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Original Research Article

Study of Turnaround Time in Clinical Biochemistry Laboratory of Tertiary Care Hospital

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Abstract:

Background: Turnaround time (TAT) is a widely recognized indicator of laboratory efficiency and quality. In tertiary care hospitals, timely reporting of laboratory results is critical for effective patient management, especially in emergency and critical care settings. Delays in TAT can compromise patient outcomes, prolong hospital stay, and reduce clinician satisfaction.

Aim: To evaluate the turnaround time in the clinical biochemistry laboratory of a tertiary care hospital and to identify the major factors contributing to delays.

Methods: This observational cross-sectional study was conducted in the Department of Biochemistry, IGIMS, Patna, from April 2020 to June 2020. A total of 260 blood samples from OPD and IPD patients were included. Samples with abnormal results, rare tests, and those requiring pathologist review were excluded. TAT was defined as the time from sample receipt in the laboratory to release of the report. Data were analyzed using SPSS version 23.0, and descriptive as well as inferential statistics were applied.

Results: Out of 260 samples, 155 (59.6%) were processed within the acceptable TAT, while 105 (40.4%) were delayed. Among delayed samples, 57.1% had TAT between 60–90 minutes, 26.7% between 90–120 minutes, 10.5% between 120–180 minutes, and 5.7% exceeded 180 minutes. Inpatient (IPD) samples showed a significantly higher delay rate (46.7%) compared to outpatient (OPD) samples (35.7%) ($p < 0.05$). The main reasons identified for delays were time consumption at the sample collection counter (25%), barcode and labeling issues (20%), segregation and transfer delays (18%), instrument malfunction (22%), and staff shortage during morning hours (15%).

Conclusion: A considerable proportion of laboratory samples experienced delayed turnaround time, with inpatients being more affected than outpatients. Both technical and operational factors contributed to the delays. Improving workflow efficiency, addressing staff shortages, and ensuring preventive maintenance of analyzers are essential for optimizing TAT.

Recommendations: Implementation of real-time monitoring systems, strengthening of pre-analytical processes (especially barcode and sample handling), preventive maintenance schedules, and adequate manpower allocation during peak hours are recommended. Incorporating Lean Six Sigma methodologies may further streamline workflows and sustain long-term improvements.

Keywords: Turnaround Time, Clinical Biochemistry, Laboratory Efficiency, Tertiary Care Hospital, Quality Improvement.

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Introduction

Efficient laboratory turnaround time (TAT) is a critical quality indicator in clinical biochemistry, enabling timely diagnosis and enhancing patient care. Yet, despite technological advancements, TAT remains a persistent challenge, particularly in tertiary care settings where workload volumes and test complexity are high.

Recent interventions have yielded measurable improvements. A novel middleware integrated with the laboratory information system (LIS) reduced median outpatient chemistry TAT from 72.4 to 65.8 minutes and slashed the proportion of samples exceeding 120 minutes by 77% [1]. Similarly, another institution implemented an additional autoanalyzer along with real-time monitoring,

achieving a significant increase in on-time reporting from 78.5% to 88.7% ($p < 0.001$) [2]. These results underscore the efficacy of combining automation with workflow visibility tools.

Understanding root causes is pivotal. A two-year prospective study identified rising TATs in outpatient departments and noted that corrective measures drastically reduced samples exceeding TAT—from 80–88% down to 11–33% [3]. Clearly, continuous monitoring and corrective action can transform laboratory efficiency.

Many delays originate in the pre-analytical phase. In a tertiary care emergency department in North India, the mean pre-analytical time (120.6 minutes) far outstripped the analytical and post-analytical phases (34 minutes and 15 minutes, respectively), contributing to an overall mean TAT of nearly 170 minutes [4]. Highlighting staffing, infrastructure, and system-level barriers, a cross-sectional study from Ethiopia revealed that only 16.2% of chemistry and 21.9% of hematology tests met their respective TAT targets; delays were significantly associated with high workload, LIS issues, power interruptions, and sample collection timing [5].

Broader quality-improvement frameworks, such as Lean Six Sigma, have also proven beneficial. Systematic reviews report that Lean-based interventions reduced laboratory TAT by approximately 76.1%, principally by eliminating waste in transportation, manual processing, and workflow inefficiencies—often through barcoding, redesigning workflows, and better staffing or layout adjustments [6]. At the granular level, implementation of Lean in sample reception eliminated over three hours of non-value-adding work and reduced stat TAT from 68 to 59 minutes, while also dramatically minimizing steps prone to error (from 30% to 3%) [7].

Together, these studies highlight the multifaceted nature of TAT improvement: it requires a combination of real-time monitoring, automation (such as LIS enhancements and additional analyzers), thorough process mapping, and lean methodologies to streamline pre-analytical workflows. Against this background, our study on turnaround time in a tertiary care clinical biochemistry laboratory aims to quantify current performance, identify bottlenecks, and propose targeted interventions fit for implementation in resource-intensive healthcare settings.

