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Research Article

Turnaround Time in Clinical Chemistry Laboratory: A Hospital Based Study on Billing-to-Reporting and Collection-to-Reporting Times

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Abstract

Objective: The objective of the study was to determine the billing-to-reporting and collection-to-reporting turnaround times of clinical chemistry samples in a tertiary care teaching hospital laboratory.

Materials and Methods: It was a hospital based cross-sectional study conducted at the clinical chemistry section of Central Clinical Laboratory, College of Medical Sciences and Teaching Hospital, Bharatpur, Chitwan, Nepal, from September to November 2017. Billing, collection and reporting times for 1737 clinical chemistry samples were retrieved from the hospital laboratory information system to calculate the billing-to-reporting and collection-to-reporting turnaround times.

Results: Overall, the median (interquartile interval) billing-to-reporting time was 138.0 (96.0-182.0) minutes and collection-to-reporting time was 98.0 (77.0 - 136.0) minutes. These turnaround times were significantly lesser in the casualty and OPD samples as compared to the non-casualty and IPD samples, respectively; and highest in the surgical samples ($p < 0.001$). Additionally, the samples billed or collected during night shift were reported slowly was compared to those billed or collected during the morning shift ($p < 0.010$); the trend was consistent for casualty and non-casualty samples; OPD samples; and samples from different departments. Lastly, only 2.7% of the samples were reported within 60 minutes of billing, 42.8% within 120 minutes and 72.3% within 180 minutes; 10.9% of the samples were reported within 60 minutes of collection, 66.4% within 120 minutes and 91.2% within 180 minutes.

Conclusion: The analytical turnaround time and delay in the present study were appreciably greater than in many studies. To this end, further studies can be planned to determine the causes of such delays.

Keywords: Timeliness; Clinical Chemistry; Billing; Collection; Reporting; Turnaround Time

Abbreviations

IRC: Institutional Review Committee; TAT: Turnaround Time; OPD: Outpatient Department; IPD: Inpatient Department; LIS: Laboratory Information System; SPSS: Statistical Package for Social Sciences; ICU: Intensive Care Unit.

Introduction

Timeliness in the delivery of results is one of the fundamental mainstays of a competent clinical laboratory whose key goal is to deliver a better-quality service to its clienteles. This attribute can be monitored very efficiently by establishing a parameter, viz., turnaround time (TAT). In an ideal scenery, therapeutic TAT is defined as the time taken from requisition of diagnostic tests to the point until clinical decisions are made based on the test results. For practical purposes, laboratory TAT, the time from ordering of test to delivery of results, with its variants is commonly employed by the laboratories. Laboratory TAT, per se, can by fittingly grouped into pre-analytical, analytical and post-analytical TATs. Preanalytical TAT includes the time from test requisition and embraces the process of assemblage and transportation of the sample; analytical phage comprises the time taken to yield a result and the post-analytical phase contains the time from completing an analysis to reporting of the result [1,2].

Plethora of studies have reported diversified ranges of turnaround times overall and in different phases of the laboratory sample analysis. Median TATs for casualty samples have been found to vary from as low as 40 minutes to as high as 45 hours. For outpatient samples, studies have reported this time to range from 35 min to 5.5 hours [2-6]. In line with the international guidelines, Bilwani., *et al.* reported 60 minutes as the recommended threshold [7]. To this end, Chung., *et al.* observed 98% of the specimens being reported well within one hour, with the analytical phase contributing to about one-third of the overall TAT [8]. Goswami., *et al.* also reported the contribution of analytical phase as being only about one-fourth of the total TAT [4]. To add to these evidences, Mahdaviazad., *et al.* reported the analytical phase accounting for about $3/5^{th}$ of the overall TAT [3].

In light of this background, the present study was designed to determine the billing-to-reporting and collection-to-reporting times of samples received at the clinical chemistry laboratory of the hospital during a 12-hours-period from the midnight, including portions of night and morning shifts. Additionally, we compared the analytical delays (after deducing the inevitable delays in sample handing, processing and analyzing in the analyzers) for samples received from different departments and at different intervals of times.

