 88.2 | 11.8 | 100 | |
| | Coagulation | n | 1651 | 696 | 2347 | |
| | | % | 70.3 | 29.7 | 100 | |
| | Urinalysis | n | 1684 | 1500 | 3184 | |
| | | % | 52.9 | 47.1 | 100 | |
| | Troponin | n | 133 | 258 | 391 | |
| | | % | 34.0 | 66.0 | 100 | |
| | Total | n | 14592 | 5309 | 19901 | - |
| | | % | 73.3 | 26.7 | 100 | |
| November | Biochemistry | n | 7654 | 5524 | 13178 | <0.001 |
| | | % | 58.1 | 41.9 | 100 | |
| | Complete blood count | n | 9577 | 2661 | 12238 | |
| | | % | 78.3 | 21.7 | 100 | |
| | Hormone | n | 1710 | 289 | 1999 | |
| | | % | 85.5 | 14.5 | 100 | |
| | Coagulation | n | 3479 | 1866 | 5345 | |
| | | % | 65.1 | 34.9 | 100 | |
| | Urinalysis | n | 2987 | 2772 | 5759 | |
| | | % | 51.9 | 48.1 | 100 | |
| | Troponin | n | 232 | 769 | 1001 | |
| | | % | 23.2 | 76.8 | 100 | |
| | Total | n | 25639 | 13881 | 39520 | - |
| | | % | 64.9 | 35.1 | 100 | |
| December | Biochemistry | n | 10613 | 4040 | 14653 | <0.001 |
| | | % | 72.4 | 27.6 | 100 | |
| | Complete blood count | n | 11433 | 3094 | 14527 | |
| | | % | 78.7 | 21.3 | 100 | |
| | Hormone | n | 1995 | 223 | 2218 | |
| | | % | 89.9 | 10.1 | 100 | |
| | Coagulation | n | 4665 | 2209 | 6874 | |
| | | % | 67.9 | 32.1 | 100 | |
| | Urinalysis | n | 3648 | 2872 | 6520 | |
| | | % | 56.0 | 44.0 | 100 | |
| | Troponin | n | 323 | 910 | 1233 | |
| | | % | 26.2 | 73.8 | 100 | |
| | Total | n | 32677 | 13348 | 46025 | - |
| | | % | 71.0 | 29.0 | 100 | |

Statistical findings regarding the comparison of delay rates according to tube types in October, November and December for outpatient clinic are presented in Table 8. For the outpatient clinic, the delay rates according to tube types in October, November and December were significantly different (P<0.001). In October, the highest delay rate was for complete urinalysis and the lowest delay rate was for complete blood count. In November, the highest delay rate was for biochemistry and the lowest for complete blood count. In December, the highest delay rate was for biochemistry and the lowest for complete blood count.

**Table 8. Statistical findings for the comparison of delay rates for outpatient clinic in October, November and December according to types of tubes**

| | | | Delay | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| October | Biochemistry | n | 12914 | 10159 | 23073 | <0.001 |
| | | % | 56.0 | 44.0 | 100 | |
| | Complete blood count | n | 16113 | 1161 | 17274 | |
| | | % | 93.3 | 6.7 | 100 | |
| | Hormone | n | 9182 | 7517 | 16699 | |
| | | % | 55.0 | 45.0 | 100 | |
| | Coagulation | n | 3723 | 980 | 4703 | |
| | | % | 79.2 | 20.8 | 100 | |
| | Urinalysis | n | 3247 | 3420 | 6667 | |
| | | % | 48.7 | 51.3 | 100 | |
| | Troponin | n | 2628 | 2537 | 5165 | |
| | | % | 50.9 | 49.1 | 100 | |
| | Total | n | 47807 | 25774 | 73581 | - |
| | | % | 65.0 | 35.0 | 100 | |
| November | Biochemistry | n | 24660 | 19649 | 44309 | <0.001 |
| | | % | 55.7 | 44.3 | 100 | |
| | Complete blood count | n | 34805 | 1097 | 35902 | |
| | | % | 96.9 | 3.1 | 100 | |
| | Hormone | n | 21911 | 11087 | 32998 | |
| | | % | 66.4 | 33.6 | 100 | |
| | Coagulation | n | 7695 | 1370 | 9065 | |
| | | % | 84.9 | 15.1 | 100 | |
| | Urinalysis | n | 11062 | 2981 | 14043 | |
| | | % | 78.8 | 21.2 | 100 | |
| | Troponin | n | 6465 | 3686 | 10151 | |
| | | % | 63.7 | 36.3 | 100 | |
| | Total | n | 106598 | 39870 | 146468 | - |
| | | % | 72.8 | 27.2 | 100 | |
| December | Biochemistry | n | 29554 | 21312 | 50866 | <0.001 |
| | | % | 58.1 | 41.9 | 100 | |
| | Complete blood count | n | 41687 | 1259 | 42946 | |
| | | % | 97.1 | 2.9 | 100 | |
| | Hormone | n | 29601 | 9949 | 39550 | |
| | | % | 74.8 | 25.2 | 100 | |
| | Coagulation | n | 9901 | 862 | 10763 | |
| | | % | 92.0 | 8.0 | 100 | |
| | Urinalysis | n | 13981 | 1944 | 15925 | |
| | | % | 87.8 | 12.2 | 100 | |
| | Troponin | n | 9499 | 2574 | 12073 | |
| | | % | 78.7 | 21.3 | 100 | |
| | Total | n | 134223 | 37900 | 172123 | - |
| | | % | 78.0 | 22.0 | 100 | |

Statistical findings regarding the comparison of delay rates for inpatient clinic in October, November and December according to tube types are presented in Table 9. The delay rates for inpatient clinic according to tube types in October, November and December were significantly different (P<0.001). In October and November, the highest delay rate was hormone and the lowest delay rate was complete blood count. In December, the highest and lowest delay rates were found for troponin and complete blood count, respectively.

