An Evaluation of Turn Around Times (TAT) in The Clinical Pathology Laboratory of A Referral Hospital and Root Cause Analysis of Delay in Despatch of Reports

Laboratory Medicine

*Dr. Asitava Deb Roy	Assistant Professor, Department of Pathology Sikkim Manipal Institute of Medical Sciences *Corresponding Author
Dr. Jyotsna Kapil	Professor, Department of Microbiology Sikkim Manipal Institute of Medical Sciences

INTRODUCTION:

Clinical laboratory testing is an essential element in the delivery of health care services [1,2]. The dependence of patient management on laboratory data highlights the need for ensuring the quality of these services [1,2]. Delays in reporting laboratory results can cause a concomitant delay in the diagnosis and management of patients [3]. The Joint Commission has underlined this fact by stating that the laboratory is required to systematically assess and improve important functions and work processes and their outcomes [4].

Clinical laboratories take pride in being extremely data driven. Many quality indicators are continuously monitored, analyzed, and used to allocate resources and improve service. These quality indicators include the turnaround times (TATs) necessary to report laboratory results to clinical staff. Turnaround time (TAT) is one of the most obvious measures of a laboratory service. Direct assessment of TAT helps managers to understand whether local performance is improving and how it compares with published norms. The total TAT for laboratory assays includes the entire interval from ordering of the test to the clinician's awareness of the result (ie, "brain-to-brain"). It consists of the intervals from order placement to specimen collection, as well as the time necessary for transport to the laboratory, accessioning in the laboratory, centrifugation, aliquoting, additional preanalytic steps if necessary, transport times within and between laboratories, analysis time, the time after completion of analysis until result verification, and the time it takes for the clinical team to be informed of the result [5].

Lack of full control over phlebotomy and specimen transport make it difficult for the laboratory to address delays caused in the preanalytic stages that take place outside the laboratory [6-9].

In addition, ordering and collection times are not always fully documented for all samples, and it is currently not possible to determine when clinicians become aware of most laboratory results. Assessment and improvement of TAT as well as assessment of physician satisfaction as a base for improvement efforts is essential for laboratory quality management.

This study was conducted with the following aims and objectives:
1. Evaluation of turn-around times (TATs) of routine blood examination.
2. Record the cases which have higher TAT
3. Analyze the causes which resulted in higher TAT
4. Suggest measures to improve TATs to ensure laboratory quality.

METHODOLOGY:
Study setting:
The study was conducted in the laboratory of Central Referral Hospital, Gangtok, Sikkim.

Study design:
The study was a cross-sectional prospective study.

Sample size:
A total of 50 samples were evaluated.

Target sample:
The turnaround times (TAT) of complete blood counts (CBC) ordered by physicians for outdoor patients were evaluated.

CBC was defined by the laboratory as series of basic haematological tests performed simultaneously by one automated analyser and verified by the pathologist.

Inclusion criteria:
1. All the patients attended the out-patient clinic and came to the laboratory to get a sample collected.

Exclusion criteria:
1. Patients who were previously registered with the hospital.
2. Specimens from patients admitted for same day surgery.

Data collection:
Turnaround times

For measurement of TAT, it was classified into 3 phases:
• pre-analytical;
• analytical; and
• post-analytical.

The pre-analytical phase included:
• T1 (waiting time of patient for sampling): starting from patient arrival to the laboratory to the start of processing of test request,
• T2 (processing of test request),
• T3 (collection of blood),
• T4 (placing of blood in tubes and labeling) and
• T5 (blood mixing).

The analytical phase included:
• T6 (sample analysis) and
• T7 (verification of results).

The post-analytical phase included:
• T8 (transcription of results) and
• T9 (reporting of results to physicians).

An observational form including these steps was used to track the complete blood count testing and record their TAT.

For every step in sample collection and testing, from the time the patient entered the laboratory premises, time was noted by a reverse interval timer.

