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Factors affecting turnaround time in the clinical laboratory of the Kathmandu University Hospital, Nepal

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ABSTRACT

Background

The turnaround time (TAT) as defined by most of the laboratories is the time interval between the specimens received in the laboratory to the time of reports dispatched with verification. Nearly 80% of hospital-attached clinical laboratories receive complaints about delayed TAT. Reporting in time is a crucial indicator of quality services along with accurate, precise and reliable reports, thus each clinical laboratory should identify affecting factors to eliminate them for the enhancement of quality services.

Methodology

Dhulikhel Hospital-Kathmandu University Hospital is a tertiary care hospital, where this observational descriptive study was conducted in 2017. Requested tests received on database in the Department of Clinical Biochemistry Laboratory along with test requisition form (TRF) were carefully screened for any possible error. When analysis of individual patient's tests was completed, results of individual parameters were entered in the database manually. TAT was

calculated as a time period between specimens received to analysis completed. Once test analysis has completed it was immediately followed by verification.

Results

A total of 36,108 patients' reports generated from the Department of Clinical Biochemistry Laboratory during study period were analyzed. Nearly 36% of reports exceeded the predefined TAT in case of stat tests, while around 7% of reports were out of predefined TAT in case of routine tests. Among prolonged TAT, around 75% of reports were delayed due to various extra analytical reasons and approximately 48% of total delayed reports were found only due to error by cash unit.

Conclusion

The major reasons of delayed laboratory reports were due to time consumed to fix the pre-analytical errors created by other departments rather than laboratory itself. Cash unit alone has the highest degree of error in total testing process and it is the most significant factor for prolonged TAT. However reasons for prolonged TAT may vary with hospital to hospital depending upon different factors.

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INTRODUCTION

Most of the medical decisions are made on the basis of laboratory findings [1]. So, clinical laboratory findings must be accurate and well-timed. Waiting for laboratory reports for long time is often disappointing for patients and clinicians too. Hence, it is better for each laboratory to have its own turnaround time (TAT) [2-5]. Accuracy, reproducibility and punctuality have their own grounds in the field of clinical laboratory science [6,7]. However, in general clinical laboratories focus on accuracy and reliability of the test reports and pay less attention to the prompt release of laboratory reports [8]. Early diagnosis and appropriate treatment of the patients is an outcome of the calculated accuracy and well-timed execution of the work [9, 10]. Analysis of the test report in time can also be an important factor for the patients to cut out their expenses by shortening the time of their hospital stay [9, 10].

The total/therapeutic TAT is the time "from vein to brain", it is the interval between the test request and the therapeutic decision, while the laboratory TAT starts when the sample arrives at the laboratory and ends when the report is released after the validation of the results [11, 12]. However, many laboratories confine their definition of TAT to intra-laboratory due to limitations in control of extra laboratory factors [13].

TAT varies from laboratory to laboratory and also depends on the varying explanation of the laboratories and the clinicians [11, 14]. Furthermore, TAT can also be categorized on the basis of test types and patient's priority (outpatients, inpatients, emergency) [11]. Total Testing Process (TTP) in clinical laboratory, as described by Lundberg, has nine steps namely, ordering, collection, identification, transportation, preparation, analysis, reporting, interpretation and action [15].

A study done by the College of American Pathologists, CAP Q-Probes, in 1998, found that, 41% of the laboratories defined emergency TAT as the interval between sample arrival and result reporting, 27% defined it as the time from test ordering to reporting of the results and 18% defined it as the interval between sample collection and result reporting [16].

TAT is a measure of punctuality and is often regarded as one of the determinants of laboratory efficiency [9]. Humans, being impatient by nature, need everything to be done rapidly including the clinical laboratory reports. Thus, they prefer

the hospitals that guarantee fast service and do not make them wait for long hours for their test reports and proper diagnosis, treatment and management of their problems. These facts thus prove TAT crucial for both, medical as well as commercial point of view [6].