**Table 9. Statistical findings for the comparison of delay rates for inpatient clinic in October, November and December according to types of tubes**

| | | | Delay | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| October | Biochemistry | n | 7575 | 2765 | 10340 | <0.001 |
| | | % | 73.3 | 26.7 | 100 | |
| | Complete blood count | n | 9031 | 304 | 9335 | |
| | | % | 96.7 | 3.3 | 100 | |
| | Hormone | n | 769 | 960 | 1729 | |
| | | % | 44.5 | 55.5 | 100 | |
| | Coagulation | n | 3726 | 472 | 4198 | |
| | | % | 88.8 | 11.2 | 100 | |
| | Urinalysis | n | 1146 | 333 | 1479 | |
| | | % | 77.5 | 22.5 | 100 | |
| | Troponin | n | 967 | 401 | 1368 | |
| | | % | 70.7 | 29.3 | 100 | |
| | Total | n | 23214 | 5235 | 28449 | - |
| | | % | 81.6 | 18.4 | 100 | |
| November | Biochemistry | n | 16330 | 7179 | 23509 | <0.001 |
| | | % | 69.5 | 30.5 | 100 | |
| | Complete blood count | n | 20414 | 1105 | 21519 | |
| | | % | 94.9 | 5.1 | 100 | |
| | Hormone | n | 2093 | 1816 | 3909 | |
| | | % | 53.5 | 46.5 | 100 | |
| | Coagulation | n | 8411 | 1162 | 9573 | |
| | | % | 87.9 | 12.1 | 100 | |
| | Urinalysis | n | 2532 | 459 | 2991 | |
| | | % | 84.7 | 15.3 | 100 | |
| | Troponin | n | 1738 | 1139 | 2877 | |
| | | % | 60.4 | 39.6 | 100 | |
| | Total | n | 51518 | 12860 | 64378 | - |
| | | % | 80.0 | 20.0 | 100 | |
| December | Biochemistry | n | 19923 | 6595 | 26518 | <0.001 |
| | | % | 75.1 | 24.9 | 100 | |
| | Complete blood count | n | 25587 | 1038 | 26625 | |
| | | % | 96.1 | 3.9 | 100 | |
| | Hormone | n | 3778 | 1133 | 4911 | |
| | | % | 76.9 | 23.1 | 100 | |
| | Coagulation | n | 10554 | 1954 | 12508 | |
| | | % | 84.4 | 15.6 | 100 | |
| | Urinalysis | n | 2992 | 329 | 3321 | |
| | | % | 90.1 | 9.9 | 100 | |
| | Troponin | n | 2436 | 1223 | 3659 | |
| | | % | 66.6 | 33.4 | 100 | |
| | Total | n | 65270 | 12272 | 77542 | - |
| | | % | 84.2 | 15.8 | 100 | |

Statistical findings regarding the comparison of the delay rates for biochemistry tubes in October, November and December according to the services are presented in Table 10. The delay rates for biochemistry tubes in October, November and December were significantly different among inpatient clinic (P<0.001). In October, November and December, the highest delay rate was observed in outpatient blood count and the lowest delay rate was observed in inpatient blood count.

**Table 10. Statistical findings for the comparison of delay rates in biochemistry tubes in October, November and December according to services**

| | | | Delay | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| **October** | **Emergency** | n | 4747 | 2020 | 6767 | <0.001 |
| | | % | 70.1 | 29.9 | 100 | |
| | **Outpatient** | n | 12914 | 10159 | 23073 | |
| | | % | 56.0 | 44.0 | 100 | |
| | **Inpatient** | n | 7575 | 2765 | 10340 | |
| | | % | 73.3 | 26.7 | 100 | |
| | **Total** | n | 25236 | 14944 | 40180 | - |
| | | % | 62.8 | 37.2 | 100 | |
| **November** | **Emergency** | n | 7654 | 5524 | 13178 | <0.001 |
| | | % | 58.1 | 41.9 | 100 | |
| | **Outpatient** | n | 24660 | 19649 | 44309 | |
| | | % | 55.7 | 44.3 | 100 | |
| | **Inpatient** | n | 16330 | 7179 | 23509 | |
| | | % | 69.5 | 30.5 | 100 | |
| | **Total** | n | 48644 | 32352 | 80996 | - |
| | | % | 60.1 | 39.9 | 100 | |
| **December** | **Emergency** | n | 10613 | 4040 | 14653 | <0.001 |
| | | % | 72.4 | 27.6 | 100 | |
| | **Outpatient** | n | 29554 | 21312 | 50866 | |
| | | % | 58.1 | 41.9 | 100 | |
| | **Inpatient** | n | 19923 | 6595 | 26518 | |
| | | % | 75.1 | 24.9 | 100 | |
| | **Total** | n | 60090 | 31947 | 92037 | - |
| | | % | 65.3 | 34.7 | 100 | |

Statistical findings regarding the comparison of delay rates for complete blood count tubes of patients hospitalized in October, November and December are presented in Table 11. The delay rates for complete blood count tubes were significantly different among inpatient clinic in October, November and December (P<0.001). The highest delay rate was seen in emergency samples in October, November and December, while the lowest delay rate was seen in inpatient clinic in October and outpatients in November and December.

**Table 11.** Statistical findings for the comparison of delay rates in complete blood count tubes in October, November and December according to services

| | | | Delay | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| **October** | **Emergency** | n | 5725 | 748 | 6473 | <0.001 |
| | | % | 88.4 | 11.6 | 100 | |
| | **Outpatient** | n | 16113 | 1161 | 17274 | |
| | | % | 93.3 | 6.7 | 100 | |
| | **Inpatient** | n | 9031 | 304 | 9335 | |
| | | % | 96.7 | 3.3 | 100 | |
| | **Total** | n | 30869 | 2213 | 33082 | - |
| | | % | 93.3 | 6.7 | 100 | |
| **November** | **Emergency** | n | 9577 | 2661 | 12238 | <0.001 |
| | | % | 78.3 | 21.7 | 100 | |
| | **Outpatient** | n | 34805 | 1097 | 35902 | |
| | | % | 96.9 | 3.1 | 100 | |
| | **Inpatient** | n | 20414 | 1105 | 21519 | |
| | | % | 94.9 | 5.1 | 100 | |
| | **Total** | n | 64796 | 4863 | 69659 | - |
| | | % | 93.0 | 7.0 | 100 | |
| **December** | **Emergency** | n | 11433 | 3094 | 14527 | <0.001 |
| | | % | 78.7 | 21.3 | 100 | |
| | **Outpatient** | n | 41687 | 1259 | 42946 | |
| | | % | 97.1 | 2.9 | 100 | |
| | **Inpatient** | n | 25587 | 1038 | 26625 | |
| | | % | 96.1 | 3.9 | 100 | |
| | **Total** | n | 78707 | 5391 | 84098 | - |
| | | % | 93.6 | 6.4 | 100 | |