The following steps were noted:
1. Patient enters the laboratory premises and waits for his turn to be called by the phlebotomist. (T1)
2. Phlebotomist calls the patient and processes the request

(T2)

3. Phlebotomist/nurse collects the blood sample. (T3)
4. Labelling of the vacutainers is done by the phlebotomist (T4)
5. The sample is then transported from the sample collection area to the laboratory where the tests are done (T5).
6. Sample analysis (T6): Sample analysis includes:
- Pre-run processing: in blood mixers for proper mixing of blood sample with the anticoagulant before putting the sample in the machine
- Sample run in the autoanalyser and generation of reports by the machine
- Preparing a peripheral blood smear for every sample which is run on the analyser
7. Verification by the pathologist (T7)
8. Typing the reports in the system (T8)
9. Reporting to the physician (T9)

The sample analysis was done in a fully automated five part differential counter (Beckman Coulter AcT 5 Diff CP). For every sample run on the analyser, a corresponding peripheral blood smear (PBS) was prepared by the technician for verification by the pathologist. The pathologist first examined the PBS and then compared the results with the results of the machine. Since PBS is the gold standard in reporting CBC, any anomalous result given by the machine would be corrected and verified by the PBS examination.

According to the Q Probes performance indicator [27] the following recommendations were taken into account.

The 75th percentile of intra-laboratory 90% completion TAT for CBC as given by the study is 96 mins (from collection to verification). This can be taken as threshold if we wish to ensure that our laboratory performs as well as the top quarter of laboratories that reported to the CAP. This threshold was however too stringent for our setup.

Therefore, we chose the 50th percentile threshold which ensures that our laboratory performs better than the bottom half of the laboratories that reported to CAP. The threshold value as given by the Q probes study (1997) [10] is 161 mins (Collection to verification). However this does not take into account the waiting time of patients (T1), which was around 15-20 mins in average, in our hospital. Hence, the threshold TAT for our study was taken as 180 mins.

RESULTS AND OBSERVATIONS:
The total TAT was calculated as the algebraic sum of all the nine intervals (T1-T9).

It was observed that the intra-laboratory median TAT for CBC was 180 mins (3 hrs). Therefore, any test reported after 180 mins was taken into account as delayed TAT.

Of the 50 random samples which were included in our study, 32 (64%) samples were from male patients and 18 (36%) were from females. Maximum (15 out of 50; 30%) of the samples came from the age group of 16-30 yrs.

Maximum (15 out of 50; 30%) of the samples came from the department of Medicine followed by Paediatrics, Obstetrics, Surgery and Orthopaedics. The distribution of samples according to the requesting department is shown in Table 1 and Figure 1.

The nature of requests was segregated according to the urgency of reporting requested by the clinicians. 40 cases (80%) were routinely requested and 10 cases (20%) were to be reported urgently (Table 2, Figure 2). The out-patient samples were requested from 9.00 am till 5.00 pm. 28 (56%) samples were requested between 9.00 am till 1.00 pm and the rest 22 (44%) were requested from 2.00 pm to 5.00 pm (Table 3).

Turnaround times were calculated by taking algebraic sum of the time taken at every step from sample collection to reporting of results (T1 to T9).

Maximum samples (31; 62%) were reported within the threshold of 180 mins (as per Q probes study 1997) shown in Table 4. Rest 19 (38%) samples had a TAT of more than 180 mins. Table 4 shows the turnaround times of the 19 samples which were reported beyond the threshold of 180 mins. The highest TAT was 232 mins which was 52 mins beyond the threshold of 180 mins. The various reasons for delay in reporting results i.e. greater TAT are shown in Table 5 and Figure 3. The major cause of delayed TAT (47.4%) was due to breakdown of the analyser, followed by negligence on the part of doctors (21%). Lack of man power and delay in transcription contributed equally to the same (15.8%).

DISCUSSION:
The clinicians are dependent on laboratory services for the initiation and evaluation of treatment modalities. It is hence our prerogative to ensure timeliness. It is evident from the results of our study that there is a lot of scope for the improvement of turnaround time in our setting. The perception of us, clinical biochemists regarding laboratory efficiency has undergone tremendous change over the last couple of years. We understand that the pre- and postanalytical phases are equally important for the laboratories more so where TAT is concerned.

