

RESEARCH ARTICLE

LABORATORY TURN AROUND TIME FOR BIOCHEMISTRY INVESTIGATIONS IN EMERGENCY DEPARTMENT OF A TERTIARY CARE HOSPITAL OF NORTH INDIA

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Manuscript Info

Abstract

Background: Laboratory turnaround time is considered one of the most important indicators of work efficiency in hospitals, physicians always need timely results to take effective clinical decisions especially in the emergency department where these results can guide physicians whether to admit patients to the hospital, discharge them home or do further investigations.

Objectives:1. Calculate the turnaround time for the various biochemical investigations from accident and emergency of a tertiary care institute.2. To find the percentage contribution of pre-analytical, analytical and post analytical phases to TAT.

Materials And Methods: This was a prospective, descriptive, singlecenter study of therapeutic TAT for biochemistry investigations in accident and emergency of a tertiary care hospital. The study was conducted for a period of 3 months from August 2020 to Oct 2020. During the present study period, all biochemistry investigations ordered from emergency department were studied. The Lundberg definition of TAT was used in this study. This means that the pre-analytical TAT used was from the point of order of tests to the receipt of samples at the laboratory. Similarly, the post-analytic phase started from the time results were available at the laboratory to the point where clinicians could access it for action.

Results: The turnaround time (TAT) has been monitored in total of 7515 samples for biochemistry evaluation with mean TAT of 169.6 min. It was noted that the mean pre analytical time period was 120.6 min , Analytical time period 34 min while post analytical time period was 15 min. In our study of the pre-analytical phase 37.7%, 39.3%, and 22.9% tests were completed within 60, 60-120 and above 120 minutes, respectively. With respect to the analytical phase, 80.4% and 19.6% tests were completed below 45 minutes and above 45 minutes, respectively.

Conclusion: Despite efficient analysis of results, the pre analytic period contributed the most delay in TAT. Collecting the blood samples under standard conditions, filling the test request slips, marking the samples with bar-codes contributed to long TAT.

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*Key words:-*TAT:Turnaround Time, Pre-Analytical, Analytical, Post-Analytical Phases

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Introduction:-

A functional and accessible clinical laboratory infrastructure plays a crucial role in determining the diagnosis and treatment of communicable and non-communicable diseases alike. ⁽¹⁾.Turnaround time (TAT) is commonly defined as the time from when a test is ordered until the result is reported which includes the pre- analytical, analytical and post-analytical time. Turnaround time (TAT) has been considered as cornerstone for measuring laboratory performance ⁽²⁾.

Clinical laboratory plays a major part in aiding the health care providers to make accurate decisions, where it performs tests, which are requested by the health care providers on their specimens and produce accurate and precise results ⁽³⁾. These results must be available and accessible whenever they are needed by the healthcare providers ⁽⁴⁾. Laboratory turnaround time is considered one of the most important indicators of work efficiency in hospitals, physicians always need timely results to take effective clinical decisions especially in the emergency department where these results can guide physicians whether to admit patients to the hospital, discharge them home or do further investigations ⁽⁵⁾.

A 90% completion time (sample registration to result reporting) of <60 minutes for common laboratory tests is suggested as an initial goal for acceptable TAT. The steps in performing a laboratory test were outlined by Lundberg, who described the brain to brain TAT or "total testing cycle" as a series of nine steps: ordering, collection, identification, transportation, preparation, analysis, reporting, interpretation and action. ^(6,7).

Nevertheless TAT is one of the most noticeable signs of a laboratory service and is used by many clinicians to judge the quality of the laboratory. ⁽⁸⁾. Delays in TAT elicit immediate complaints from users while adequate TAT goes unremarked.⁽⁹⁾ Unsatisfactory TAT is a major source of complaints to the laboratory regarding poor service and consumes much time and effort from laboratory staff in complaint resolution and service improvement. Despite advances in analytical technology, transport systems and computerization, many laboratories have had difficulties improving their TATs . Emergency department (ED) TATs have not improved over several decades. In 1965 a mean ED TAT of 55 minutes was reported, in 1978 a mean of 55 minutes was reported while in 1983 mean collection to report TAT was 86 minutes for a chemistry panel including potassium⁽¹⁰⁾.

Literature has shown the importance of clinical laboratories in facilitating clinical decision-making processes in a range of clinical diseases⁽¹¹⁻¹³⁾. Inadequate access to quality-assured laboratory results often leads to further wastage of limited resources and potential harm to patients⁽¹⁴⁾.