Statistical findings regarding the comparison of the delay rates for hormone tubes according to the services in which the samples were taken in October, November and December are presented in Table 12. The delay rates for hormone tubes showed a significant difference among inpatient clinic in October, November and December (P<0.001). In October and November, the highest delay rate was observed in the inpatient clinic and the lowest delay rate was observed in the emergency department. In December, the highest delay rate was observed in outpatient clinic and the lowest delay rate was observed in emergency department.

**Table 12. Statistical findings for the comparison of delay rates in hormone tubes in October, November and December according to services**

| | | | Delay | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| **October** | **Emergency** | n | 652 | 87 | 739 | <0.001 |
| | | % | 88.2 | 11.8 | 100 | |
| | **Outpatient** | n | 9182 | 7517 | 16699 | |
| | | % | 55.0 | 45.0 | 100 | |
| | **Inpatient** | n | 769 | 960 | 1729 | |
| | | % | 44.5 | 55.5 | 100 | |
| | **Total** | n | 10603 | 8564 | 19167 | - |
| | | % | 55.3 | 44.7 | 100 | |
| **November** | **Emergency** | n | 1710 | 289 | 1999 | <0.001 |
| | | % | 85.5 | 14.5 | 100 | |
| | **Outpatient** | n | 21911 | 11087 | 32998 | |
| | | % | 66.4 | 33.6 | 100 | |
| | **Inpatient** | n | 2093 | 1816 | 3909 | |
| | | % | 53.5 | 46.5 | 100 | |
| | **Total** | n | 25714 | 13192 | 38906 | - |
| | | % | 66.1 | 33.9 | 100 | |
| **December** | **Emergency** | n | 1995 | 223 | 2218 | <0.001 |
| | | % | 89.9 | 10.1 | 100 | |
| | **Outpatient** | n | 29601 | 9949 | 39550 | |
| | | % | 74.8 | 25.2 | 100 | |
| | **Inpatient** | n | 3778 | 1133 | 4911 | |
| | | % | 76.9 | 23.1 | 100 | |
| | **Total** | n | 35374 | 11305 | 46679 | - |
| | | % | 75.8 | 24.2 | 100 | |

Statistical findings regarding the comparison of delay rates in coagulation tubes according to the services in October, November and December are presented in Table 13. In October, November and December, the delay rates of coagulation tubes showed a significant difference among inpatient clinic (P<0.001). The highest delay rate was observed in the emergency department in October, November and December, while the lowest delay rate was observed in inpatient clinic in October and November and in outpatients in December.

**Table 13. Statistical findings for the comparison of delay rates in coagulation tubes in October, November and December according to services**

| | | | Delay | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| **October** | **Emergency** | n | 1651 | 696 | 2347 | <0.001 |
| | | % | 70.3 | 29.7 | 100 | |
| | **Outpatient** | n | 3723 | 980 | 4703 | |
| | | % | 79.2 | 20.8 | 100 | |
| | **Inpatient** | n | 3726 | 472 | 4198 | |
| | | % | 88.8 | 11.2 | 100 | |
| | **Total** | n | 9100 | 2148 | 11248 | - |
| | | % | 80.9 | 19.1 | 100 | |
| **November** | **Emergency** | n | 3479 | 1866 | 5345 | <0.001 |
| | | % | 65.1 | 34.9 | 100 | |
| | **Outpatient** | n | 7695 | 1370 | 9065 | |
| | | % | 84.9 | 15.1 | 100 | |
| | **Inpatient** | n | 8411 | 1162 | 9573 | |
| | | % | 87.9 | 12.1 | 100 | |
| | **Total** | n | 19585 | 4398 | 23983 | - |
| | | % | 81.7 | 18.3 | 100 | |
| **December** | **Emergency** | n | 4665 | 2209 | 6874 | <0.001 |
| | | % | 67.9 | 32.1 | 100 | |
| | **Outpatient** | n | 9901 | 862 | 10763 | |
| | | % | 92.0 | 8.0 | 100 | |
| | **Inpatient** | n | 10554 | 1954 | 12508 | |
| | | % | 84.4 | 15.6 | 100 | |
| | **Total** | n | 25120 | 5025 | 30145 | - |
| | | % | 83.3 | 16.7 | 100 | |

Statistical findings regarding the comparison of delay rates for complete urinalysis tubes according to the services in October, November and December are presented in Table 14. The delay rates for these samples were significantly different among inpatient clinic in October, November and December (P<0.001). In October, the highest delay rate was observed in the outpatient clinic, and the highest delay rate was observed in the emergency department in November and December. The lowest delay rate was seen for samples collected from inpatient clinic in October, November and December.

