Monitoring and Root Cause Analysis of Clinical Biochemistry Turn Around Time at an Academic Hospital

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Abstract Quality can be defined as the ability of a product or service to satisfy the needs and expectations of the customer. Laboratories are more focusing on technical and analytical quality for reliability and accuracy of test results. Patients and clinicians however are interested in rapid, reliable and efficient service from laboratory. Turn around time (TAT), the timeliness with which laboratory personnel deliver test results, is one of the most noticeable signs of laboratory service and is often used as a key performance indicator of laboratory performance. This study is aims to provide clue for laboratory TAT monitoring and root cause analysis. In a 2 year period a total of 75,499 specimens of outdoor patient department were monitor, of this a total of 4,142 specimens exceeded TAT. With consistent efforts to monitor, root cause analysis and corrective measures, we are able to decreased the specimens exceeding TAT from 7–8 to 3.7 %. Though it is difficult task to monitor TAT with the help of laboratory information system, real time documentation and authentic data retrievable, along with identification of causes for

delays and its remedial measures, improve laboratory TAT and thus patient satisfaction.

Keywords Clinical biochemistry · Root cause analysis · Turn around time · Outdoor patient department

Introduction

World class service provider industries are characterized by their attention to reducing waits and delays. In contrast, timeliness of result reporting has not been a major focus in clinical laboratories [1, 2]. Since voluntary accreditation is made possible by National Accreditation Board for Testing and Calibration of Laboratories (NABL) in developing countries like India, the analytical quality of laboratory test results have improved. However it is not only the accuracy or reliability of test result that satisfies the patients or the physicians but the speediness of availability of laboratory test result also is important. The turn around time (TAT), the timeliness with which laboratory personnel delivers the test results, is suggested as one of the quality indicators of the standard of laboratory performance by which the clinicians [3] and the accreditation organizations judge a laboratory [4].

Certain studies suggest that the TAT of laboratory tests directly influences the duration of stay of patients in the Emergency Department (ED) [5], as a reduction of laboratory TAT reduces ED stay [6], and hence enhances the safety and satisfaction of patients [7]. Decreasing the TAT of laboratory tests, help in reducing overcrowding in the ED [8].

For indoor patients timely, accurate and reliable lab test results reduce hospital stay, enhance the safety &

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satisfaction of the patients. This equally applies to outdoor patients also. Therefore it is the responsibility of laboratory to make improvement in TAT. Most of the labs fail to do this as improving the TAT is a difficult task.

The aim of this study is to provide guidelines for monitoring and identifying the causes of delay in TAT and suggesting actions to eliminate them to make improvement in the TAT of laboratory test results.

Materials and Methods

This is a cross sectional study conducted at the Clinical Biochemistry section of the Central Diagnostic laboratory an NABL accredited laboratory of Shree Krishna Hospital attached to Pramukh Swami Medical College providing services to 5 Intensive Care Unit's (Medical, Surgical, Cardiac, Neonatal & Paediatric). It was decided to follow PDCA (Plan, Do, Check, Act) cycle to manage the quality objectively and one of the quality indicators considered was, TAT of laboratory test results. The first task was to define TAT. There have not been consistent ways to define, record or analyze TAT. The laboratory TAT can be defined in different ways based on the test type (stat vs. routine), the type of analyte and the type of Institution. It is commonly defined as the time from a test is ordered until the result is reported [9]. On the one hand TAT, for example, can be defined as “the time from receipt of the specimen in the lab” until “time of availability of the result” (known as laboratory TAT) [10], as well as “the time from the physician's request” until the “time the physician views the result” (known as total TAT) [11].

In our laboratory, TAT is defined as “the time of sample collection” till “the report is dispatched to the patient”. Then a consensus was reached between the Biochemist, Laboratory Director & Clinicians and the acceptable TAT of laboratory test results for parameters like Glucose, Creatinine, Urea, Uric acid, Total Proteins & albumin, ALT, AST, Bilirubin, ALP, Calcium, Magnesium, Phosphorous, LDH, Total Cholesterol, Triglyceride, HDL-C, Amylase & Lipase was decided to be 1 h and 30 min (1.5 h). The TAT for Total PSA, TSH, Ferritin, Iron, Total iron binding capacity and HbA1c was decided to be 2 h and that for G6PD, Adenosine deaminase (ADA), LFT, TFT, Lipid profile, serum and urine osmolality Vitamin B12, FSH, LH, prolactin and HCG was decided to be 3 h.