Total laboratory testing process is divided into three phases, namely; pre-analytical, analytical and post-analytical, and TAT depends on these three phases [17]. The pre-analytical phase refers to the time period between requisition of test to the sample being reached to the hands of professionals and prepared for analysis. The analytical phase is the period of measurement; this is the interval between the beginning of the measurement (actual testing) and the confirmation of the test results. The post-analytical period indicates the time from result verification or printing to the time when the physician actually observes the results [18, 19, 20]. Among these three phases, pre-analytical and post-analytical phases contribute to nearly 96% of the TAT [9] and factors may vary depending upon the infrastructures of the institution, degree of automation, and experience and attribution of the employee [21, 22]. Dhulikhel Hospital-Kathmandu University Hospital (DH-KUH) has predefined TAT of one hour for tests requested from emergency department and intensive care unit (ICU) while two and half hour for tests requested from outpatient departments and indoor departments.

METHODOLOGY

Study design

This is a cross-sectional, descriptive and observational study based on the data obtained from the Department of Clinical Biochemistry Laboratory of Dhulikhel Hospital-Kathmandu University Hospital. Obtained data were closely analyzed to observe current TAT and factors affecting prolonged TAT. All the samples along with their Test Requisition Form (TRF) available at Department of Clinical Biochemistry Laboratory of Dhulikhel Hospital in six months' time from March to August 2017 were analyzed.

Selection criteria

Inclusion criteria

All the criteria matched specimens and TRF received at the Department of Clinical Biochemistry Laboratory of Dhulikhel Hospital-Kathmandu University Hospital were analyzed.

Exclusion criteria

a. Specimens for fasting and postprandial blood glucose measurement. (As there is no system to record time of postprandial sample reception)
b. Sudden addition or cancellation of the tests via telephone by clinician.
c. Test for Sex Hormone Binding Globulin, Vitamin B12, Folic acid and Anti Cyclic Citrullinated Peptide. (These tests are performed twice a week only)
d. Test for hemoglobin or serum protein Electrophoresis. (Performed weekly only)

Data collection and TAT calculation

The time of sample arrival and time of analysis completed were recorded in Excel tables and the differences were calculated. Simultaneously, if any obstacle was found in TTP, it was mentioned in TRF and was noted in the spread sheet.

Procedure

In the specimen collection unit, collection time was mentioned in TRF and collected samples and TRFs were transported to the Department of Clinical Biochemistry Laboratory by trained staff. The TRFs and samples were then received by technician in the Department of Clinical Biochemistry Laboratory and verified according

to pre-structured standard operating procedure (SOP). The sample receiving time and parameters were immediately entered in Midas Version 3.2. If any possible error was noticed during sample receiving process, that was mentioned over TRF of respective patients. The sample receiving time entered in Midas is automatically printed on the report as sample received time. After completion of the individual patient's tests, the observed values for all the requested parameters were manually entered in reporting database software Midas. If any problem happened during analysis e.g. test was repeated or sudden machine breakdown, they were mentioned on the TRF without any delay by concerned staffs. The time when observed value is entered in Midas, appears as test analysis completed time in the patient's report.

Figure 1 Flow chart of the Total Testing Process (TTP)