**Table 14. Statistical findings for the comparison of delay rates in urinalysis tubes in October, November and December according to services**

| | | | Delay | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| **October** | **Emergency** | n | 1684 | 1500 | 3184 | <0.001 |
| | | % | 52.9 | 47.1 | 100 | |
| | **Outpatient** | n | 3247 | 3420 | 6667 | |
| | | % | 48.7 | 51.3 | 100 | |
| | **Inpatient** | n | 1146 | 333 | 1479 | |
| | | % | 77.5 | 22.5 | 100 | |
| | **Total** | n | 6077 | 5253 | 11330 | - |
| | | % | 53.6 | 46.4 | 100 | |
| **November** | **Emergency** | n | 2987 | 2772 | 5759 | <0.001 |
| | | % | 51.9 | 48.1 | 100 | |
| | **Outpatient** | n | 11062 | 2981 | 14043 | |
| | | % | 78.8 | 21.2 | 100 | |
| | **Inpatient** | n | 2532 | 459 | 2991 | |
| | | % | 84.7 | 15.3 | 100 | |
| | **Total** | n | 16581 | 6212 | 22793 | - |
| | | % | 72.7 | 27.3 | 100 | |
| **December** | **Emergency** | n | 3648 | 2872 | 6520 | <0.001 |
| | | % | 56.0 | 44.0 | 100 | |
| | **Outpatient** | n | 13981 | 1944 | 15925 | |
| | | % | 87.8 | 12.2 | 100 | |
| | **Inpatient** | n | 2992 | 329 | 3321 | |
| | | % | 90.1 | 9.9 | 100 | |
| | **Total** | n | 20621 | 5145 | 25766 | - |
| | | % | 80.0 | 20.0 | 100 | |

Statistical findings regarding the comparison of the delay rates for troponin tubes in October, November and December according to services are shown in Table 15. The delay rates for troponin tubes were significantly different among inpatient clinic in October, November and December (P<0.001). The highest delay rate was observed in the emergency department in October, November and December. The lowest delay rate was seen in inpatient clinic in October and in outpatients in November and December.

**Table 15. Statistical findings for the comparison of delay rates in troponin tubes in October, November and December according to services**

| | | | Delay | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| **October** | **Emergency** | n | 133 | 258 | 391 | <0.001 |
| | | % | 34.0 | 66.0 | 100 | |
| | **Outpatient** | n | 2628 | 2537 | 5165 | |
| | | % | 50.9 | 49.1 | 100 | |
| | **Inpatient** | n | 967 | 401 | 1368 | |
| | | % | 70.7 | 29.3 | 100 | |
| | **Total** | n | 3728 | 3196 | 6924 | - |
| | | % | 53.8 | 46.2 | 100 | |
| **November** | **Emergency** | n | 232 | 769 | 1001 | <0.001 |
| | | % | 23.2 | 76.8 | 100 | |
| | **Outpatient** | n | 6465 | 3686 | 10151 | |
| | | % | 63.7 | 36.3 | 100 | |
| | **Inpatient** | n | 1738 | 1139 | 2877 | |
| | | % | 60.4 | 39.6 | 100 | |
| | **Total** | n | 8435 | 5594 | 14029 | - |
| | | % | 60.1 | 39.9 | 100 | |
| **December** | **Emergency** | n | 323 | 910 | 1233 | <0.001 |
| | | % | 26.2 | 73.8 | 100 | |
| | **Outpatient** | n | 9499 | 2574 | 12073 | |
| | | % | 78.7 | 21.3 | 100 | |
| | **Inpatient** | n | 2436 | 1223 | 3659 | |
| | | % | 66.6 | 33.4 | 100 | |
| | **Total** | n | 12258 | 4707 | 16965 | - |
| | | % | 72.3 | 27.7 | 100 | |

Statistical findings regarding the comparison of the delay rates for all tubes in the emergency department, outpatient clinic and inpatient clinic in October, November and December are presented in Table 16. The delay rates for all tubes in the emergency department, outpatient clinic and inpatient clinic were significantly different (P<0.001). The highest delay rate in the emergency department was observed in November and the lowest delay rate was observed in October. In outpatient clinic, the highest delay rate was observed in October and the lowest in December. In inpatient clinic, the highest delay rate was seen in November and the lowest in December.

**Table 16. Statistical findings for the comparison of the delay rates experienced in the Emergency, Outpatient Clinic and İnpatient clinic for all tubes between October, November and December**

| | | | Result | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| **Emergency** | **October** | n | 14592 | 5309 | 19901 | <0.001 |
| | | % | 73.3 | 26.7 | 100 | |
| | **November** | n | 25639 | 13881 | 39520 | |
| | | % | 64.9 | 35.1 | 100 | |
| | **December** | n | 32677 | 13348 | 46025 | |
| | | % | 71.0 | 29.0 | 100 | |
| | **Total** | n | 72908 | 32538 | 105446 | - |
| | | % | 100.0 | 100.0 | 100 | |
| **Outpatient** | **October** | n | 47807 | 25774 | 73581 | <0.001 |
| | | % | 65.0 | 35.0 | 100 | |
| | **November** | n | 106598 | 39870 | 146468 | |
| | | % | 72.8 | 27.2 | 100 | |
| | **December** | n | 134223 | 37900 | 172123 | |
| | | % | 78.0 | 22.0 | 100 | |
| | **Total** | n | 288628 | 103544 | 392172 | - |
| | | % | 100.0 | 100.0 | 100 | |
| **Inpatient** | **October** | n | 23214 | 5235 | 28449 | <0.001 |
| | | % | 81.6 | 18.4 | 100 | |
| | **November** | n | 51518 | 12860 | 64378 | |
| | | % | 80.0 | 20.0 | 100 | |
| | **December** | n | 65270 | 12272 | 77542 | |
| | | % | 84.2 | 15.8 | 100 | |
| | **Total** | n | 140002 | 30367 | 170369 | - |
| | | % | 100.0 | 100.0 | 100 | |

Statistical findings regarding the comparison of delay rates at the Emergency department in October, November and December according to types of tubes are presented in Table 17. Statistical findings regarding the comparison of delay rates at outpatient clinic in October, November and December according to types of tubes are presented in Table 18. Statistical findings regarding the comparison of delay rates of inpatient clinic in October, November and December according to types of tubes are presented in Table 19.