The entry of the time is made on six occasions for outdoor patient department (OPD) patients, starting from OPD specimen collection station till the report is delivered back at the same station from where the patients collect the report, as represented below;

Table 1 Number and percentage of specimens that exceeded stipulated TAT for 2011–2012

Year/month	January	February	March	April	May	June	July	August	September	October	November	December
2011	Total No. of specimens	7736	8,297	8,538	7,292	7,766	8,360	7,573	8,029	8,222	8,644	8,432
	No: of OPD specimens	2,862	2,924	3,443	2,955	2,905	3,089	3,227	3,229	2,508	3,142	2,894
	No: of specimens exceeding TAT	229	202	292	153	128	156	212	216	181	179	170
	Percentage of specimens exceeding TAT	8	6.9	8.5	5.2	4.4	5.1	6.6	6.7	7.2	5.7	5.9
2012	Total No. of specimens	7,803	9,000	9,038	8,479	8,058	8,204	7,457	8,342	8,856	7,652	7,706
	No: of OPD specimens	2,467	2,990	3,578	3,115	3,167	3,452	3,470	3,211	3,422	3,728	3,286
	No: of specimens exceeding TAT	174	214	159	155	154	144	125	128	153	130	123
	Percentage of specimens exceeding TAT	7.1	7.2	4.4	5.0	4.9	4.2	3.6	4.0	4.5	3.5	3.7

Fig. 1 Comparison of specimens exceeding the TAT for 2011–2012

1. Bar-code generation and specimen sample collection at OPD collection station
2. Transport of specimen form OPD collection station to Pneumatic Station
3. Pre-analytical processing & distribution of specimen at Pneumatic station to different labs section
4. Sample Processing at Biochemistry lab, testing & test result validation
5. Report dispatching from Clinical Biochemistry section to Pneumatic station
6. Dispatch of report form Pneumatic station though OPD collection centre and to the patient

Hence this involves three phasing, pre-analytical (steps 1–4), analytical (steps 4–5) and post-analytical (steps 5–6).

With the help of the in-house computer system department it is made possible to retrieve the data of specimens exceeding TAT and time taken at each station on a daily basis. The laboratory technicians and the resident doctors record the reasons for the delay of those specimens exceeding the TAT at each station. The compile data were presented and discussed in the monthly laboratory services meetings and also in the six monthly management review meeting for remedial measures.

Results

The study began in January 2011 and it is a continuous process. The data presented here is from January 2011 to December 2012. During this 2 year period, the Clinical Biochemistry section received a total of 1,90,332 specimens out of which 75,499 specimens were from OPD. It was observed that a total of 4,142 specimens exceeded stipulated TAT.

From Table 1 and Fig. 1 it is obvious that in spite of an increase workload in 2012 in comparison to 2011, with consistent efforts we are able to decreased the TAT from 7–8 to 3.7 %.

By subdividing TAT on a time frame we can identify the station at which the delay took place and so we can try to

explore the reasons for the delays and come our with solutions. The TAT exceeding 5 h was mainly due to the outsourcing of the tests (not performed in our laboratory), report dispatched on the next day due to collection of specimens after 4.30 pm, major breakdown in equipment, and incorrect entry of time at one of the work station. The delays between 2 and 5 h were due to misplacing specimen or the test report and the test report of specimen from home collection. Specimens with a TAT exceeding 30 min to 2 h were mainly due to the need of specimen dilution, requirement of clinical correlation and due to quality control outliers, requiring further corrective measures (Table 2).

Discussion

A reduce TAT for the ICU and emergency specimens directly benefit physician & patients but that of OPD influences the perception of laboratory in the community & serves as indicator of laboratory performance as to how fast

Table 2 Number and percentage of specimens exceeding TAT by time duration

	2011	2012	Total
<30 min	1,294 (55.0 %)	1,048 (58.5 %)	2,397 (56.5 %)
30 min–1 h	328 (14.0 %)	205 (11.4 %)	547 (12.9 %)
1–2 h	210 (8.9 %)	202 (11.3 %)	421 (9.9 %)
2–5 h	341 (14.5 %)	244 (13.6 %)	600 (14.1 %)
>5 h	178 (7.6 %)	92 (5.2 %)	278 (6.5 %)
OPD specimens exceeding TAT	2,351 (6.4 %)	1,791 (4.6 %)	4,142 (5.6 %)
Total number of OPD specimens (outdoor only)	36,493	39,006	75,499
All specimens (indoor and outdoor patients)	91,175	99,157	1,90,332

the laboratory is able to provide test report, irrespective of whether it is in academic hospital or a non-academic one or a small or a large laboratory. Thus the TAT varies from laboratory to laboratory [12]. It also depends on how the TAT is defined. In a 1998 CAP Q-Probes Study [13], 41.1 % of laboratories defined emergency department (ED) TAT as the time taken from the receipt of a specimen in the laboratory to the time of reporting of the test result, 27.0 % defined the TAT as the time taken from the time of ordering the test to the reporting of the result and 18.2 % defined it as the time taken from collecting a specimen to the reporting of the result.