Materials and Methods

It was a hospital-laboratory based cross-sectional study, conducted at the Department of Biochemistry in collaboration with the Clinical Chemistry Section, Central Clinical Laboratory, College of Medical Sciences and Teaching Hospital, a tertiary-care center. The total duration of the study was three months (September to November 2017). After procuring clearance from the Institution-

al Review Committee (IRC), the time points at which the samples were billed by the counter (billing-time); collected by the laboratory (collection-time) and results reported (reporting-time) for 1737 biochemistry samples were retrieved from the hospital laboratory information system (LIS) database. From these time points, billing-to-reporting time and collection-to-reporting time were calculated as the difference of reporting time with billing time and collection time respectively. Only those samples that were received by the laboratory from 12:00 AM to 12:00 noon (12 hours) were included in the study. Any samples with aberrant, ambiguous or erroneous billing, collection and/or reporting times were deemed ineligible for analysis.

Statistical Analysis

The collected data were entered using Microsoft Excel 2007 software. After preliminary cleaning, they were further entered and analyzed in Statistical Package for Social Science (SPSS) version 16.0. The categorical variables were tabulated as frequency and percentage; presented as bar graphs, as necessary and difference tested by Chi-Squared test. For continuous variables, normality of distribution was checked graphically and statistically. As the different calculated durations were found to be significantly different from normal distribution, they were expressed as median (interquartile intervals), and their difference tested by Mann Whitney test. Statistical significance was defined at 95% confidence intervals, as $p < 0.05$.

Results

Of the total samples received at the laboratory, a total of 1737 was considered for analysis, i.e., determination of two turnaround times (billing-to-reporting and collection-to-reporting times). During the night shift, i.e., from 12:00 Midnight to 6:00 AM in the morning, 886 (51.0%) samples were invoiced. Of these, 507 (29.2% of total samples; 32.75% of invoiced samples) were received in the laboratory and the results of only 159 (9.2% of total samples; 17.95% of invoiced samples; 31.36% of samples received) were reported. On the other hand, the laboratory in the morning shift (from 6:00 AM to 12:00 Noon) confronted a significant throughput, with the receipt of 1230 (70.8% of total) and reporting of 1578 (90.8% of total) samples (Figure 1).

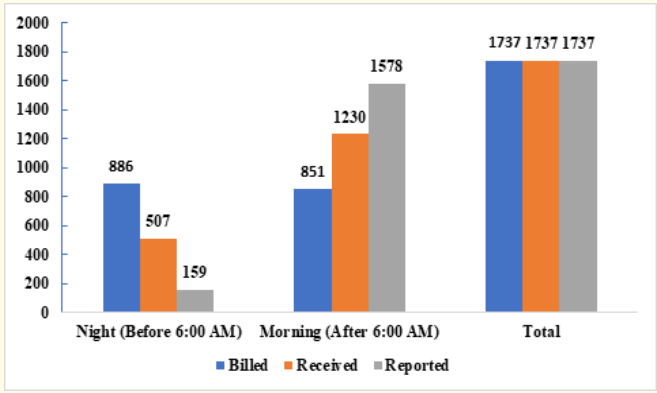

Figure 1: Distribution of the total samples as they were billed, received or reported during the night or morning shifts.

Overall, the median (interquartile interval) billing-to-reporting time was 138.0 (96.0 - 182.0) min and collection to reporting time was 98.0(77.0 - 136.0) min. Billing-to-reporting time for the casualty samples was significantly lesser than that for the non-casualty samples [113.0 (82.0 - 144.8) min vs 147.0 (99.0-186.0) min, $p < 0.001$]. Furthermore, it was significantly lesser in the OPD samples as compared to the IPD samples ($p < 0.001$); highest in the surgery, least in the miscellaneous, and intermediate in the medicine samples [medicine vs surgery ($p < 0.001$); medicine vs miscellaneous ($p < 0.001$) and surgery vs miscellaneous ($p < 0.001$)]. Similarly, collection-to-reporting time was also significantly lesser in the casualty than in the non-casualty samples [80.0 (54.8 - 104.0) min vs 102.0 (81.0 - 141.0) min), $p < 0.001$]. Again, it was significantly lesser in the OPD than in the IPD samples ($p < 0.001$); the highest in the surgery and least in the miscellaneous samples [medicine vs surgery ($p < 0.001$); medicine vs miscellaneous ($p < 0.001$); and surgery vs miscellaneous ($p < 0.001$)] (Table 1).