**Table 17. Statistical findings for the comparison of delay rates experienced in the emergency department between October, November and December according to types of tubes**

| | | | Result | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| **Biochemistry** | **October** | n | 4747 | 2020 | 6767 | <0.001 |
| | | % | 70.1 | 29.9 | 100 | |
| | **November** | n | 7654 | 5524 | 13178 | |
| | | % | 58.1 | 41.9 | 100 | |
| | **December** | n | 10613 | 4040 | 14653 | |
| | | % | 72.4 | 27.6 | 100 | |
| **Complete blood count** | **October** | n | 5725 | 748 | 6473 | <0.001 |
| | | % | 88.4 | 11.6 | 100 | |
| | **November** | n | 9577 | 2661 | 12238 | |
| | | % | 78.3 | 21.7 | 100 | |
| | **December** | n | 11433 | 3094 | 14527 | |
| | | % | 78.7 | 21.3 | 100 | |
| **Hormone** | **October** | n | 652 | 87 | 739 | <0.001 |
| | | % | 88.2 | 11.8 | 100 | |
| | **November** | n | 1710 | 289 | 1999 | |
| | | % | 85.5 | 14.5 | 100 | |
| | **December** | n | 1995 | 223 | 2218 | |
| | | % | 89.9 | 10.1 | 100 | |
| **Coagulation** | **October** | n | 1651 | 696 | 2347 | <0.001 |
| | | % | 70.3 | 29.7 | 100 | |
| | **November** | n | 3479 | 1866 | 5345 | |
| | | % | 65.1 | 34.9 | 100 | |
| | **December** | n | 4665 | 2209 | 6874 | |
| | | % | 67.9 | 32.1 | 100 | |
| **Urinalysis** | **October** | n | 1684 | 1500 | 3184 | <0.001 |
| | | % | 52.9 | 47.1 | 100 | |
| | **November** | n | 2987 | 2772 | 5759 | |
| | | % | 51.9 | 48.1 | 100 | |
| | **December** | n | 3648 | 2872 | 6520 | |
| | | % | 56.0 | 44.0 | 100 | |
| **Troponin** | **October** | n | 133 | 258 | 391 | <0.001 |
| | | % | 34.0 | 66.0 | 100 | |
| | **November** | n | 232 | 769 | 1001 | |
| | | % | 23.2 | 76.8 | 100 | |
| | **December** | n | 323 | 910 | 1233 | |
| | | % | 26.2 | 73.8 | 100 | |

**Table 18. Statistical findings for the comparison of delay rates experienced in the outpatient clinic between October, November and December according to types of tubes**

| | | | Result | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| **Biochemistry** | **October** | n | 12914 | 10159 | 23073 | <0.001 |
| | | % | 56.0 | 44.0 | 100 | |
| | **November** | n | 24660 | 19649 | 44309 | |
| | | % | 55.7 | 44.3 | 100 | |
| | **December** | n | 29554 | 21312 | 50866 | |
| | | % | 58.1 | 41.9 | 100 | |
| **Complete blood count** | **October** | n | 16113 | 1161 | 17274 | <0.001 |
| | | % | 93.3 | 6.7 | 100 | |
| | **November** | n | 34805 | 1097 | 35902 | |
| | | % | 96.9 | 3.1 | 100 | |
| | **December** | n | 41687 | 1259 | 42946 | |
| | | % | 97.1 | 2.9 | 100 | |
| **Hormone** | **October** | n | 9182 | 7517 | 16699 | <0.001 |
| | | % | 55.0 | 45.0 | 100 | |
| | **November** | n | 21911 | 11087 | 32998 | |
| | | % | 66.4 | 33.6 | 100 | |
| | **December** | n | 29601 | 9949 | 39550 | |
| | | % | 74.8 | 25.2 | 100 | |
| **Coagulation** | **October** | n | 3723 | 980 | 4703 | <0.001 |
| | | % | 79.2 | 20.8 | 100 | |
| | **November** | n | 7695 | 1370 | 9065 | |
| | | % | 84.9 | 15.1 | 100 | |
| | **December** | n | 9901 | 862 | 10763 | |
| | | % | 92.0 | 8.0 | 100 | |
| **Urinalysis** | **October** | n | 3247 | 3420 | 6667 | <0.001 |
| | | % | 48.7 | 51.3 | 100 | |
| | **November** | n | 11062 | 2981 | 14043 | |
| | | % | 78.8 | 21.2 | 100 | |
| | **December** | n | 13981 | 1944 | 15925 | |
| | | % | 87.8 | 12.2 | 100 | |
| **Troponin** | **October** | n | 2628 | 2537 | 5165 | <0.001 |
| | | % | 50.9 | 49.1 | 100 | |
| | **November** | n | 6465 | 3686 | 10151 | |
| | | % | 63.7 | 36.3 | 100 | |
| | **December** | n | 9499 | 2574 | 12073 | |
| | | % | 78.7 | 21.3 | 100 | |

**Table 19. Statistical findings for the comparison of delay rates experienced in the inpatient clinic between October, November and December according to types of tubes**

| | | | Result | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| **Biochemistry** | **October** | n | 7575 | 2765 | 10340 | <0.001 |
| | | % | 73.3 | 26.7 | 100 | |
| | **November** | n | 16330 | 7179 | 23509 | |
| | | % | 69.5 | 30.5 | 100 | |
| | **December** | n | 19923 | 6595 | 26518 | |
| | | % | 75.1 | 24.9 | 100 | |
| **Complete blood count** | **October** | n | 9031 | 304 | 9335 | <0.001 |
| | | % | 96.7 | 3.3 | 100 | |
| | **November** | n | 20414 | 1105 | 21519 | |
| | | % | 94.9 | 5.1 | 100 | |
| | **December** | n | 25587 | 1038 | 26625 | |
| | | % | 96.1 | 3.9 | 100 | |
| **Hormone** | **October** | n | 769 | 960 | 1729 | <0.001 |
| | | % | 44.5 | 55.5 | 100 | |
| | **November** | n | 2093 | 1816 | 3909 | |
| | | % | 53.5 | 46.5 | 100 | |
| | **December** | n | 3778 | 1133 | 4911 | |
| | | % | 76.9 | 23.1 | 100 | |
| **Coagulation** | **October** | n | 3726 | 472 | 4198 | <0.001 |
| | | % | 88.8 | 11.2 | 100 | |
| | **November** | n | 8411 | 1162 | 9573 | |
| | | % | 87.9 | 12.1 | 100 | |
| | **December** | n | 10554 | 1954 | 12508 | |
| | | % | 84.4 | 15.6 | 100 | |
| **Urinalysis** | **October** | n | 1146 | 333 | 1479 | <0.001 |
| | | % | 77.5 | 22.5 | 100 | |
| | **November** | n | 2532 | 459 | 2991 | |
| | | % | 84.7 | 15.3 | 100 | |
| | **December** | n | 2992 | 329 | 3321 | |
| | | % | 90.1 | 9.9 | 100 | |
| **Troponin** | **October** | n | 967 | 401 | 1368 | <0.001 |
| | | % | 70.7 | 29.3 | 100 | |
| | **November** | n | 1738 | 1139 | 2877 | |
| | | % | 60.4 | 39.6 | 100 | |
| | **December** | n | 2436 | 1223 | 3659 | |
| | | % | 66.6 | 33.4 | 100 | |

Statistical findings regarding the comparison of delay rates according to types of tubes independent of time and services are presented in Table 20. Delay rates are significantly different according to the types of tubes (P<0.001). The highest delay rate was found in Biochemistry tubes and the lowest delay rate was found in complete blood count tubes.