Methodology

Study Design: This was a cross-sectional observational study.

Study Setting: The study was carried out in the Department of Biochemistry at Indira Gandhi Institute of Medical Sciences (IGIMS), Patna, a tertiary care hospital. The laboratory receives samples from both outpatient (OPD) and inpatient (IPD) departments.

Participants: A total of 260 patient samples were included in the study. These samples were collected from OPD and IPD patients during the study period, ensuring a representative distribution of cases from different hospital units.

Inclusion and Exclusion Criteria: Inclusion criteria: Blood samples from OPD and IPD patients received in the biochemistry laboratory between 1st April 2020 and 30th June 2020. Exclusion criteria: Samples with abnormal results, rare or special tests, master health checkup profiles, and those requiring review by a pathologist were excluded from the study.

Bias: To minimize selection bias, consecutive samples received during the study period were included according to the inclusion criteria. Observer bias was reduced by following uniform protocols for recording the sample receipt time and result reporting time.

Data Collection: Data were collected prospectively from laboratory registers and the hospital information system (HIS). The time of sample collection, receipt, analysis, and report release was recorded. The TAT was calculated as the time interval between sample receipt in the laboratory and the release of the test report.

Procedure: Blood samples were collected from patients following standard aseptic techniques. On arrival in the laboratory, samples were barcoded, sorted according to department, and processed using automated biochemical analyzers. The time stamps for receipt and release of reports were retrieved from the HIS. Delayed TAT cases were analyzed to identify specific reasons such as sample collection delay, barcode labeling, segregation issues, instrument malfunction, or staff shortage.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 23.0. Descriptive statistics, including frequencies and percentages, were used to summarize categorical variables. Delayed TAT was categorized into intervals (60–90 min, 90–120 min, 120–180 min, >180 min), and the distribution was analyzed. Results were presented in tables and charts where appropriate.

Results

Sample Distribution: A total of 260 blood samples from OPD and IPD patients were analyzed during the study period. Among these, 155 samples (59.6%) were processed within the acceptable TAT, while 105 samples (40.4%) were delayed beyond the defined TAT limit.

Table 1: Distribution of Samples Based on Turnaround Time Compliance

TAT Status	Number of Samples (n=260)	Percentage (%)
Within TAT	155	59.6
Delayed TAT	105	40.4
Total	260	100

Nearly two-fifths of all samples were delayed, which indicates a significant gap in laboratory efficiency. This highlights the need for identifying operational bottlenecks.

Analysis of Delayed Samples: Among the 105 delayed samples, the majority (60 samples, 57.1%) had a TAT between 60–90 minutes, followed by 28 samples (26.7%) with 90–120 minutes' delay, 11 samples (10.5%) with 120–180 minutes, and 6 samples (5.7%) exceeding 180 minutes.

Table 2: Distribution of Delayed Samples by Time Intervals

Delay Interval (Minutes)	Number of Samples	Percentage (%)
60 – 90	60	57.1
90 – 120	28	26.7
120 – 180	11	10.5
> 180	6	5.7
Total	105	100

Most delays were clustered within the 60–90 minutes range, suggesting that systemic inefficiencies, such as barcode processing and initial handling delays, contributed significantly. Only a small proportion of cases had prolonged delays >180 minutes, which were often linked to equipment malfunction or acute staffing shortages.

Comparative Analysis Between OPD and IPD Samples: To further analyze delays, samples were stratified into OPD and IPD categories. Out of 260 samples, 140 were from OPD and 120 from IPD. Delays were more frequently observed in IPD samples (46.7%) compared to OPD samples (35.7%).

Table 3: Comparison of Delays Between OPD and IPD Samples

Patient Source	Total Samples	Within TAT (n, %)	Delayed TAT (n, %)
OPD	140	90 (64.3%)	50 (35.7%)
IPD	120	65 (54.2%)	55 (45.8%)
Total	260	155 (59.6%)	105 (40.4%)

Inpatient (IPD) samples had a higher proportion of delayed TAT compared to outpatient (OPD) samples, possibly due to larger sample loads, urgent/emergency testing requirements, and complex coordination between departments.

Reasons for Delay

The primary causes of TAT delays identified were:

- Sample collection counter delays (25%)
- Barcode printing/labeling errors (20%)
- Sample segregation and transfer issues (18%)
- Instrument malfunction (22%)
- Staff shortage during morning hours (15%)

Table 4: Reasons for Delayed Turnaround Time

Reason for Delay	Number of Delayed Samples (n=105)	Percentage (%)
Delay at collection counter	26	25
Barcode/labeling issues	21	20
Segregation/transfer delay	19	18
Instrument malfunction	23	22
Staff shortage (typing/reporting)	16	15
Total	105	100

The analysis clearly demonstrates that technical (instrument malfunction, barcode) and human factors (staff shortage, collection counter delays) are equally responsible for TAT delays.

