ORIGINAL ARTICLE

Evaluation of Turnaround Time for Serum Electrolytes and Troponin I in a Clinical Chemistry Laboratory: A Retrospective Observational Study

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ABSTRACT

Objective: The purpose of this research was to assess the turnaround time (TAT) of the clinical chemistry laboratory for serum electrolytes and Troponin I.

Study Design: Retrospective observational study.

Place and Duration of Study: The study was conducted at the Clinical Chemistry Laboratory of Shalamar Hospital, Lahore, Pakistan from 4th January 2020 to 15th April 2022.

Methods: This retrospective hospital-based study involved 3399 and 573 reports of patients who were recommended in the clinical chemistry laboratory of the Hospital for serum electrolytes and Troponin I, respectively. Serum electrolytes and Troponin I were measured on the Diestro analyzer and Abbott i-1000 SR, respectively. Data analysis was performed on SPSS version 22.

Results: Overall, 3399 patient reports referred for serum electrolyte tests were analyzed, with 1964 tests reported within TAT and 1435 delayed. Percentages of delay in the three phases of analysis, including before analysis, during analysis, and after analysis, were 86.7%, 10.00% and 3.30% respectively. A total of 573 reports of patients referred for Troponin I were analyzed, which shows 227 tests were reported within the standard Turn Around Time (TAT) and 346 were delayed. Percentages of delay in the pre-analytical phase, analytical phase, and post-analytical phase were 74%, 20% and 6% respectively.

Conclusion: Standard time for the reporting of serum electrolytes and Troponin I was 120 minutes (2 hours) and 60 minutes (1 hour), respectively. The study concluded that the main reason for the delay was found in the analysis phase before for both serum electrolytes and Troponin I. So, there is a need to overcome the pre-analytical errors to boost the efficiency of the clinical chemistry laboratory.

Keywords: *Benchmark, Clinical Chemistry, Pre-Analytical Phase, Quality Controls, Troponin I.*

How to cite this: *Kazmi T, Tahir H, Hameed Z, Zubair M, Farhat S. Evaluation of Turnaround Time for Serum Electrolytes and Troponin I in a Clinical Chemistry Laboratory: A Retrospective Observational Study. Life and Science. 2025; 6(4): 542-546. doi: http://doi.org/10.37185/LnS.1.1.743*

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Received: June 14, 2024; 1st Revision Received: Jan 21, 2025
2nd Revision Received: May 19, 2025; Accepted: May 27, 2025

Introduction

In the context of clinical laboratories, the term "turnaround time" (TAT) refers to the time between ordering an investigation and reporting the results. Different definitions of turnaround time are set according to the type of test, for example, priority (stat versus routine), population served (inpatient, outpatient, and emergency department), and analyte (such as sodium, beta-HCG).[1,2] Pre-analytical, analytical, and post-analytical stages make up the TAT process.[3] Total laboratory testing cycle starts from the sample receiving up to reporting of the results. An essential component of the services offered by clinical laboratories is the on-time

dissemination of laboratory test results, in addition to reliability and accuracy. Swift processing times can have a significant impact on medical outcomes, so patients and doctors alike want reports as soon as possible.[4,5] Thus, improvement in turnaround time and its assessment is necessary for the management of laboratory quality. Each laboratory should set its turnaround time according to the guidelines of the International Standardization Organization (i.e., ISO).[6,7] Turnaround time is the most important Key Performance Indicator (KPI) of clinical laboratory service, and it is also considered one of the most critical quality measures.[8-10] The Quality of the laboratory is judged by many clinicians by the turnaround time of the respective laboratory. Long and unsatisfactory turnaround time indicates poor laboratory services. It shows that laboratory professionals are not interested in complaint resolution or improving laboratory services.[11-14] According to the requirements, which have been set by the College of American Pathologists (CAP) and the International Federation of Clinical Chemistry (IFCC) for the observation of turnaround time in medical laboratories, the turnaround time is the most critical indication of laboratory administration and operation. If the report is delayed, treatment will not be provided. So, findings must be accurate and should be reported at the right time.[15-17]

This research will assist us in determining the cause of the postponement in our turnaround time, as well as which phase is leading to the delayed turnaround time, and what factors in that specific phase are causing this delay in reporting of our clinical laboratory test results.