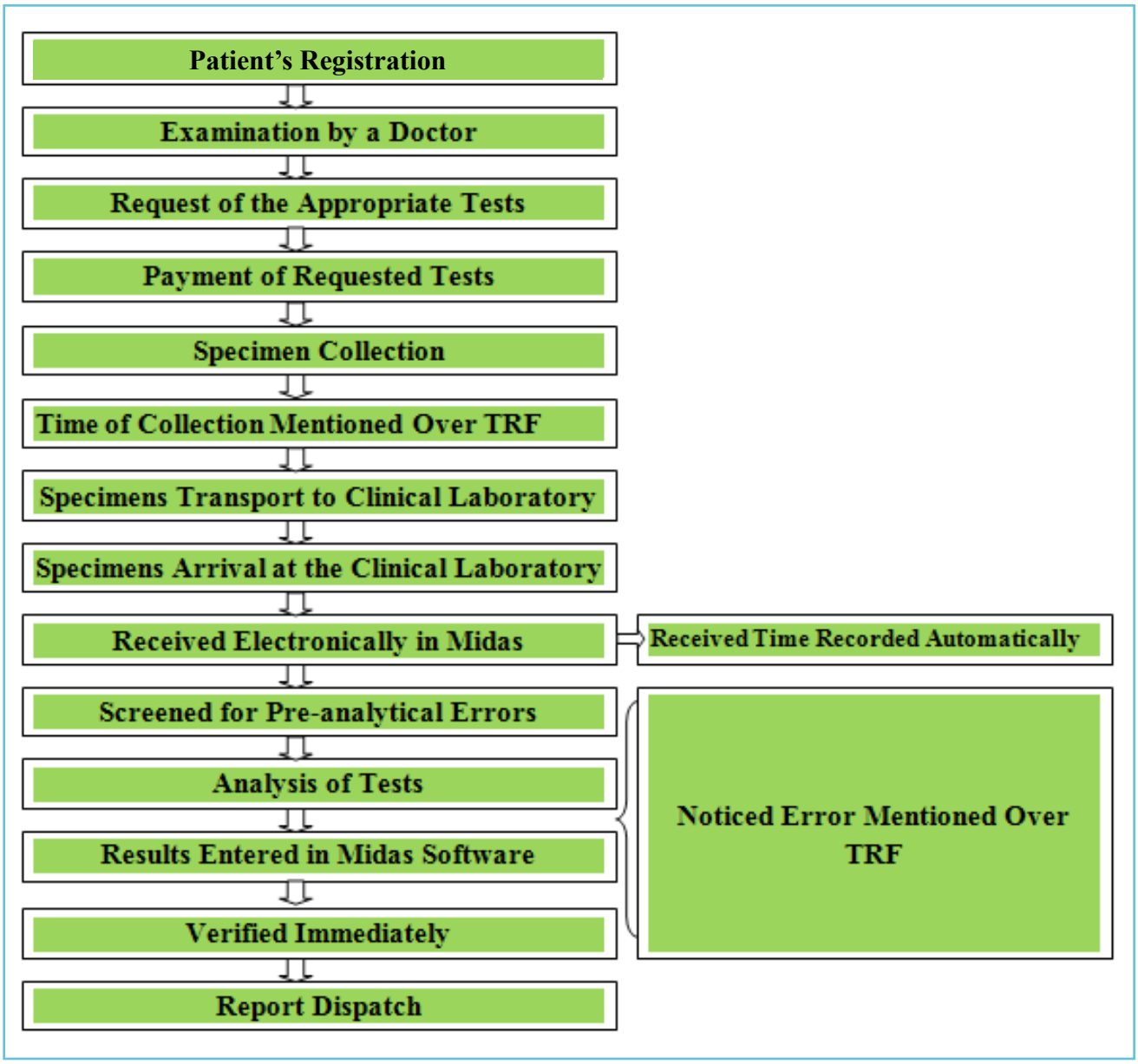


Figure 1 presents the flow chart of the total testing process in Dhulikhel Hospital-Kathmandu University Hospital.

Any factors that were encountered during the whole process, from receiving the samples to releasing the reports, might be responsible for prolonged TAT. They were mentioned on the TRF by concerned staff and were closely monitored by the author and research assistant. Every day all the criteria matching reports generated from the Department of Clinical Biochemistry Laboratory were analyzed for current TAT, together with the reasons of prolonged TAT mentioned on the TRFs. TTP was performed, as shown in Figure 1.

Ethical considerations

The research proposal was submitted to the Institutional Review Committee (IRC) of the Kathmandu University School of Medical Sciences, and data collection was started after getting ethical clearance.