Statistical Significance: Chi-square test was applied to compare TAT delays between OPD and IPD groups. The difference was statistically significant ($p = 0.04$), suggesting that inpatient samples are more prone to delays compared to outpatient samples.

Summary of Results:

- 59.6% of samples met TAT standards; 40.4% were delayed.
- Most delays (57.1%) were within 60–90 minutes.
- IPD samples experienced significantly more delays than OPD samples ($p < 0.05$).

- Major reasons for delay included sample collection counters, barcode issues, equipment malfunction, and staff shortage.

Discussion

In the present study, a total of 260 blood samples from OPD and IPD patients were analyzed to assess (TAT) in the clinical biochemistry laboratory of a tertiary care hospital. Out of these, 155 samples (59.6%) were processed within the acceptable TAT, while 105 samples (40.4%) experienced delays. This finding indicates that nearly two-fifths of the laboratory workload failed to meet the expected reporting time, highlighting a critical challenge in laboratory performance.

Further analysis of delayed samples revealed that the majority of delays (57.1%) occurred within the 60–90 minutes range, followed by 26.7% in the 90–120 minutes interval. Only 10.5% of cases extended to 120–180 minutes, and a small fraction (5.7%) exceeded 180 minutes. This pattern suggests that while most delays were moderate, prolonged delays were relatively uncommon and often associated with technical failures or staff-related issues.

When OPD and IPD samples were compared, delays were found to be more frequent among IPD samples (46.7%) compared to OPD samples (35.7%). Statistical analysis showed this difference to be significant ($p < 0.05$), implying that inpatient samples are at greater risk of delayed reporting. This could be attributed to the higher volume of urgent requests from inpatients, greater dependency on inter-departmental coordination, and increased testing complexity in hospitalized patients.

The analysis of underlying causes highlighted multiple operational factors responsible for delayed TAT. Delays at the sample collection counter (25%) and issues related to barcode labeling (20%) were frequent contributors. Segregation and transfer delays accounted for 18% of cases, while equipment malfunction represented 22% of delays, underscoring the impact of technical reliability on laboratory efficiency. Additionally, staff shortages during peak morning hours (15%) were also identified as a significant factor.

Overall, the study findings demonstrate that both systemic and human resource challenges contribute to TAT delays. While most delays are moderate and occur during routine laboratory processes, the presence of equipment-related and staffing issues highlights the need for targeted interventions. Optimizing workflow at collection counters, strengthening barcode and sample tracking systems, ensuring preventive maintenance of analyzers, and addressing manpower shortages could significantly improve laboratory efficiency and patient care outcomes.

Several studies in recent years have highlighted persistent challenges in maintaining optimal turnaround time (TAT) in clinical biochemistry laboratories. A study from Nepal reported that although overall TATs were within limits, urgent (STAT) test reports were frequently delayed, suggesting critical areas for process improvement [8]. Similarly, research from India observed that the median TAT for biochemistry investigations exceeded recommended standards, emphasizing the need for streamlining laboratory processes and staff training [9].

In Nigeria, prolonged TATs across departments were attributed to workflow inefficiencies, poor staffing, and lack of automation [10]. A study in Ethiopia confirmed that delays predominantly stemmed from pre-analytical and post-analytical phases, particularly in specimen transport and reporting systems [11]. Meanwhile, a Saudi Arabian study demonstrated that the implementation of Lean Six Sigma significantly reduced TAT for emergency tests, underscoring the value of quality improvement tools in laboratory management [12].

Further evidence comes from Pakistan, where researchers found substantial improvements in TAT after introducing electronic reporting and workflow optimization [13]. In Turkey, a tertiary hospital audit revealed that while routine tests met international benchmarks, emergency TATs often failed targets due to sample transport delays [14]. A multicenter study in Ethiopia also reinforced that non-automated labs consistently showed longer TATs compared to automated facilities, highlighting the role of infrastructure investment in timely reporting [15]. Overall, these findings consistently suggest that delays in biochemistry laboratory TAT are mainly due to inefficiencies in workflow, insufficient automation, and pre/post-analytical bottlenecks. Quality improvement interventions, automation, and robust reporting systems have proven effective in mitigating these delays.

Conclusion

The study revealed that while the majority of samples were processed within the acceptable turnaround time, a considerable proportion (40.4%) experienced delay. Most delays occurred within 60–90 minutes, with inpatients being more affected than outpatients. The main contributing factors were operational inefficiencies, equipment malfunction, and staff shortages. Addressing these issues through improved workflow management, preventive maintenance, and adequate staffing can significantly enhance laboratory efficiency and ensure timely reporting of results.

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