TAT has been described in various ways by the researchers. The "total testing cycle" describes TAT as consortium of nine steps ordering, collection, identification, transport, preparation, analysis, reporting, interpretation, and action [11]. The term therapeutic TAT is describes the interval when a test is requested to the time some therapeutic decision is taken [12]. TAT can be classified as pre-analytical, analytical and post-analytical depending on the different phases of sample processing [13].

The index study has evaluated 50 samples for turnaround time of CBC profile. The major requisitioning department was Medicine followed by Paediatrics, OBG, Surgery and Orthopaedics. Forty samples were routinely ordered, however, 10 samples were requested for urgent reporting. Most of these urgent test requests were given by the Paediatrics department.

Our study demonstrates that the 50th percentile of intra-laboratory 90% completion TAT for the emergency and the outpatient CBC samples is being maintained at less than 180 mins for 31 (62%) of the total number of samples (n=50). The rest of the 19 (38%) samples had a higher than median TAT (> 180 mins). The causes of a higher TAT have been varied and were mostly due to delay in the analytic phase. This was unlike other studies where the most common cause of delayed TAT was the pre and post analytic phase.

The delay in pre and post analytic phases however contributed equally in increasing the TAT.
Causes of delay in TAT (Root cause analysis)

The reasons for delay were:
1. Lack of man power:
The sample collection area had only one phlebotomist to handle about 60-70 blood collections between 9 am to 4.30 pm daily. This led to a greater waiting time (T1) for the patients which ultimately led to a greater TAT.

2. Breakdown of machine and its consequences:

- Machine breakdown was a common and very frequent problem faced in our institute. This was basically due to lack of skilled technicians running the machine and improper quality control and maintenance of the machine.
- Sikkim, being a remote area, it would take a long time for the engineers to communicate and repair the machine on site. This led to a greater down time for the machine
- Moreover, there was no any automated machine as back up for this analyser. As a result, in case of breakdown of machines, a CBC would be done by manual methods which would again lead to a greater TAT.
- Manual test results were often erroneous because of faulty techniques by untrained technicians. As a result, tests had to be repeated by a skilled technologist or a doctor. Repeating tests would mean a longer TAT.

3. Negligence on the part of doctors:

- Doctors who were responsible for reporting also had other responsibilities like undergraduate teaching sessions, seminars, journal clubs etc. Therefore, sometimes it would be difficult for them to report a CBC on time. This led to greater TAT.
- Since 1pm to 2pm was lunch time, doctors were usually away for lunch during this period. So the samples which came in and around this time were sometimes reported late.
- Occasionally, few doctors used to forget to report slides leading to delay in reporting.

4. Delay in transcription and reporting to physicians:

- Typing of results in the system was usually done by typist after verification by the pathologist. Therefore, sometimes, there was a gap time of around 30 mins to 1 hr between reporting by the pathologist and result entry into the system.
- Reporting of only critical values were done by the technician to the concerned consultant. Routine results were however not informed to consultants but were collected by the patients usually the next day.

Suggestions to prevent delayed TAT:

There are different ways in which each of the phases— pre, analytical and post-analytical phases can be expedited in order to achieve optimum turnaround time.

The pre-analytic phase can be improved with the following modifications:

1. The pneumatic system is a path breaking innovation that has revolutionized sample transport. Many studies have proven the efficiency of this mechanism in reducing inadvertent delays as a result of human courier [14]. One study found that inclusion of a pneumatic tubing system led to a significant reduction of TATs [15].
2. The other means of minimizing pre-analytical delays are adoption of ideal phlebotomy practices, bar coding of samples and computer generated requisition slips. All these practices will reduce the delays that are incurred as a result of illegible slips and faulty sample collection techniques. Use of gel vacutainers can reduce the delays that are caused during centrifugation.

The analytical phase can be streamlined by:

1. Complete automation of laboratories
2. Use of machines with higher throughputs,
3. Ensuring minimal downtime and adequacy of backup,
4. Adoption of efficient quality control procedures, automatic dilutions in case of results exceeding linearity, prompt validation of reports etc.
5. It is also essential to ensure effective division of labor

among the technicians so that sample processing and reporting occurs smoothly.
6. The staff should be trained to handle urgent samples with utmost care and expedite their processing [16-18].