RESULTS

This study was conducted in the year 2017 by analyzing a total of 36108 samples along with their TRF. Out of those, only 24644 samples were fit for the actual study. 11464 (31.74%) samples with TRF were not suitable because those requested tests had less than 20 minutes TAT which is practically not possible. This had happened because technical staff of clinical laboratory did not follow the standard operating procedure of TTP. Especially, in the late evening and night, technical staffs had done analysis of tests without receiving sample electronically in Midas, instead the samples were electronically entered only after completion of analysis or in between of analysis. So, the observed TAT was very short which is not possible in real situation (Table 1).

When 24644 patients' reports were analyzed for TAT and affecting factors, 2434 (9.8%) of them had prolonged TAT in comparison to predefined TAT. But only 2010 patients out of 24644 were found to have reasons documented on TRF for stretched TAT. When specific reasons for prolonged TAT were analyzed in 2010 patient's reports, 973 (48.4%) patients' reports were delayed due to problem created in cash unit either incomplete payment or payment not according to test requested in TRF.

Nearly half of the total affected TAT was observed due to problem in cash unit and unfortunately patients from all the departments had to pay before test proceeds. Department of Clinical Biochemistry Laboratory reporting database is designed in such way that report cannot be generated unless a proper payment is made therefore the cash unit is the most important factor for prolonged TAT in Dhulikhel Hospital.

Repetition of tests is another leading factor of prolonged TAT in the Department of Clinical Biochemistry Laboratory of DH-KUH which is 494 (24.5%) out of 2010 patients. 313 (15.5%) patients did not get their reports on predefined time due to sample related factors. Visually detected hemolyzed specimens were absolutely rejected which resulted in delayed reports of 210 patients. It contributed delay of 10.44% patients' report. Furthermore, lingering of laboratory reports were due to poor inventory, failure of analyzers either due to irregular maintenance or lack of properly functioning analyzers were noticeable factors responsible for delay in 230 (11.4%) patients' reports.

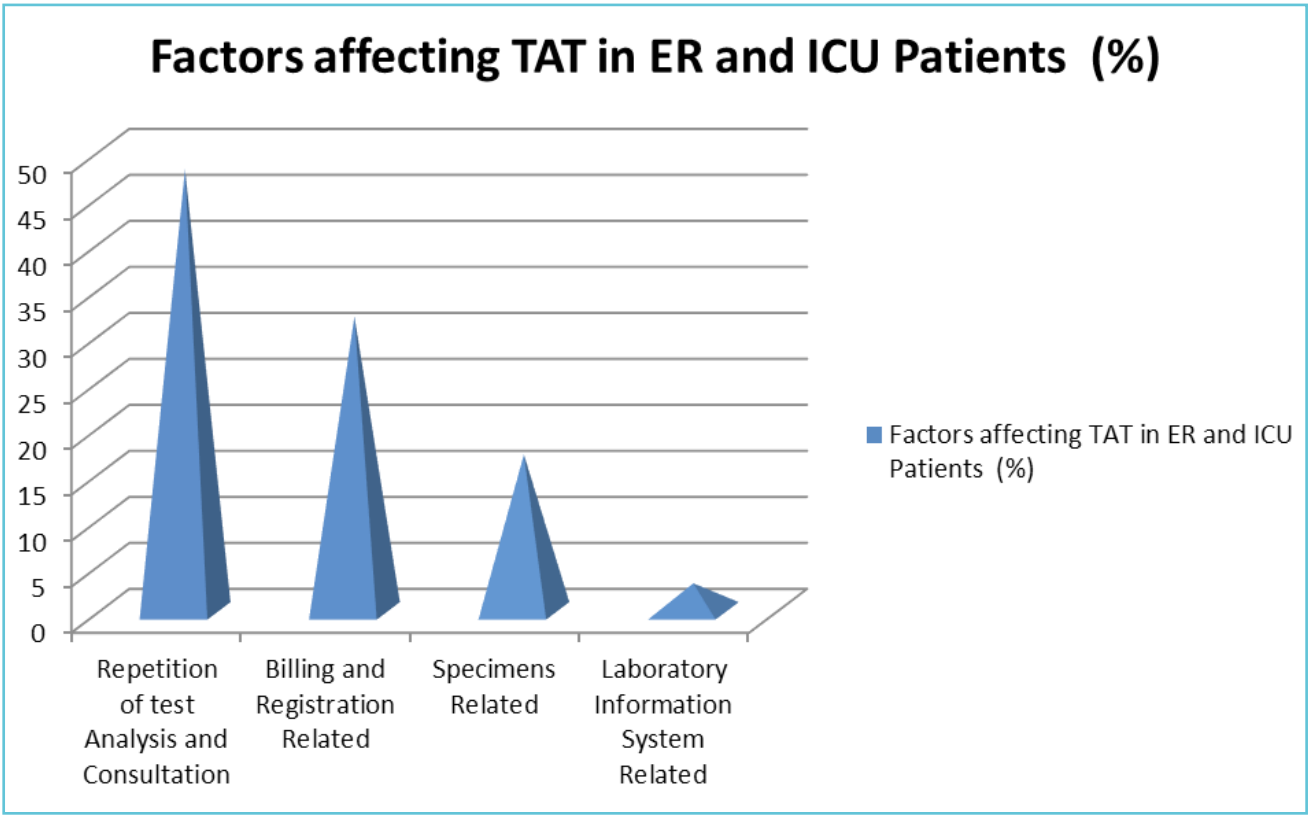
Table 2 clearly illustrates the number of samples from different departments in a particular time frame and their mean TAT. The frequency of long TAT is quite different among samples from ER/ICU and OPD/Indoors. Frequency of abnormal TAT for samples received from ER/ICU is five times higher than samples received from OPD and other indoor departments.