The definition of the TAT although important, the ultimate goal should be to provide right result at right time. In our set up TAT is defined as “the period between the time

of specimen collection” and “the time of dispatch of report to the patient” and is further subdivided into three phases (pre-analytical, analytical & post-analytical). 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.

Manor [14] and Rollo et al. [15] reported that the non-analytical delays, such as transporting and reporting delays, are the main causes of lagging laboratory TAT and Bilwani et al. [16] had found the delay was due to pre analytic cause in 74.2 % of samples. In our study 45 % of specimens having exceeded TAT was due to various non-analytical delays and almost 35 % were due to all phases delay. Bilwani had reported that most of the delays in TAT of

Table 3 Root cause analysis and corrective measures taken to reduce TAT

Phases	Identified causes for delay	Contribution to exceeded TAT (%)	Corrective measures to reduce TAT
Pre-analytical	Incorrect entry of the name of patient, investigation, hospital number as a result of bad handwriting	<1	Opted for Use of computerized (online) physician order entry Bar code labeling
	Hemolysis and the need for repeat sampling	<1	Training of phlebotomist & using of Vacutainer (instead of syringe and needle)
	Waiting at collection centre & transport time (from collection to pneumatic station),	13	Proper management of human courier service when Pneumatic system breakdown occurs
	Pre analytical processing (centrifugation and specimen distribution)	17	Posting of more efficient personnel at peak hours. More centrifuging machines put to use
	Need for getting of specimen from other sections of lab (from microbiology or hematology section e.g. EDTA sample for Hb & glycated Hb)	2	Split the specimen sample at Pneumatic station and distribute to needy section
Analytical	Delay in analyte testing due to heavy workload, equipment breakdown	3	Proper human resources utilization, procuring stand by equipment like chemistry analyzer & electrolytes analyzer etc
	Single test specimen, specimens from ICUs or Cancer centre short TAT specimens)	<1	Identified by fluorescence color label Process on priority, load on fully automated analyzer on STAT (Short Turn Around Time) mode
	Misplaced specimens	<1	Assigning the responsibilities of the processing to the one receiving the samples itself
	Need for specimen dilution & re-run due to the test result remaining above the analytical measuring range	1.5	Auto dilution mode preferred on fully automated analyzer
Post analytical	Delay in transcription of the result from the equipment to the register & from the register to the LIS	4	Interfacing all the equipments with laboratory information system (LIS)
	Result validation (review and clinical correlation)	2	Physicians are requested to provide probable clinical diagnosis or indication of test with a brief clinical history in LIS
	Misplacement of report wrong entry of time at Pneumatic or at collection stations	3	Education and training
	Report dispatched on the next day due to OPD closures (after 6.00 pm)	<1	If the test results are critical, the patient is advised on telephone to contact his/her consultant doctors.
All phases	No specific reason	35	Delays of 5–10 min at each phase and specimen exceeding TAT by <30 min can be accepted
	Other causes like out sourcing of the test (tests not done in our lab) home collection test	15	Need to redefine TAT, Give Distinct ID Different process to calculate TAT

short turnaround time (STAT) tests were more than 60 min. In my set up almost 57 % delay was within 30 min and these were due to all phases-delays.

Most of the laboratories will accept up to 10 % outliers (Steindel [17], Hee-Jung Chung [18]). Bilwani et al. [16] have reported 10.4, 2.0 and 2.03 % exceeded the TAT. In our laboratory in the beginning the TAT was 8 % but with root cause analysis and corrective measures the TAT dropped down to 3.7 %.

To improve the TAT of laboratory test results, implementation of appropriate corrective measures are also important. As Fernandes et al. [19] reported that the use of the pneumatic tube system reduced mean haemoglobin TAT from 43 to 33 min and mean potassium TAT from 72 to 64 min with no significant difference in hemolysis rate (6 % with a pneumatic tube system and 10 % with a human courier). Individual studies have demonstrated improved TAT, with savings on the costs of transport staff. However, such systems can under-perform due to poor design (which is often based on mail transport) or insufficient canisters [20]. In our case there is little improvement in pre-analytical TAT, after installation of Pneumatic system.

Bilwani et al. [16] noted that 40 % of TAT was due to machine breakdown in analytical phase, which is similar in our case where 40 % of 10 % analytical phase errors due to the breakdown of equipment. To prevent this we procured back up equipment.