The post analytical phase can be dramatically improved with:

1. Adoption of laboratory information services (LIS). This will abolish transcriptional errors and delays caused in report dispatch to the respective wards [19].
2. In situation like ours, the report delivery can be speeded up by the deployment of additional personnel for this task.
3. The other strategies that may be adopted are prompt information to the wards regarding critical values and pre-analytical errors so that repeat samples are processed without much ado.
4. There is a pertinent need to devise transparent and effective communication system between the clinicians and laboratorians [19].

It is clear from our critical self-appraisal of our laboratory services that we have improvised the analytical phase by automation, elaborate documentation and communication of critical values and recruitment of trained laboratory personnel.

There is a scope of further improvement in our turnaround time by initiating administrative machinery for acquiring state of the art pneumatic tube delivery system and LIS.

CONCLUSION:

TAT has different interpretations for the clinicians and laboratory personnel. Although there is difference of opinions relating to the clinical outcomes of an improved TAT, the causes of delayed TAT should be identified.

Despite rapid improvements in sample delivery, processing and report dispatch as a result of technological advancements, TAT continues to be a bone of contention between the clinicians and laboratorians. We, as laboratorians, feel disheartened by the demands for faster TATs without any consideration for the procedural demands. It is also an uphill task for us to control extra laboratory factors that affect TAT adversely. We need to adopt a pragmatic approach for reducing the hindrances for optimum TAT. At the same the clinicians need to accept and recognize the inherent complexities of sample processing and give us the necessary breathing space. Improving TAT is a continuous process and we need to have a wholesome approach for reducing the obstacles for optimum TAT.

Table 1:

Department	Number of samples (n=50)	Percentage
Medicine	15	30
Paediatrics	13	26
Obstetrics	12	24
Surgery	8	16
Orthopaedics	2	4

Table 2:

Nature	Number of samples (n=50)
Urgent	10
Routine	40

Table 3:

Time	Number of samples (n=50)
9.00 am to 1.00 pm	28
2.00 pm to 5.00 pm	22

Table 4:

Serial number	Sample number	TAT (in minutes)	Reason for greater TAT
1	3	193	Negligence by doctors
2	6	194	Negligence by doctors
3	7	197	Breakdown of machine
4	8	223	Breakdown of machine
5	9	232	Breakdown of machine
6	10	217	Breakdown of machine
7	11	201	Breakdown of machine
8	12	209	Breakdown of machine
9	13	220	Breakdown of machine
10	14	228	Breakdown of machine
11	15	202	Delay in transcription and reporting
12	17	191	Delay in transcription and reporting
13	20	200	Delay in transcription and reporting
14	22	204	Negligence by doctors
15	23	201	Negligence by doctors
16	25	200	Negligence by doctors
17	34	205	Lack of man power
18	38	198	Lack of man power
19	41	184	Lack of man power

Table 5:

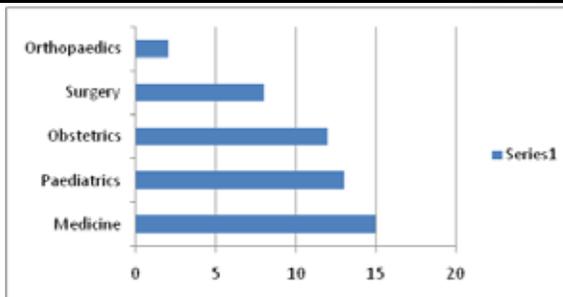| Sl. No.	Causes	Number of samples (n=19)	Percentage (%)
1	Lack of man power	3	15.8
2	Breakdown of machine	9	47.4
3	Negligence of doctors	4	21.0
4	Delay in transcription	3	15.8