TAT has also been classified as pre-analytical, analytical and post-analytical depending on the different phases of sample processing.⁽¹⁵⁾ This review summarizes the literature regarding laboratory TAT, focusing on the different definitions, measures, expectations, published data, associations with clinical outcomes and approaches to improve TAT. It aims to provide a consolidated source of benchmarking data useful to the laboratory in setting TAT goals and to encourage introduction of TAT monitoring for continuous quality improvement.⁽¹⁶⁾.

Delayed TATs also increases the frequency of duplicate samples sent to the laboratory. This further increases the workload on the laboratory. Assessment and improvement of turnaround times is essential for laboratory quality management as well as ensuring patient satisfaction ⁽¹⁷⁾. Marking the timings on six occasions so that we can get information on the subdivided TAT, which further helps us to understand the delay was due to which phase or process and this can be addressed in depth to reduce the TAT. Laboratory personnel give more importance to the quality, accuracy and precision and least importance is given to turnaround time (TAT). However, service to patient by a hospital would be assessed by the rapidity of result delivery as seen by TAT. Therefore TAT is a very important tool by which a laboratory is assessed ⁽¹⁸⁾.

An opportunity to improve diagnostic testing relies on identification of laboratory workflow to identify bottlenecks in turnaround time (TAT). Workflow evaluation helps in rethinking of processes and can help clinical laboratories do more with less. Improving workflow efficiency in the laboratory is a cost-effective approach to maximizing health benefits for patients despite limited resources being available ⁽¹⁹⁾. Quality improvement efforts geared towards improving the workflow have shown improved efficiency in hospital care settings within lower middle income countries (LMICs)⁽²⁰⁻²²⁾.

To summarize, it is the patient's right to get proper healthcare services in a timely manner. Therefore, health care providers need to get the results of the requested Lab tests in a short TAT in order to treat and diagnose patients properly. This means that the hospital laboratory department needs to improve its performance by shortening its analytical TAT. Evaluating analytical TAT has been the aim of a number of studies, even though, every hospital is different in terms of low income countries (LICs), instrumentations, settings, workflow, patient etc. In addition, different studies use different tests.

The aim of the present study is to determine the turnaround time (TAT) of the biochemistry laboratory, to evaluate the contribution of pre-analytical and post-analytical phases as compared to analytical phase to the total turnaround time (TAT).

Objectives:-

- 1. Calculate the turnaround time for the various biochemical investigations from accident and emergency of a tertiary care institute.
- 2. To find the percentage contribution of pre-analytical, analytical and post analytical phases to TAT.

Materials And Methods:-

This was a prospective, cross sectional, single-center study of therapeutic TAT for biochemistry investigations in accident and emergency of a tertiary care hospital. The study was conducted for a period of 3 months from august 2020 to oct 2020. During the present study period, a total of 7515 specimens were analyzed in the Clinical biochemistry lab.

The samples were drawn by the doctor or any other staff and were collected in the sample collection area. The samples were transported to the laboratory by their respective attendants. The samples received in the laboratory were first screened for any pre-analytical errors followed by their processing. After screening the samples for any pre-analytical errors, the analytical process was commenced. Processing and analysis of the samples was carried out by our technicians and is supervised by the Lab Incharge. Routine maintenance, calibration and quality control evaluation was carried out. The sample run was initiated only after satisfactory quality control results. A Quality control samples were run daily in the laboratory for all the analytes to identify any intra-assay variation. Data were closely analyzed to observe current TAT and its variation with working shifts. Log book was maintained regarding the time of phlebotomy, identification, transportation, analysis and reporting

The laboratories operate 24/7 and testing is run continuously although samples are received in batches. The Lundberg definition of TAT was used in this study. This means that the pre-analytical TAT used was from the point of order of tests to the receipt of samples at the laboratory. Similarly, the post-analytic phase started from the time results were available at the laboratory to the point where clinicians could access it for action.



Difference between various time period and total time was calculated by simple mathematical algorithms in Microsoft excel. Percentage time contributed by particular phase to total time period was calculated.

Exclusion criteria:

Specimens for fasting and postprandial blood glucose measurement. (As there is no system to record time of postprandial sample reception and these test are being catered manually)

Results:-

Turnaround time (TAT) is one of the most noticeable signs of laboratory service and is often used as a key performance indicator of laboratory performance. The turnaround time (TAT) has been monitored in 7515 samples taken from patients in accident and emergency of a tertiary care institute from august 2020 to oct 2020 over a period of 3 months which came 169.6 min.