	Billing-to-Reporting Time			Collection-to-Reporting Time		
	Shifts (Sample-Billing)		Total	Shifts (Sample-Billing)		Total
	Night	Morning		Night	Morning	
Total Samples	142.0 (97.0-198.0)	130.0 (95.0-175.0)	138.0 (96.0-182.0)	99.0 (81.0-139.3)	97.0 (72.0-133.0)	98.0 (77.0-136.0)
Casualty	115.0 (82.0-152.0)	108.0 (76.0-138.0)	113.0 (82.0-144.8)	87.0 (75.0-129.0)	72.0 (50.0-104.0)	80.0 (54.8-104.0)
Non-Casualty	148.0 (99.0-202.0)	143.0 (99.0-179.0)	147.0 (99.0-186.0)	102.0 (83.0-141.0)	101.0 (77.0-141.5)	102.0 (81.0-141.0)
OPD/IPD						
OPD	99.0 (82.0-119.0)	96.0 (75.0-115.0)	97.0 (79.0-115.0)	87.0 (72.0-102.0)	84.0 (63.0-97.0)	85.0 (67.3-99.0)
IPD	181.0 (132.0-220.0)	162.0 (132.0-184.0)	171.0 (132.0-205.0)	114.0 (86.0-156.0)	128.0 (89.0-151.0)	119.0 (88.0-154.0)
Departments						
Medicine	153.0 (103.0-210.0)	141.0 (102.0-177.0)	150.0 (102.0-194.0)	103.0 (85.0-133.0)	101.0 (77.0-132.0)	102.0 (82.0-132.0)
Surgery	166.0 (91.0-201.0)	160.0 (102.0-191.0)	162.0 (99.0-191.0)	125.0 (81.0-156.0)	123.0 (89.0-172.0)	125.0 (84.0-157.0)
Miscellaneous	102.0 (93.0-127.0)	87.0 (75.0-179.0)	101.0 (79.0-132.0)	96.0 (75.8-105.8)	85.0 (63.0-150.0)	85.0 (65.0-114.0)

Table 1: Billing-to-Reporting and Collection-to-Reporting Turnaround Times for the total samples and those of different departments.

Billing-to-reporting time for the overall samples invoiced in the night shift was 142.0 (97.0 - 198.0) min against 130.0 (95.0 - 175.0) min for samples invoiced in the morning shift; the difference was statistically significant ($p < 0.001$); this trend was consistent in the casualty and non-casualty samples; OPD and IPD samples; and samples from different departments. However, the difference was statistically significant only in casualty ($p < 0.001$) and OPD samples ($p = 0.003$). Collection-to-reporting time for samples billed during the night shift was 99.0 (81.0 - 139.0) min against 97.0 (72.0 - 133.0) min for those billed during the morning shift; with a statistically significant difference ($p = 0.002$); the trend being consistent for casualty and non-casualty samples; OPD samples only; and samples from different departments. Notwithstanding, the difference was statistically significant in non-casualty ($p = 0.003$) samples and samples from medicine department ($p < 0.001$). Interestingly, this duration was significantly greater in the IPD samples invoiced during the morning shift ($p < 0.001$) (Table 1).

After billing, only 47 (2.7%) samples were reported within 60 minutes, 743 (42.8%) within 120 minutes and 1255 (72.3%) within 180 minutes. Similarly, after collection in the laboratory, 190 (10.9%) samples were reported within 60 minutes, 1153 (66.4%) within 120 minutes and 1584 (91.2%) within 180 minutes. Of the samples invoiced during the morning shift, 3.5% and 13.9% were reported within 60 minutes; 21.7% and 8.7% after 180 minutes of invoicing and collection respectively. Similarly, of the samples reported during the morning shift, 2.8% and 11.7% were reported within 60 minutes; 26.6% and 7.4% after 180 minutes of invoicing and collection respectively. Of the samples invoiced during the night shift, 1.9% and 8.1% were reported within 60 minutes; 33.5% and 8.9% after 180 minutes of invoicing and collection respectively. Similarly, of the samples reported during the morning shift, 1.9% and 3.8% were reported within 60 minutes; 39.0% and 22.6% after 180 minutes of invoicing and collection respectively (Table 2).