Bar graph in Figure 2 reflects that repetition of test analysis for reconfirmation and consultation

Table 1 Specific reasons and their frequencies for prolonged TAT

Factors	Specific reason	Number	Frequency (%)
Payment for Tests in Cash Unit	Payment Missing (Incomplete payment)	542	26.96
	Wrong payment (Not according to tests prescribed)	297	14.77
	Wrong registration (Paid in another patients account)	127	6.31
	Excess payment (Mostly double payment)	07	0.34
Tests Repetition	Critical value reconfirmation and consultation	494	24.57
Specimen related	Hemolyzed	210	10.44
	Insufficient	40	1.99
	Not Received	17	0.84
	Unlabelled	15	0.74
	Unsuitable Specimen/test	10	0.49
	Marked Lipemic	08	0.39
	Mislabelled	07	0.34
	Clotted	06	0.29
Reagents related	Out of Stock/Not Provided/Supplied	101	5.02
	Expired	20	0.99
Machine Breakdown	Random Breakdown	66	3.28
	Preventive Maintenance Schedule	23	1.14
Reporting Software Breakdown	Reporting System (Midas) Down	20	0.99
Total	-	**2010**	-

Figure 2 Factors affecting TAT in ER and ICU patients (%)



In the case of the laboratory reports of ER and ICU patients, the leading cause of TAT prolongation is the repetition of test analysis and consultation of the results.

Table 2 Number of samples from different departments and their average TAT

Departments	ER and ICU	OPD and Indoors
Total Number of Samples	2403	22241
Prolonged TAT Samples	881 (36.66%)	1553 (6.98%)
Average TAT of Total Samples	1 hour 3 minutes	1 hour 21 minutes
Average TAT of prolonged TAT samples	1 hour 45 minutes	4 hours 30 minutes