It was noted that the total sample were 7515 over a period of 3 months with 2558 samples for the month of aug 2020, 2344 samples for the month of sep 2020 and 2613 samples for the month of oct 2020 while mean sample per day was 83.5 (Figure 1)



Figure 1:- Sample loads w.r.t different months of study.

It was noted that the sample load also varied with different working shifts with maximum samples i.e 44.2% being collected in evening hours followed by night shift i.e 29.5% and then day shift 26.22% (Figure 2)



Figure 2:- Sample load w.r.t working shifts.

The study revealed that the turn around time for biochemistry investigation was 169.6 min with majority of the contribution ie 71.1% due to pre analytical phase followed by analytical phase i.e 20.05% and post analytical phase contributed to only 8.84% TAT.

It was noted that the mean pre analytical time period was 120.6 min including the time from which investigation was ordered to the time sample was handed over to laboratory.

It was further bifurcated into two main parts i) From the time investigation was ordered by doctor to the time the sample was shifted to sample collection counter which accounted to an average of 46 min ii) While the second part was the time period till samples we transported to biochemistry lab from sample collection counter which accounted to an average of 74.6 min.

Table 1:- TAT w.r.t different time	periods.
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	Mean hrs	%age TAT
Pre analytical time period	120.6 min	71.1%
Analytical time period	34 min	20.05%
Post analytical time period	15 min	8.84%



Figure 3:- %Age contribution of different phases of TAT.

Table 2:- Variation of TAT w.r.t working shifts.

TAT	Night Shift	Day Shift	Evening Shift
	12am to 10am	10am to 4pm	4pm to 12am
Pre analytical	112.03 min	41.4 min	70.2 min
Post analytical	29.03 min	24 min	49.38 min

It was found in our study that that the mean turn around time for pre analytical phase was maximum for night shift 112.03 min (1.86 hrs) followed by evening shift (4pm-12am) i.e 70.2min(1.17 hrs) and then day shift i.e. 0.69 hours. The analytical phase was maximum for evening shift i.e. 49.38 min (0.82 hrs), followed by night shift i.e. 29.03 min (0.48 hr and then day shift (10pm to 4pm) with mean turn around time for analytical phase as 24min (0.4 hr).

Table 3:-Percentage of test completed in each phase w.r.t time interval.

Pre analytical		Post analytical	
<60 min	37.7%	<45min	80.3%
60-120 min	39.3%	>45min	19.6%
>120 min	22.9%		

In the pre-analytical phase 37.7%, 39.3%, and 22.9% tests were completed within 60, 60-120 and above 120 minutes, respectively.



Figure 4:- Percentage of test completed in pre analytical phase wrt to time intervals.

With respect to the analytical phase, 80.3% and 19.6% tests were completed below 45 minutes and above 45minutes, respectively.



Figure 5:- Percentage of tests completed in analytical phase w.r.t to time intervals.

It was seen that in the night shift the pre analytical phase for 55.55% samples was within standard <60min, while 33.33% samples were testes in 60-120 min and 11.11% samples took>120min in preanalytical phase

Pre analytical TAT	Night Shift	Day Shift	Evening Shift	
	12am to 10am	10am to 4pm	4pm to 12am	
<60min	55.55%	68.75%	7.4%	
60-120 min	33.33%	31.25%	48.14%	
>120min	11.11%	Nill	44.4%	

Table 4:- Relation between working shifts to TAT intervals.

It was seen that in the day shift the pre analytical phase of 68.75% samples was within standard <60min, while 31.25% samples were tested in 60-120 min.



Figure 7:- Pre analytical TAT w.r.t night shift.

It was seen that in the evening shift the pre analytical phase of 7.4% samples was within standard <60min, while 48.14 % samples were tested in 60-120 min and 44.4% samples took>120min in preanalytical phase.



Figure 8:- Pre analytical TAT w.r.t evening shift.

Table 5:- Relation	between	working	shifts to	analytical	TAT	intervals

Analytical time	Night Shift	Day Shift	Evening Shift	
	12am to 10am	10am to 4pm	4pm to 12am	
<45min	55.55%	100%	85.1%	
>45min	44.44%	Nil	14.8%	

It was seen that in the night shift the analytical phase of 55.55 %samples was within standard <45 min, while 44.44 % samples took> 45 min



Figure 9:- Analytical TAT w.r.t Night shift.