	Billed Samples (Shifts)		Total	Reported Samples (Shifts)		Total
	Night	Morning		Night	Morning	
Billing-to-Reporting Turnaround Time						
< 60 minutes	17 (36.2%)[a] (1.9%)[b]	30 (63.8%)[a] (3.5%)[b]	47 (2.7%)[b]	3 (6.4%)[a] (1.9%)[b]	44 (93.6%)[a] (2.8%)[b]	47 (2.7%)[b]
60 - 120 minutes	339 (48.7%)[a] (38.3%)[b]	357 (51.3%)[a] (42.0%)[b]	696 (40.1%)[b]	58 (8.3%)[a] (36.5%)[b]	638 (91.7%)[a] (40.4%)[b]	696 (40.1%)[b]
120 - 180 minutes	233 (45.5%)[a] (26.3%)[b]	279 (54.5%)[a] (32.8%)[b]	512 (29.5%)[b]	36 (7.0%)[a] (22.6%)[b]	476 (93.0%)[a] (30.2%)[b]	512 (29.5%)[b]
≥ 180 minutes	297 (61.6%)[a] (33.5%)[b]	185 (38.4%)[a] (21.7%)[b]	482 (27.7%)[b]	62 (12.9%)[a] (39.0%)[b]	420 (87.1%)[a] (26.6%)[b]	482 (27.7%)[b]
Total	886 (51.0%)[a]	851 (49.0%)[a]	1737	159 (9.2%)[a]	1578 (90.8%)[a]	1737
Collection-to-Reporting Turnaround Time						
< 60 minutes	72 (37.9%)[a] (8.1%)[b]	118 (62.1%)[a] (13.9%)[b]	190 (10.9%)[b]	6 (3.2%)[a] (3.8%)[b]	184 (96.8%)[a] (11.7%)[b]	190 (10.9%)[b]
60 - 120 minutes	510 (53.0%)[a] (57.6%)[b]	453 (47.0%)[a] (53.2%)[b]	963 (55.4%)[b]	85 (8.8%)[a] (53.5%)[b]	878 (91.2%)[a] (55.6%)[b]	963 (55.4%)[b]
120 - 180 minutes	225 (52.2%)[a] (25.4%)[b]	206 (47.8%)[a] (24.2%)[b]	431 (24.8%)[b]	32 (7.4%)[a] (20.1%)[b]	399 (92.6%)[a] (25.3%)[b]	431 (24.8%)[b]
≥ 180 minutes	79 (51.6%)[a] (8.9%)[b]	74 (48.4%)[a] (8.7%)[b]	153 (8.8%)[b]	36 (23.5%)[a] (22.6%)[b]	117 (76.5%)[a] (7.4%)[b]	153 (8.8%)[b]
Total	886 (51.0%)[a]	851 (49.0%)[b]	1737	159 (9.2%)[a]	1578 (90.8%)[a]	1737

Table 2: Distribution of the samples in different categories of Billing-to-Reporting and Collection-to-Reporting turnaround times according to the shifts during which the samples were billed or reported.

a: Distribution along the row ,b: Distribution along the column

Discussion

These days, clinical laboratories are under tremendous hassle with the relentless demands of the clinicians and the patient parties pertaining to the promptness in delivery of the test results. In this milieu, the real challenge for clinical biochemists lies in upholding a seamless balance between precision, reliability and the timeliness of the test results. Nonetheless, a common mindset of most of the laboratory professionals is to desperately focus on the analytical trivia of sample analysis without paying much due heed to the timeliness [4].