As mentioned in Table 3 we had taken corrective actions in all phases (pre-analytical, analytical & post analytical) to improve our laboratory TAT and still there is scope to improve for it e.g. by making provision to print the reports at collection centre after the result is validated by a biochemist consultant which will eliminate report transit time from laboratory to collection centre and may abolish the event, like misplacing the test reports.

Conclusion

There has been progress in the area of laboratory test result TAT in recent years, with more explicit descriptions of TAT data in the literatures. Though it is a tedious process to monitor TAT, with the increasing availability of computer software, laboratory information system that help in the real time documentation and authentic retrieval of data, regular audit, providing training to the laboratory technicians & the resident doctors, discussion in the laboratory services meeting, and the management support whenever needed to improve the TAT. It becomes possible to reduce patient waiting time and hence improving the satisfaction of patients.

Conflict of interest None.

References

- Hilborne LH, Oye RK, McArdle JE, Repinski JA, Rodgerson DO. Evaluation of stat and routine turnaround times as a component of laboratory quality. *Am J Clin Pathol*. 1989;91(3):331–5.
- Howanitz PJ, Cembrowski GS, Steindel SJ, Long TA. Physician goals and laboratory test turnaround times. a college of American Pathologists Q-Probes study of 2763 clinicians and 722 institutions. *Arch Pathol Lab Med*. 1993;117(1):22–8.
- Novis DA, Dale JC. Morning rounds inpatient test availability: a college of American Pathologist Q-Probes study of 79860 morning complete blood cell count and electrolyte test results in 367 institutions. *Arch Pathol Lab Med*. 2000;124(4):499–503.
- Valenstein P. Laboratory turnaround time. *Am J Clin Pathol*. 1996;105(6):676–88.
- Sinreich D, Sinreich D, Marmor Y. *J Health Organ Manag*. 2005;19(2):88–105.
- Holland LL, Smith LL, Blick KE. Reducing laboratory turnaround time outliers can reduce emergency department patient length of stay: an 11-hospital study. *Am J Clin Pathol*. 2005;124(5):672–4.
- Gelrud J, Burroughs H, Koterwas J. Emergency care center turnaround time—an improvement story. *J Healthc Qual*. 2008;30(1):31–7.
- Derlet RW, Richards JR. Overcrowding in the nation's emergency departments: complex causes and disturbing effects. *Ann Emerg Med*. 2000;35(1):63–8.
- Hawkins RC. Laboratory turnaround time. *Clin Biochem Rev*. 2007;28(4):179–94.
- Westbrook JI, Georgiou A, Rob MI. Computerized order entry systems: sustained impact on laboratory efficiency and mortality rates? *Stud Health Technol Inform*. 2008;136:345–50.
- Georgiou A, Williamson M, Westbrook JI, Ray S. The impact of computerized physician order entry systems on pathology services: a systematic review. *Int J Med Inform*. 2007;76(7):514–29.
- Steindel SJ, Jones BA, Howanitz PJ. Timeliness of automated routine laboratory tests: a college of American Pathologist Q - Probes study of 653 institutions. *Clin Chim Acta*. 1996;251(1):25–40.
- Steindel SJ, Howanitz PJ. Physician satisfaction and emergency department laboratory test turnaround time. *Arch Pathol Lab Med*. 2001;125(7):863–71.
- Manor PG. Turnaround times in the laboratory: a review of the literature. *Clin Lab Sci*. 1999;12(2):85–9.
- Rollo JL, Fauser BA. Computers in total quality management. Statistical process control to expedite stats. *Arch Pathol Lab Med*. 1993;117(9):900–5.
- Bilwani F, Siddiqui I, Vaqar S. Determination of delay in Turnaround Time (TAT) of stat test and its causes: AKUH experience. *J Pak Med Assoc*. 2003;53(2):65–7.
- Steindel SJ, Novis DA. Using outlier events to monitor test turnaround time. a college of American Pathologist Q - Probe study in 496 laboratories. *Arch Pathol Lab Med*. 1999;123(7):607–14.
- Chung HJ, Lee W, Chun S, Park HI, Min WK. Analysis of turnaround time by subdividing three phases for outpatient chemistry specimens. *Ann Clin Lab Sci*. 2009;39(2):144–9.
- Fernandes CM, Worster A, Eva K, Hill S, McCallum C. Pneumatic tube delivery system for blood samples reduces turnaround times without affecting sample quality. *J Emerg Nurs*. 2006;32(2):139–43.
- Saxena S, Wong ET. Does the emergency department need a dedicated stat laboratory? Continuous quality improvement as a management tool for the clinical laboratory. *Am J Clin Pathol*. 1993;100(6):606–10.