It was seen that in the day shift the analytical phase of 100 %samples was within standard <45 min



Figure 10:- Analytical TAT w.r.t day shift

Also It was seen that in the evening shift the analytical phase of 85.1% samples was within standard <45 min, while 14.8 % samples were took> 45 min



Figure 11:- Analytical TAT w.r.t Evening shift.

Discussion:-

In our study, for biochemistry tests ordered from emergency department, the mean TAT was 169.6 min with preanalytic period lasting for 120.6 min and analytical phase as 34 min. This long pre-analytic time was partly a result of the manual recording processes needed to detail ordered tests in a paper register before being verified and received for processing. These results are in line with other studies like John Radcliffe Hospital (JRH), Oxford, UK in determine that the TAT for hematology results was 1 hour 6 minutes (95% CI: 29 minutes to 2 hours 13 minutes) and that for biochemistry was 1 hour 42 minutes (95% CI: 1 hour 1 minute to 4 hours 21 minutes)⁽²³⁾. Likewise, Mahdaviazad *et al* ⁽²⁴⁾ found that the mean overall TAT varied between 1.3 - 3.1hours. In contraindication to our study Lee., *et al* ⁽²⁵⁾ obtained the median total turnaround time to be 55.0(45.0 - 69.0) min ,Furthermore, a more elaborate results of Chung., *et al* ⁽²⁶⁾ demonstrate the average TAT of 43.6 \pm 7.7 min for outpatient routine biochemistry samples

Our study revealed that the turn around time for biochemistry investigation was 169.6 min with majority of the contribution i.e. 71.1% due to pre analytical phase followed by analytical phase i.e. 20.05% and post analytical phase contributed to only 8.84% TAT,

while <u>Kushal Bhattarai</u> etal⁽²⁷⁾ found average turnaround time was 4.37hr (262.28 minutes). The pre-analytical and post analytical phases were contributed the highest turnaround-times that contributed 37.45% and 46.3%, respectively. Furthermore, Mahdaviazad., *et al.* ⁽²⁴⁾, found that the laboratory phase comprised of about 2/3rd of the TAT, a proportion significantly greater than the pre laboratory phase. Similarly, in the study of Goswami., *et al.* ⁽¹⁷⁾, the analytical phase accounted for only 1/4th of the total TAT. Bilwani et al⁽²⁸⁾ had found the delay was due to pre analytic cause in 74.2% of samples. Similarly, a study done by KN Desai et al. suggests that 74.2% of the samples were delayed due to pre analytical phase.⁽²⁹⁾

In our study of the pre-analytical phase 37.7%, 39.3%, and 22.9% tests were completed within 60, 60-120 and above 120 minutes, respectively. With respect to the analytical phase, 80.3% and 19.6% tests were completed below 45 minutes and above 45minutes, respectively. In a study by Wanker ⁽³⁰⁾, out of the aggregate samples, 54.65% fell within the acceptable TAT of 60 min furthermore Chung., *et al.* ⁽²⁶⁾ showed that only 2.0% of the specimens were reported beyond 60 min.

It was found in our study that that the mean turn around time for pre analytical phase was maximum for night shift 112.03 min (1.86 hrs) followed by evening shift (4pm-12am) i.e. 70.2min(1.17 hrs) and then day shift i.e. 0.69 hours. The analytical phase was maximum for evening shift i.e. 49.38 min (0.82 hrs), followed by night shift i.e. 29.03 min (0.48 hr and then day shift (10pm to 4pm) with mean turn around time for analytical phase as 24min (0.4 hr) .In a separate study Mahdaviazad *et al* ⁽²⁴⁾, found that TAT was significantly shorter in the night shift (2.0 ± 0.7 hrs) than in the morning (2.8 ± 1.2 hrs) (p < 0.001). The authors ascribed this pattern to the lower workload in the night shift than in the morning shift.

Conclusion:-

Despite efficient analysis of results, the pre analytic period contributed the most delay in TAT. Collecting the blood samples under standard conditions, filling the test request slips, marking the samples with bar-codes contributed to long TAT. Similarly, analytical phase can be well-run by tactics such as thorough mechanization, high throughput machines, guaranteeing least interruption and sufficient backup, use of competent quality control measures. Measures like adopting newer techniques in preanalytical phase for collection and transportation(like pneumatic tubes), speedy authentication of test reports, operational dissonance of work between the technicians and their timely trainings can indeed help tremendously

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