**Table 20. Statistical findings for the comparison of delay rates independent of time and services according to types of tubes**

| | | | Result | | Total | *P* |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| **Tube types** | **Biochemistry** | n | 133970 | 79243 | 213213 | <0.001 |
| | | % | 62.8 | 37.2 | 100 | |
| | **Complete blood count** | n | 174372 | 12467 | 186839 | |
| | | % | 93.3 | 6.7 | 100 | |
| | **Hormone** | n | 71691 | 33061 | 104752 | |
| | | % | 68.4 | 31.6 | 100 | |
| | **Coagulation** | n | 53805 | 11571 | 65376 | |
| | | % | 82.3 | 17.7 | 100 | |
| | **Urinalysis** | n | 43279 | 16610 | 59889 | |
| | | % | 72.3 | 27.7 | 100 | |
| | **Troponin** | n | 24421 | 13497 | 37918 | |
| | | % | 64.4 | 35.6 | 100 | |
| **Total** | | n | 501538 | 166449 | 667987 | - |
| | | % | 75,1 | 24.9 | 100.0 | |

Statistical findings regarding the comparison of time-independent delay rates according to types of tubes are presented in Table 21. Delay rates were significantly different in Emergency, Outpatient and Inpatient according to the types of tubes (P<0.001). Regardless of the types of tubes, the delay rates were, from lowest to highest, in inpatient (17.8%), outpatient (26.4%) and emergency departments (30.9%), respectively.The highest delay rate in emergency departments was seen for troponin (73%). In outpatient clinics, the highest delay rate was found for biochemistry (43.2%) and the lowest delay rate was found for complete blood count (3.7%). In inpatient clinic, the highest and lowest delay rates were found in hormones (37.1%) and complete blood count (4.3%), respectively.

**Table 21. Statistical findings for the comparison of time-independent delay rates according to types of tubes**

| Service type | | | | Result | | Total | *P* |
|---|---|---|---|---|---|---|---|
| | | | | No | Yes | | |
| Emergency | Tube | Biochemistry | n | 23014 | 11584 | 34598 | <0.001 |
| | | | % | 66.5 | 33.5 | 100 | |
| | | Complete blood count | n | 26735 | 6503 | 33238 | |
| | | | % | 80.4 | 19.6 | 100 | |
| | | Hormone | n | 4357 | 599 | 4956 | |
| | | | % | 87.9 | 12.1 | 100 | |
| | | Coagulation | n | 9795 | 4771 | 14566 | |
| | | | % | 67.2 | 32.8 | 100 | |
| | | Urinalysis | n | 8319 | 7144 | 15463 | |
| | | | % | 53.8 | 46.2 | 100 | |
| | | Troponin | n | 688 | 1937 | 2625 | |
| | | | % | 26.2 | 73.8 | 100 | |
| | Total | | n | 72908 | 32538 | 105446 | - |
| | | | % | 69.1 | 30.9 | 100.0 | |
| Outpatient clinic | Tube | Biochemistry | n | 67128 | 51120 | 118248 | <0.001 |
| | | | % | 56.8 | 43.2 | 100 | |
| | | Complete blood count | n | 92605 | 3517 | 96122 | |
| | | | % | 96.3 | 3.7 | 100 | |
| | | Hormone | n | 60694 | 28553 | 89247 | |
| | | | % | 68.0 | 32.0 | 100 | |
| | | Coagulation | n | 21319 | 3212 | 24531 | |
| | | | % | 86.9 | 13.1 | 100 | |
| | | Urinalysis | n | 28290 | 8345 | 36635 | |
| | | | % | 77.2 | 22.8 | 100 | |
| | | Troponin | n | 18592 | 8797 | 27389 | |
| | | | % | 67.9 | 32.1 | 100 | |
| | Total | | n | 288628 | 103544 | 392172 | - |
| | | | % | 73.6 | 26.4 | 100.0 | |
| Inpatient clinic | Tube | Biochemistry | n | 43828 | 16539 | 60367 | <0.001 |
| | | | % | 72.6 | 27.4 | 100 | |
| | | Complete blood count | n | 55032 | 2447 | 57479 | |
| | | | % | 95.7 | 4.3 | 100 | |
| | | Hormone | n | 6640 | 3909 | 10549 | |
| | | | % | 62.9 | 37.1 | 100 | |
| | | Coagulation | n | 22691 | 3588 | 26279 | |
| | | | % | 86.3 | 13.7 | 100 | |
| | | Urinalysis | n | 6670 | 1121 | 7791 | |
| | | | % | 85.6 | 14.4 | 100 | |
| | | Troponin | n | 5141 | 2763 | 7904 | |
| | | | % | 65.0 | 35.0 | 100 | |
| | Total | | n | 140002 | 30367 | 170369 | - |
| | | | % | 82.2 | 17.8 | 100.0 | |

The bar graph showing the number of delays experienced by emergency, outpatient and inpatient patients according to the types of tubes in October, November and December is shown in Figure 1. The other bar graph showing the rate of delay in emergency, outpatient and inpatient patients according to the types of tubes in October, November and December is presented in Figure 2.