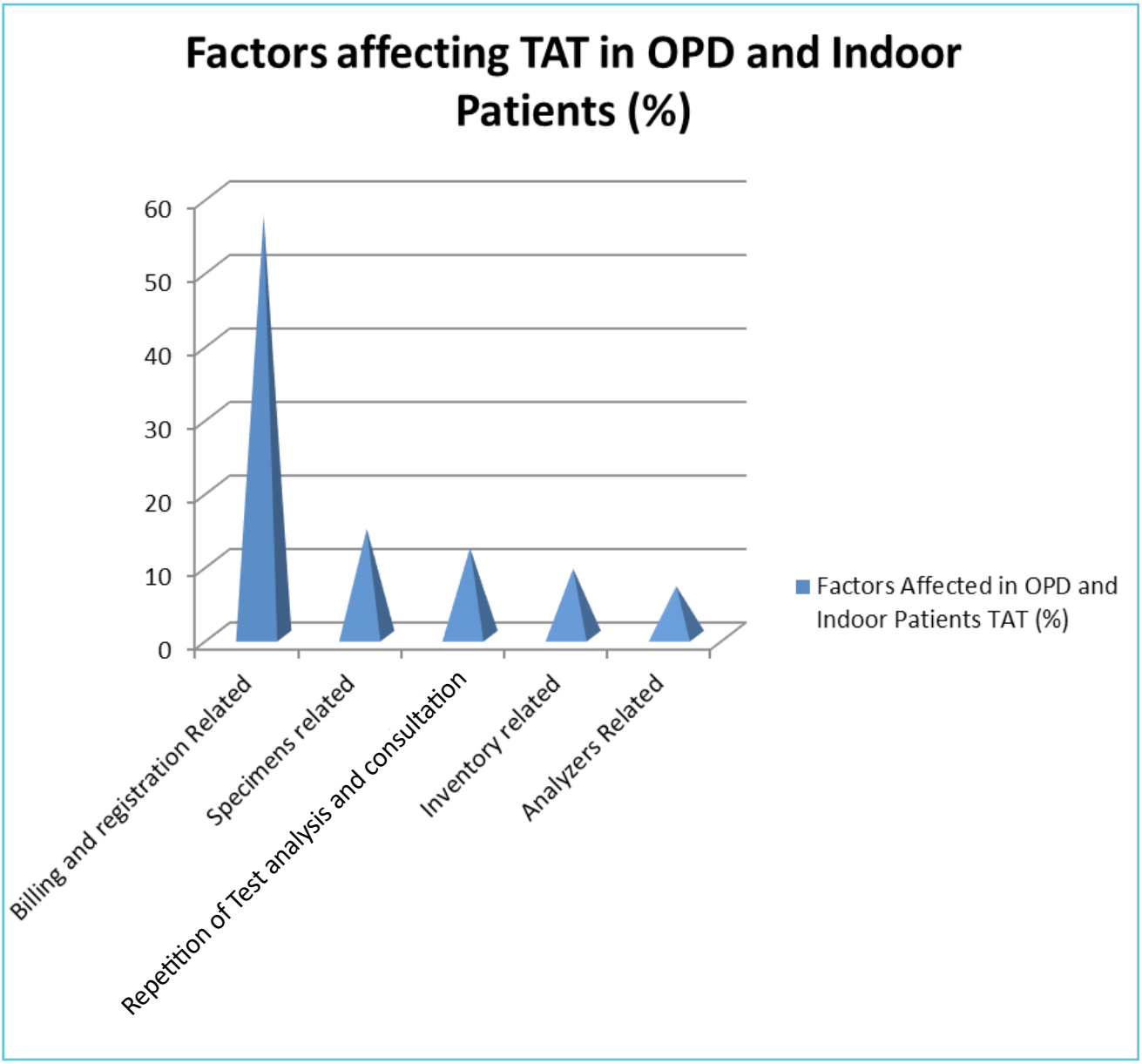
of observed value of samples received from ER/ICU is the most prominent factor covering around 45% for prolonged TAT. Factors related to billing and registrations are the second most important factors for delaying laboratory reports which is followed by specimen and laboratory information system related factors.

As shown in Figure 3, reports of tests requested from OPD and other wards had prolonged TAT due to different factors. Out of all five major factors for delayed reports, billing in cash unit is the highest, covering around 57%. Specimens related factors were the second highest, affecting nearly 15% of the delayed TAT.

When affecting factors for prolonged TAT were analyzed for individual departments, they varied according to types of services they provide. Such as the nature of service provided in emergency room (ER) and intensive care unit (ICU), where prompt action is needed and of course the laboratory reports must be delivered in time and must have less TAT than other departments like general wards and outpatients departments (OPD).