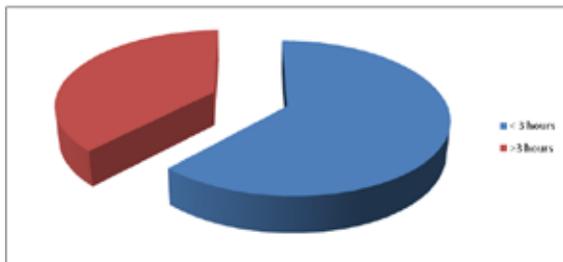Figure 1: Histogram showing distribution of samples according to the requesting department

Figure 2: Pie diagram showing distribution of samples reported within the the intralaboratory median TAT
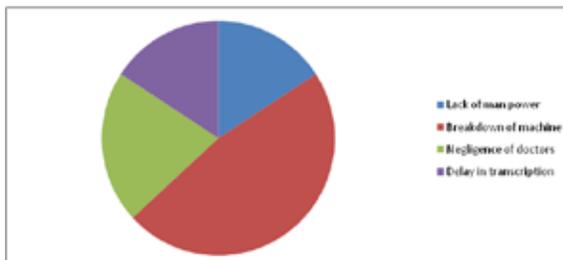

Figure 3: Pie diagram showing the percentage breakup of various causes of delay

REFERENCE

1. Shahangian S, Snyder SR. Laboratory medicine quality indicators: a review of the literature. American Journal of Clinical Pathology, 2009, 13:418–431. | 2. Chawla R et al. Evaluating laboratory performance with quality indicators. Labmedicine., 2010, 41:297–300. | 3. Holland LL, Smith LL, Blick KE. Total laboratory automation can help eliminate the laboratory as a factor in emergency department length of stay. American Journal of Clinical Pathology,2006, 125:765–770. | 4. Comprehensive accreditation manual for pathology and laboratory services. Oakbrook Terrace, Illinois, Joint Commission, 2009. | 5. Kilgore ML, Steindel SJ, Smith JA. Evaluating stat testing options in an academic health center: therapeutic turnaround time and staff satisfaction. Clin Chem. 1998;44:1597- 1603. | 6. Hawkins RC. Laboratory turnaround time. Clin Biochem Rev.2007;28:179-194. | 7. Howanitz JH, Howanitz PJ. Laboratory results: timeliness as a quality attribute and strategy. Am J Clin Pathol.2001;116:311-315. | 8. Brie A, Alexander Kratz. Determination of Turnaround Time in the Clinical Laboratory: "Accessioning-to-Result" Time Does Not Always Accurately Reflect Laboratory Performance. Am J Clin Pathol 2012;138:724-729 | 9. T.A. Elhoseeny, E.K. Mohammad. Quality of the clinical laboratory department in a specialized hospital in Alexandria, Egypt. EMHJ 2013; 19:1:81-87. | 10. Steindel SJ, Jones BA. Routine Out-Patient test Turnaround Time- Data analysis and critique. Q Probes Study. College of American Pathologists 1997. | 11. Lundberg GD. Acting on significant laboratory results. JAMA.1981;245:1762–3. | 12. Fermann GJ, Suyama J. Point of care testing in the emergency department. J Emerg Med. 2002;22:393–404. | 13. Truchaud A, Le Neel T, Brochard H, Malvaux S, Moyon M, Cazaubiel M. New tools for laboratory design and management. Clin Chem. 1997;43:1709–15. | 14. Fleisher M, Schwartz MK. Automated approaches to rapidresponse testing. A comparative evaluation of point-of-care and centralized laboratory testing. Am J Clin Pathol. 1995;104:S18–25. | 15. McQueen MJ. Role of the laboratory in meeting the needs of critical care. Clin Biochem. 1992;26(1):8–10. | 16. Hawkins RC. Laboratory turnaround time. Clin Biochem Rev.2007;28(4):179–94. | 17. Howanitz PJ. Errors in laboratory medicine: practical lessons to improve patient safety. Arch Pathol Lab Med. 2005;129:1252–61. | 18. Berry DE. Turnaround time improvement and department-wide benefits of automation in urinalysis. Clin Leadersh Manag Rev.2006;20:E3. | 19. Georgiou A, Williamson M, Westbrook JI, Ray S. The impact of computerised physician order entry systems on pathology services: a systematic review. Int J Med Inform. 2007;76:514–29. |