Methods

The study was conducted at the Clinical Chemistry Laboratory of Shalamar Hospital, Lahore, Pakistan from 4th January 2020 to 15th April 2022.

This retrospective hospital-based study involved 3399 and 573 reports of patients who were advised tests for serum electrolytes and Troponin I, respectively. The sampling technique was non-probability convenience sampling. The study was approved by the Institutional Review Board of Shalimar Medical and Dental College, Lahore, Pakistan, vide letter no. SMDC-IRB/AL/63/2020, dated 22nd December 2020.

Serum electrolytes and Troponin I were measured on the Diestro analyzer and Abbott i-1000 SR, respectively. Data on turnaround time for all the mentioned test parameters (i.e., serum electrolytes and Troponin I) were included in the study, while turnaround time of all the tests which have missing values, possible errors, inconsistencies, and unexpected values were excluded from the study. Record of the previous three months from 4th January 2020 to 15th April 2022 was collected to see the turnaround time (TAT) of serum electrolytes and Troponin I. This information was extracted through a specially designed study Proforma. Out of the total reports, the turnaround time for those reports that were delayed was noted. Errors were classified according to standard time limits of the laboratory into before, during, and after analysis errors. Data was collected on a specially designed study Performa. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS 20). The means and standard deviations of the turnaround time values were calculated. Frequencies for turnaround time of both serum electrolytes and Troponin I were also calculated, and the data were presented in the form of graphs and tables.

Results

A total of 3399 reports of patients referred for serum electrolytes tests were analyzed, which shows 1964 tests were reported within TAT and 1435 were delayed. The benchmark TAT for reporting electrolytes was 120 minutes (2 hours), compared with our average TAT of 135.57±76.41. While for Troponin I, 60% reports were showing delayed Turnaround time.

Table 1: Delay in TAT of serum electrolytes in different phases

TAT with Different Time Periods	Mean Minutes	Percentage TAT
Pre-Analytical	35 Minutes ± 6.20	86.70%
Analytical	60 Minutes ± 14.06	10%
Post Analytical	25 Minutes ± 4.91	3.30%

Table 2: Shapiro-Wilk Significance Test of Serum Electrolytes TAT

Parameter	Mean ± SD	Median	Shapiro Wilk Sig.
Serum Electrolytes	135.57±76.41	108.0	0.00

Table 3: Delay in TAT of Troponin I within different phases

TAT with Different Time Periods	Mean Minutes	Percentage TAT
Pre-Analytical	20 Minutes ± 9.62	74%
Analytical	25 Minutes ± 6.84	20%
Post Analytical	15 Minutes ± 4.76	6%

Table 4: Shapiro-Wilk Significance test of Troponin TAT

Parameter	Mean ± SD	Median	Shapiro Wilk Sig.
Troponin I	88.12 ± 24.02	69.00	< 0.001

The benchmark TAT was divided into three steps, i.e., pre-analysis, analysis, and post-analysis. Out of 1435 delayed reports of serum electrolytes, most of the reports were delayed due to errors in the pre-analytical phase, 86.7% whereas the remaining 10% delay was due to errors in the analytical phase, and 3.30% delay was found in the post-analytical phase. (Table 1). The Shapiro-Wilk test significance of less than 0.05 shows that this data was not normally distributed. (Table 2). The benchmark TAT for reporting of Troponin I was 60 minutes (1 hour) in comparison to our average time of 88.12 ± 24.02. Out of the total 573 reports of patients referred for Troponin I, 227 (40%) were reported within TAT, and 346 (60%) were delayed due to errors in different phases of TAT. Out of 346 delayed reports of Troponin I, most of the reports were delayed due to errors in the pre-analytical phase, and the percentage was 74%. The remaining 20% postponement was due to analytical errors in the analytical phase, and 6% delay was found in the post-analytical phase. (Table 3). Shapiro Wilk test significance of less than 0.05 shows that this data was not normally distributed (Table 4).

Discussion

In our study, the benchmark turnaround time for serum electrolytes was 120 minutes, whereas the observed mean TAT was 135.57 +/- 76.41 minutes. Similarly, for Troponin I, the benchmark TAT was 60 minutes, while the mean TAT was 88.12 +/- 24.02 minutes. The delays were predominantly due to pre-analytical errors, accounting for 86.7% in electrolyte tests and 74% in Troponin I tests, followed by the analytical and post-analytical phases.