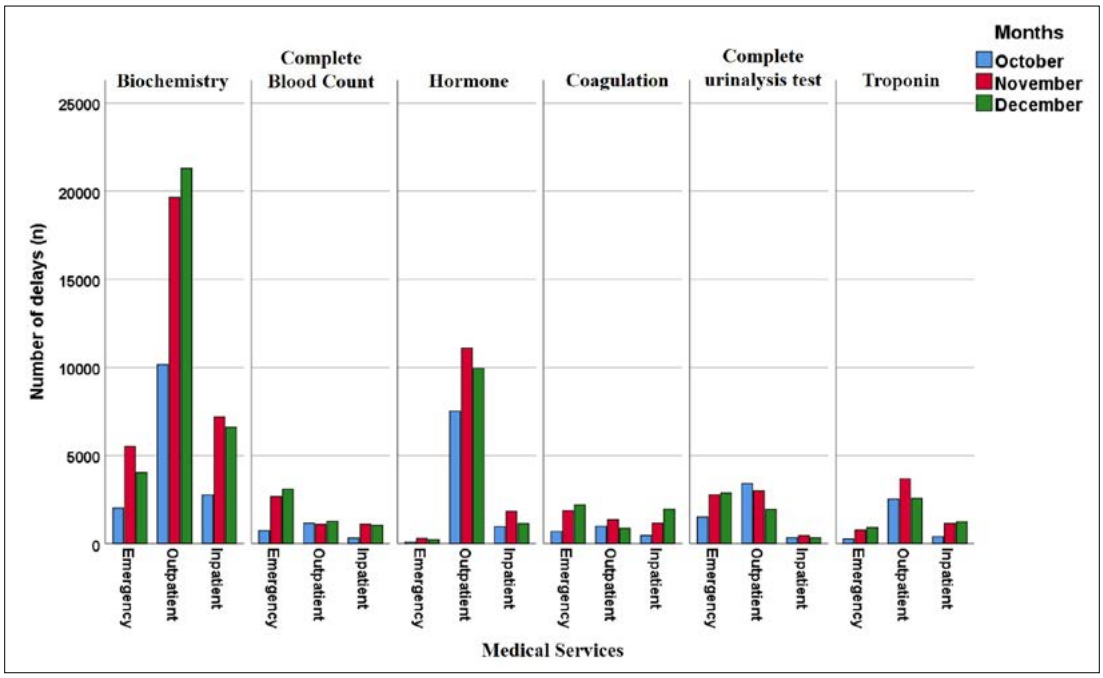


**Figure 1. Box plot showing the number of delays in the Emergency, Outpatient Clinic and Inpatient Clinic according to types of tubes in October, November and December by time**

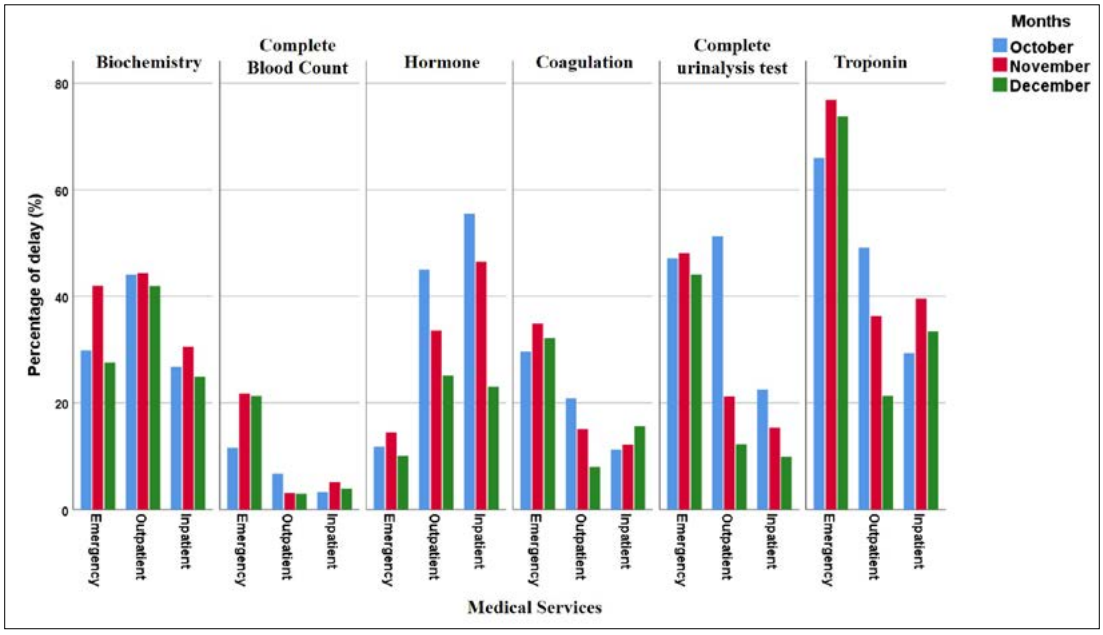


**Figure 2. Box plot showing the rate of delays in the Emergency, Outpatient Clinic and Inpatient Clinic according to types of tubes in October, November and December by time**

When only inpatient clinic were compared regardless of time and tubes, the delay rates were 17.8% in inpatient clinic, 26.4% in outpatient clinic and 30.9% in emergency department. When only tubes were evaluated regardless of time and inpatient clinic, the highest and lowest delay rates were observed for biochemistry tubes (37.2%) and complete blood count tubes (6.7%), respectively.

Regardless of time, the highest and lowest delay rates in the emergency department was observed for troponin (73.8%) and hormone (12.1%), respectively: In the outpatient clinic, the highest delay rate was for biochemistry (43.2%) and the lowest for complete blood count (3.7%). In inpatient clinic, the highest and lowest delay rates were found for hormones (37.1%) and complete blood count (4.3%), respectively. When tubes were compared according to inpatient clinic, it was observed that the highest delay rate in the emergency department was for troponin.

Considering time, there was no significant difference in the delay rates at the emergency department. In the outpatient clinic, delay rates for hormone, coagulation, complete urinalysis and troponin have decreased from October to December. In inpatient clinic, the delay rates for hormone and complete urinalysis have decreased from October to December.