As shown in bar graph, 48% of reports requested from ER or ICU were delayed due to time wasted in reconfirmation of obtained critical values of test. Mostly reconfirmation was done by repeating the tests or informing laboratory consultant before releasing such reports. Payment related

Figure 3 **Factors affecting TAT in case of OPD and indoor patients**



In case of the laboratory reports of OPD and indoor patients, the TAT prolongation is mainly billing and registration related.

issues were found to be the second most significant factor (32%) for long TAT for tests ordered from ER and ICU followed by sample related issues like hemolysis, low volume, wrong sample etc. playing role in delaying reports of 17% patients.

In addition to the above-mentioned factors, transportation of the sample is also one of the factors affecting total TAT. Transportation time can be varied, which can be from specimen collection center to the laboratory or from other wards. It is not actually affecting laboratory TAT but it may affect the total TAT. Hence, it may lead to patients' prolonged stay in hospital and dissatisfaction, ultimately affecting hospital service. In general, average transportation time of collected specimens from the collection unit to the Department of Clinical Biochemistry Laboratory was found 24 minutes.

Analyzing factors responsible for prolonged TAT in ER and ICU, this study shows critical value reconfirmation and consultation time playing a major role for delay in predetermined TAT covering 48% of the total whereas billing and registration related issues were the next significant reason (32%) for the same. Sample related issues contributed around 17% to the total delay in TAT.

DISCUSSION

How punctually a hospital provides service to the patient is an important determinant of quality of that hospital. In this study samples along with their TRFs were analyzed to generate relevant information about the TAT. Statistical analysis was applied for samples taken from ER and ICU departments and OPD and indoor departments. The average TAT for the samples received from all departments was 1 hour and 19 minutes.

Specific analysis for individual departments showed average TAT for ER and ICU departments and OPD and indoor departments as 1 hour and 3 minutes and 1 hour and 21 minutes respectively. The study carried out by *F. Bilwani et al.* showed that only 2.03% of the stat samples had longer TAT than acceptable range [6] while our study suggested that for ER and ICU departments a total of 36.66% of all samples investigated showed prolonged TAT.

This variation in TAT was mainly due to the delayed entry of the time at which the report was generation. The laboratory technicians generally inform the ER and ICU department immediately via phone call and enter the data later when they are relatively free.

Tests requested from OPD and indoor departments showed nearly four times less prolonged TAT in comparison to emergency and ICU, and the ratio of samples showing TAT prolongation stood at 6.98%.

A study performed by *K. P. Chauhan et al.* suggested that percentage of specimens exceeding TAT in 2011 was 6.4% which decreased to 4.6% by year 2012 [14]. The slightly higher prolonged TAT in our case was due to the registration and billing issues, analyzer errors, inventory of reagent related issues and sample related issues along with reconfirmation and consultation time. In this study, among all factors involved for excessive TAT, preanalytical factors were responsible for nearly 75% of the delay whereas around 24% of the delay was due to analytical factors.

Similarly, a study done by *KN. Desai et al.* suggests that 74.2% of the samples were delayed due to preanalytical phase [7].

In contrast to this result, a study performed by *F. Bilwani et al.* emphasizes that most of the delays were due to analyzer error constituting 40% of the total specimens [6].

In our study analyzer error was responsible for only 6.83% of the TAT prolongation observed exclusively for OPD and indoor departments.

CONCLUSION

Achievement of quality service is not simply possible in hospital attached laboratories without finding the factors for prolonged TAT and immediate improvement of that area by hospital management. However, factors affecting TAT in clinical laboratories may vary from institute to institute depending upon institutional infrastructure, their own setup, policy, system and attributes of employees working in different departments of the hospital. In case of the Department of Clinical Biochemistry Laboratory of Dhulikhel Hospital-Kathmandu University Hospital, the major reasons for delay in laboratory reports were due to the time burnt out to fix the preanalytical errors created by other departments and cash unit alone was the major factor with highest degree of error in total testing process.

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