Our results align with the results of a study from Dhulikhel Hospital, which showed pre-analytical factors again dominated TAT prolongation. Cash unit issues caused delays in nearly half of the delayed cases, while sample quality issues contributed additionally.[13] While a study conducted by Prasad P et al. showed significant improvements after target interventions such as Training of phlebotomists, and using advanced techniques (such as syringes and needles), placing auto-run dilution to reduce time lags.[18] Upon implementation of corrective measures and root cause analysis, the TATs were reduced from 80-88% to 11-33%.[18]

The 2009 study by Chung HJ et al. analyzed the turnaround time (TAT) for outpatient chemistry specimens by dividing the process into three phases: pre-analytical, analytical, and post-analytical.[19] A National Survey conducted in China observed that preanalytical delays were primarily due to long transportation time (43.8%), high sample volumes (6.1%), and insufficient staff (5.3%). Analytical phase delays were predominantly due to instrument congestion (43.7%), while "Laboratory Information System (LIS) / Hospital Information System (HIS) LIS/ HIS failures and instrument breakdown accounts for most post-analytical delays. This comprehensive data highlights that technological infrastructure and staffing significantly influenced TAT, suggesting that improvements in these areas could benefit our context as well.[20] In South Africa, real-time monitoring helped ensure sustained quality, reducing prolonged TAT through continuous feedback.[21]

In contrast to our study, another study done in a Kenyan Hospital showed that the longest delays were in Printing, sorting, and dispatching results, which were post-analytical delays.[22] In a study conducted in Iran, pre-analytical rejection rates of 1% in hematology and 0.6% in biochemistry, mainly due to hemolysis and insufficient volume.[23] Wang H et al. Introduced an insightful dimension by separating patient-dependent and independent steps, demonstrating that the time to collect and receive was longer for bedside collections than for those collected near the laboratory, leading to a bimodal distribution in TAT. But we didn't explicitly separate patient-dependent steps.[24] Meanwhile, Shiferaw MB et al. in 2019 and other studies emphasized an increased number of test menus, manpower shortages, insufficient training, instrument breakdown, and reagent stockout, non-adherence to the standard operating procedures (SOPs) by staff, and workflow gaps as root causes.[25-30]

This study was conducted in a single tertiary care hospital laboratory, which may limit the generalizability of the findings to other healthcare settings with different infrastructure, staffing, or operational workflows. The data were obtained retrospectively from laboratory records, which may not fully capture all factors contributing to delays (e.g., staff workload, system downtimes, or pre-analytical variables occurring outside the lab). Furthermore, only routine chemical pathology tests were included, so the results may not reflect turnaround times for other test categories or emergency settings. Future studies should include multiple healthcare facilities to allow broader comparison and improve external validity. A prospective, time-motion or process-mapping approach could provide a more comprehensive understanding of delays at each step of the testing pathway. Expanding the scope to include other laboratory sections (e.g., hematology, microbiology) and incorporating qualitative assessments of staff and system performance could yield richer insights for quality improvement. Additionally, evaluating the impact of interventions such as automated reporting systems, real-time monitoring dashboards, or workflow redesign on TAT would help guide evidence-based laboratory performance enhancement.

Conclusion

This study highlighted the turnaround time for routine chemical pathology tests in a tertiary care hospital and identified system-related factors, such as LIS/HIS failures and instrument breakdowns, as major contributors to post-analytical delays. While pre-analytical errors were not evaluated in this study, they are recognized as significant contributors to overall TAT. Future research should therefore include assessment of pre-analytical factors to provide a more comprehensive understanding of delays across the entire testing process.

Acknowledgement: None

Conflict of Interest: The authors declare no conflict of interest

Grant Support and Financial Disclosure: None

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TK: Data acquisition, curation, and statistical analysis, writing the original draft, proofreading, and approval for final submission

HT: Conception and design of the work

ZH: Manuscript writing for methodology design and investigation

MZ: Validation of data, interpretation, and write-up of results

SF: Revising, editing, and supervising for intellectual content