## DISCUSSION

The turnaround time is one of the important indicators of quality as well as the accuracy and reliability of the test results of laboratories (2-4). The longer turnaround time of the laboratory means the longer the patients' access to diagnosis and treatment and the longer the hospital stay (8-10).

Delays in reaching diagnosis and treatment and prolonged hospitalization lead to an increased risk of medical complications. It also significantly reduces the satisfaction of clinicians and patients about the laboratory (11,12).

The analysis and adjustments required for laboratories to achieve the 'ideal timeliness' target involve a multi-stage process. First of all, the target TAT for each test should be determined and the TAT should be monitored. For samples that exceed the target time, the preanalytical, analytical and postanalytical process should be thoroughly reviewed. Adjustments should be made to address modifiable factors that cause time delays.

In our study, when the three-month period of our laboratory's establishment period was examined, it was observed that the highest delay rate in the first month was observed for samples from outpatient clinics. In our laboratory, emergency samples and routine samples are analyzed on different devices.

Considering the high number of samples from outpatient clinics in the evaluations made regarding the process, the number of devices for routine analyzes was increased. As a result of this adjustment, it has been observed that the delay rate in outpatient clinics has decreased over the months.

The delay rate in the emergency department increased in the second month in parallel with the rapid increase in the number of samples and decreased again in the following month. It was observed that the most important factor for the delay in emergency samples was the delay in the delivery of samples to the device due to the insufficient number of technical personnel in charge of emergency devices, and therefore the number of personnel was increased. Thus, in newly established laboratories, delays in result delivery times can be reduced when the rapid increase in the number of samples in the first months is intervened with appropriate adjustments.

In our study, when the delay rates for different tests for all inpatient clinic were compared on a monthly basis, it was observed that the highest delay rate in the first month was for complete urinalysis. When the reason for this delay in urinalysis in the first month was analyzed, it was observed that the insufficient number of personnel allocated for the urine device in the on-call teams played a role.

This delay rate decreased in the second month when the number of urine device personnel was increased. As the waiting time at room temperature increases in urine samples, changes such as pH increase and decrease in the number of leukocytes may occur.

Therefore, the waiting time after sample collection should be maximum 4 hours (16). During the establishment phase of newly established laboratories, urine samples may remain in the background when the personnel in the on-call teams are directed to more critical and urgent tests and air devices. However, complete urinalysis is the first-line test in the diagnosis of urinary system diseases. Therefore, attempts to reduce the number of waiting specimens and provide accurate results are important.

In our study, the highest delay rate was observed in biochemistry and troponin tests in October. In December, the highest delay rate was observed in biochemistry tests.

It is also noteworthy that troponin was the most delayed test in the emergency department in all three months. In the first months, troponin and biochemistry samples were delivered to the laboratory in the same tube, which played an important role in this delay.

In the following period, troponin and biochemistry tubes were separated. Since troponin is a critical test used in the diagnosis of acute coronary syndrome, the target TAT is recommended as <60 minutes in clinical and laboratory guidelines. It has also been reported that the length of stay of patients in the emergency department is shortened when the target value is reached in troponin TAT (17). The increase in the number and capacity of patients in emergency departments has also been shown to play an important role in the increase in troponin TAT (18).

When the delay rates were compared according to the types of tubes, regardless of time and services, the highest delay rate was observed for biochemistry tubes, while the lowest delay rate was observed for complete blood count tubes. The higher number of biochemistry samples compared to other samples plays an important role in the delay.

Because high sample volume is an important factor in TAT delay. In order to prevent this delay, an increase in both the number of personnel and the number of devices is planned.

In a large cohort study that examined TAT values for biochemistry tests, it was reported that TAT delays were mostly caused by the preanalytical and analytical process. In the same study, it was reported that laboratories prefer to monitor part of the preanalytical process (the part after the sample arrives at the laboratory) and the analytical process, which are mostly under their control, when monitoring TAT (19). Therefore, the part of the preanalytical process before the sample reaches the laboratory is not adequately monitored by many laboratories.

Achieving the desired target value in TAT is a multi-stage process. Patient triage, keeping the laboratory at a capacity to respond to patient volume, sufficient number of personnel responsible for sample collection-transfer-acceptance and analysis, number and capacity of devices, sufficient number of specialists in the postanalytical process and quality management are some of the issues that should be considered in the management of the process. Some of the important results of our study include a decrease in the frequency of device malfunctions, full operation of the pneumatic system throughout the hospital, installation of preanalytical rail systems, and shorter TAT after the increase in the number of biochemistry specialists and laboratory technicians. Since the approval support system (automatic approval) was not in place at the time of the study, we could not measure its impact on TAT.

In conclusion, we found that analyzing TAT and delays in our newly established laboratory was useful in several areas. First of all, it allowed us to discover areas where we were understaffed and under-equipped despite the increased number of samples. We closely examined the process for problems in these areas and took various measures for improvement. Therefore, TAT monitoring and early detection of existing delays are important for improving quality in the laboratory. Reduced TAT approaching the target value lead to increased clinician and patient satisfaction.

TAT is one of the most important parameters used by clinicians to assess the quality of a laboratory. It is therefore an important service feature that all laboratories should pay attention to. We attribute the shortening of TAT for all samples as time progresses to the increasing number of technicians working in the laboratory and their experience, more organized sample transportation system, slightly more biochemistry specialists, and more efficient hospital and laboratory information management systems. The benefits of our study include clearly demonstrating the rapid turnaround times of newly established biochemistry laboratories in large hospitals and centers, showing the variations in these times between clinics, increasing clinicians' satisfaction with the laboratory, reducing costs by shortening hospital stays, and developing measures that can be considered.

There are some limitations and situations that may cause bias in our study, such as the use of only 3 months of data, frequent technical malfunctions in autoanalyzers due to the new establishment of our laboratory, prolonged TAT due to inexperience of some personnel, insufficient number of laboratory technicians, and the pneumatic system not yet fully functioning regularly.

**Declerations**

The authors received no financial support for the research and/or authorship of this article. There is no conflict of interest.

This study was approved by the Ankara Bilkent City Hospital Ethics Committee (Dated: 30.11.2022; Approval Number: E1/3060/2022)

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