	Casualty Sample		Total	OPD/IPD		Total	Departments			Total
	Yes	No		OPD	IPD		Medicine	Surgery	Other	
Billing-to-Reporting Turnaround Time										
< 60 min	19 (40.4%)[a] (6.6%)[b]	28 (59.6%)[a] (1.9%)[b]	47 (2.7%)[b]	22 (78.6%)[a] (4.5%)[b]	6 (21.4%)[a] (0.6%)[b]	28 (1.9%)[b]	19 (67.9%)[a] (2.1%)[b]	4 (14.3%)[a] (1.1%)[b]	5 (17.9%)[a] (2.8%)[b]	28 (1.9%)[b]
60 - 120 min	142 (20.4%)[a] (49.7%)[b]	554 (79.6%)[a] (38.2%)[b]	696 (40.1%)[b]	353 (63.7%)[a] (72.9%)[b]	201 (36.3%)[a] (20.8%)[b]	554 (38.2%)[b]	327 (59.0%)[a] (36.5%)[b]	118 (21.3%)[a] (31.5%)[b]	109 (19.7%)[a] (60.2%)[b]	554 (38.2%)[b]
120 - 180 min	96 (18.8%)[a] (33.6%)[b]	416 (81.3%)[a] (28.7%)[b]	512 (29.5%)[b]	77 (18.5%)[a] (15.9%)[b]	339 (81.5%)$_a$ (35.1%)[b]	416 (28.7%)[b]	259 (62.3%)[a] (28.9%)[b]	113 (27.2%)[a] (30.1%)[b]	44 (10.6%)$_a$ (24.3%)[b]	416 (28.7%)[b]
≥ 180 min	29 (6.0%)[a] (10.1%)[b]	453 (94.0%)[a] (31.2%)[b]	482 (27.7%)[b]	32 (7.1%)[a] (6.6%)[b]	421 (92.9%)[a] (43.5%)[b]	453 (31.2%)[b]	290 (64.0%)[a] (32.4%)[b]	140 (30.9%)[a] (37.3%)[b]	23 (5.1%)[a] (12.7%)[b]	453 (31.2%)[b]
Total	286 (16.5%)[a]	1451 (83.5%)[a]	1737	484 (33.4%)[a]	967 (66.6%)[a]	1451	895 (61.7%)[a]	375 (25.8%)[a]	181 (12.5%)[a]	1451
Collection-to-Reporting Turnaround Time										
< 60 min	77 (40.5%)[a] (26.9%)[b]	113 (59.5%)[a] (7.8%)[b]	190 (10.9%)[b]	61 (54.0%)[a] (12.6%)[b]	52 (46.0%)[a] (5.4%)[b]	113 (7.8%)[b]	59 (52.2%)[a] (6.6%)[b]	33 (29.2%)[a] (8.8%)[b]	21 (18.6%)[a] (11.6%)[b]	113 (7.8%)[b]
60 - 120 min	164 (17.0%)[a] (57.3%)[b]	799 (83.0%)[a] (55.1%)[b]	963 (55.4%)[b]	364 (45.6%)[a] (75.2%)[b]	435 (54.4%)[a] (45.0%)[b]	799 (55.1%)[b]	531 (66.5%)[a] (59.3%)[b]	147 (18.4%)[a] (39.2%)[b]	121 (15.1%)[a] (66.9%)[b]	799 (55.1%)[b]
120 - 180 min	34 (7.9%)[a] (11.9%)[b]	397 (92.1%)[a] (27.4%)[b]	431 (24.8%)[b]	43 (10.8%)[a] (8.9%)[b]	354 (89.2%)[a] (36.6%)[b]	397 (27.4%)[b]	227 (57.2%)[a] (25.4%)[b]	138 (34.8%)[a] (36.8%)[b]	32 (8.1%)$_a$ (17.7%)[b]	397 (27.4%)[b]
≥ 180 min	11 (7.2%)[a] (3.8%)[b]	142 (92.8%)[a] (9.8%)[b]	153 (8.8%)[b]	16 (11.3%)[a] (3.3%)[b]	126 (88.7%)[a] (13.0%)[b]	142 (9.8%)[b]	78 (54.9%)[a] (8.7%)[b]	57 (40.1%)[a] (15.2%)[b]	7 (4.9%)[a] (3.9%)[b]	142 (9.8%)[b]
Total	286 (16.5%)[a]	1451 (83.5%)[b]	1737	484 (33.4%)[a]	967 (66.6%)[a]	1451	895 (61.7%)[a]	375 (25.8%)[a]	181 (12.5%)[a]	1451

Table 3: Distribution of the samples in different categories of Billing-to-Reporting and Collection-to-Reporting turnaround times according to the different departments as the sources of the samples.

a: Distribution along the row, b: Distribution along the column

Turnaround time (TAT), a proven benchmark of an efficient and apt laboratory service and yet often overlooked by most of the laboratories, embraces the time taken from the ordering of a test to the delivery of the results, or in an ideal scenario, up to the moment when clinical decisions are made based on the results. Laboratory turnaround time (TAT) has been defined in different contexts, i.e., whether a test is stat or routine, what type of analytes are being considered, etc. This important laboratory parameter is customarily determined in consort with the three sequential phases of sample analysis, i.e., pre-analytical, analytical and post-analytical phases [1,8,9].

There have been considerable variations in the way laboratories define TAT. For example, emergency department TAT, as highlighted in a 1998 College of American Pathologist Q-Probes Study, was defined differently by different laboratories; from sample receipt to result reporting (about 2/5th), from test ordering to result reporting (1/5th), from specimen collection to result reporting

(1/5th) [8]. To put the whole idea into better perspective, a phrase merits special mentioning, "total testing cycle." It designates TAT as a temporal confederation of various steps as test requisition, collection of samples, documentation, shipping, preparation of these samples before analysis, sample-analysis, reporting of the test results, clinical corroborations and necessary therapeutic decisions as made by the physicians [4,10].

In our study, the billing-to-reporting and collection-to-reporting times for different clinical chemistry samples from different departments, billed at the counter, collected at the central clinical laboratory and reported during the night and morning shifts were determined and compared.

In their study, Lee., *et al* [11]. obtained the median total turnaround time to be 55.0(45.0 - 69.0) min. Likewise, Mahdaviazad., *et al* [3]. found that the mean overall TAT varied between 1.3 - 3.1 hours. In the present study, the overall median billing-to-reporting time was 138.0(96.0-182.0) min and the collection-to-reporting time was 98.0 (77.0 - 136.0) min. Furthermore, a more elaborate results of Chung., *et al* [8]. demonstrate the average TAT of 43.6 ± 7.7 min for outpatient routine biochemistry samples, with 29.7 ± 6.9, 13.9 ± 4.1, and 0.02 ± 0.13 min as the preanalytical, analytical and postanalytical TATs respectively. To this end, as per our study, the billing-to-reporting and collection-to-reporting times in casualty samples were 113.0 (82.0 - 144.8) min and 80.0 (54.8-104.0) respectively. Similarly, for the non-casualty samples, they were 147.0 (99.0 - 186.0) and 102.0 (54.8 - 104.0) respectively. As evident from the results, these variants of TAT in our laboratory were considerably higher than reported in many other studies.

In a study by Wanker [12], out of the aggregate samples, 54.65% fell within the acceptable TAT of 60 min. Further, of the total overdue samples, 57.83% were reported within 90 min. Bilwani., et al. [7], in their study, found only 2.03% of the total samples being reported beyond the acceptable turnaround time. Further analysis of the excess TAT results revealed 45.3% samples were reported with the excess delay of more than one hour. The results of study done by Chung., *et al.* [8] showed that only 2.0% of the specimens were reported beyond 60 min. In contrast to the above studies, our study showed that only 2.7% of the samples were reported within 60 minutes of billing and 10.9%, within 60 minutes of collection in the laboratory. Moreover, 27.7% of the samples were reported after 180 minutes of billing; and 8.7% were reported after 180 minutes of collection.

Goswami., *et al.* [4] found the turnaround time for the OPD samples as 24 hrs and for IPD samples as 5.5 hrs; while it was 60 min for stat samples. In a separate study, Mahdaviazad., *et al.* [3] compared the mean TATs of samples between weekends and weekdays; morning and night shifts. The longest delay of 2.5 ± 0.9 hrs was found on Sundays and the shortest on Fridays (1.9 ± 0.7 hrs); the difference was statistically significant ($p < 0.001$). Moreover, it 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. One study found higher average TAT in the OPD samples (90 minutes) than the IPD (35 min) [2,3]. Likewise, many studies have shown this delay for the casualty samples ranging from 40 min to 45 hrs [3,4,6]. In our study, both the billing-to-reporting and collection-to-reporting times were significantly lesser in the casualty than non-casualty ($p < 0.001$) and in the OPD than in the IPD samples ($p < 0.001$). Further, both the durations were lesser in the samples invoiced during the morning than during the night shifts in overall, casualty, non-casualty, OPD and IPD samples. Some findings unique to our study are related to these TATs in samples from different departments. Both the durations were significantly higher in the samples from surgery than the medicine department ($p < 0.001$). For all departments, these TATs were greater in samples billed during the night shift than during the morning shift. Interestingly, the difference in collection-to-reporting times between samples invoiced during night and morning shifts was significant for medicine samples ($p < 0.001$). Additionally, this duration was significantly greater in the IPD sampled invoiced during the morning shift.

The present study had to put up with many limitations. Foremost, we analysed the TAT for only those samples received during the period of 12 hours, starting from midnight. Although they encompassed the significant portions of samples in night and morning shifts, those of other shifts (day-shift and evening-shift) were avoided.

Secondly, we calculated two rough TATs (billing-to-reporting and collection-to-reporting), without precisely the pre- and post-analytical TATs. Studies have shown the pre-analytical TAT to be the most significant contributor. Notwithstanding, post-analytical TAT is also equally vital. As reported by Mahdaviazad., *et al.* [3], the laboratory phase comprised of about 2/3rd of the TAT, a proportion significantly greater than the prelaboratory phase. Similarly, in the study of Goswami., *et al.* [4], the analytical phase accounted for only 1/4th of the total TAT. Additionally, Chung., *et al.* [8] reported that the deferrals in the preanalytical phase were largely liable for delay of 60 to 90 minutes in reporting the results.

Third, inpatient samples in our study were not categorized as ICU and ward samples, due to technical glitches in the software in laboratory information system (LIS). Turnaround time in ICU setting is equally important and can be a significant contributor to the prognostic likelihoods of the patients.

Lastly, as the present study was entirely dependent on the LIS database, we could not elicit the causes of abnormal delay in the analytical TAT. Roughly 2/5th of preanalytical and analytical delays are due to some sort of technical hitches [13] In a study by Bilwani., *et al.* [7], technical issues cited as the reasons for delay in TAT were machine malfunctioning, glitches in maintenance, and negligence of the technicians, apart from the often misjudged cause, viz., dearth of proficient staffs. To add to the list, problems in coping with the machines, reporting of anomalous results necessitating corroboration, mishaps in the laboratory and delays due to erroneously inputted data were also amongst the commonest reasons cited [7,14]. Among many factors affecting the TAT, size of the laboratory merits special attention. Evidence has it that laboratories in non-teaching hospitals and small institutions report the results more swiftly as compared to the teaching hospitals and larger institutions, respectively [7] Delays incurred during some undertakings of non-analytical phase, such as shipping and reporting are amongst the often overlooked causes of overshooting of laboratory TAT [8,15,16].

Various methods have been advocated by different studies to shorten the laboratory TAT [8,15,17-23]. Running an outpost laboratory and employing point-of-care chemistry test can appreciably curtail the TAT [8,22]. In one study by Kilgore., *et al.* [1], use of satellite laboratory culminated in reports being dispatched

significantly more swiftly ($p < 0.001$) than the central stat laboratory. Use of pneumatic tube system for collecting and transporting the samples can also considerably truncate the TAT [8,19]. Unforeseen adjournments inherent to manual shipping method can be adeptly trimmed by this contrivance [4,24,25]. Collecting the blood samples under standard conditions, marking the samples with bar-codes, and test request slips generated electronically can subside deferrals in preanalytical phase [4]. Similarly, analytical phase can be well-run by tactics such as thorough mechanization, high throughput machines, guaranteeing least interruption and sufficient backup, espousal of competent quality control measures. Speedy authentication of test reports, operational dissonance of work between the technicians and their timely trainings can indeed help tremendously [4,26-28]. Finally, timeliness in post-analytical phase can be improved by implementation of laboratory information system (LIS), and informing the concerned health care practitioners and departments about the critical values and preanalytical errors, at the earliest [4,29]. Such an approach for the pre-analytical errors help greatly assists in analysis of repeat samples without significant delay. This obviously calls for a transparent and operative communication system within the hospital [30].

Timeliness of results in the hospital laboratories has plethora of productive inklings in various vital premises of the healthcare management such as improved patient and clinician contentment, boosted patient outcomes, moderated expenses, and increased revenue [31]. Many evidences have pointedly indicated certain circumstances such as operation theaters and emergency departments, where timely test results have had substantial impact on the overall outcome [7,32]. The importance of the TAT cannot be emphasized enough when the apt scrutiny of this parameter can furnish valuable information, aiding in resolving the grounds of delay and enabling them to be rectified well in advance. On the other hand, overdue TAT can be counter-productive by unnecessarily swelling the analytic load of laboratory, e.g., by intensifying the incidence of facsimile samples [4].

Despite the limitations, the findings of the present study can certainly set a foundation for conducting further studies aimed specifically to elicit the causes of undue deferrals. These in turn, can be appropriately addressed to improve the overall aptness of the laboratory service delivery.

Conclusion

Overall, the median turnaround time as determined in our study was higher as compared to the findings of many studies. Nevertheless, casualty and OPD samples were reported more swiftly than the non-casualty and OPD samples, respectively. Furthermore, the samples billed or collected during the night shift were reported more slowly as compared to those invoiced or collected during the morning shift. In light of the above findings, further studies can be planned to exactly define the grounds for such disparities in the findings.

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Conflict of Interest

The authors declare no conflict of interest whatsoever.

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