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Research Article

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Total Laboratory Automation System in Clinical Biochemistry: Efficient Turnaround Time (TAT) with Prompt, Accurate, Quality Assured Reports for Sustainable Patient Care of Accident and Emergency Department-At a Tertiary Care Hospital

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Abstract

Objective: To compare and assess benefits of Total Laboratory Automation and its impact on Turnaround Time for Accident and Emergency Department requested chemistry and liver function profile tests.

Materials and Methods: It's an observational study based on efficiency of Total lab automation with integrated system of Cobas p471, p512, e801, c503 and p501 in clinical chemistry work flow and achievable targeted TAT of AED requested chemistry profile tests viz, urea, creatinine, electrolytes (tagged as Profile UCE), and Liver function tests (tagged as profile LFTs), on urgent basis, STAT. Target assigned TAT was within 40-45 minutes from receiving within Bio lab to report for selected fixed volume of 25 patient's samples with mentioned tests. Study period was 1st January 2023 to 30th November 2023 and compared with the data obtained in 2022 for same time period using Mann-Whitney U statistical analysis test with $P < 0.05$ as significant.

Results: Results are summarized in Figures 1 to 4. Comparative analysis of TAT years 2022 and 2023 (Jan to November) for AED routine chemistry profile, of Urea, Creatinine, Electrolytes (Cl, Na, K, HCO3) and that of liver function (Bilirubin, Alkaline Phosphatase, Aspartate aminotransferase, Alanine aminotransferase, gamma-glutamyl transpeptidase) tests analyzed on Total Lab automation system, manifested 25.41% improvement in UCE-TAT and 24.47% in LFTs-TAT, 2022 vs 2023 with Statistical significance difference of $P < 0.00004$ and $P < 0.00008$ respectively.

Conclusion: Present study manifested sustainability of effective and prompt TAT for AED chemistry profiles by utilizing TLA system and able to provide proficient and prompt reports within 45 minutes. Strategies such as dedicated trained staff, dedicated TLA instruments, and efficient standardized methods and policies were employed to have a sustainable turnaround time for timely medical decisions and treatments.

Short Title: Significance of Total Laboratory Automation in Clinical Biochemistry Lab

Keywords: Total Laboratory Automation (TLA), Turnaround Time (TAT), Liver function tests (LTFs), Chemistry Profile.

1. Introduction

Total Lab Automation (TLA) is considered to be one of the most important breakthroughs in the recent history of Laboratory diagnostics. Modern Laboratories, especially those associated with tertiary care Hospitals, all around the world, such as our Liaquat National Hospital, are adopting TLA workflow solutions. Moreover, swift turnaround time (TAT) is now regard as one of the best assessing tool of any clinical lab performance. For most of the patents reports, it should be reported within prescribed time period so that physicians can take medical decision without delay [1,2,3].

For Liaquat National Hospital laboratories, with the current strength of reporting 2.5 million parametric tests per year, Management has a vision of further modernizing clinical Laboratories. Henceforth, LNH has achieved another milestone by acquiring multi-work station Cobas Total Laboratory automation system, p471, p512, e801, c503 and p501, which not only further strengthens efficient and reliable lab results but also provides clinical data for evidence-based management.

Our TLA has capabilities of automated early inspection of the samples, quality check, centrifugation & sorting for multi-unit distribution with a throughput of 1400 samples, wide variety of around 200 cumulative tests assays on either of immunochemistry and clinical chemistry units and integrated Post Analytical unit with storage & archiving capacity of around 13500 samples, and therefore capable of performing several tasks simultaneously and efficiently with precision, standardization, and technical consistency thereby reducing the reporting time, ensuring customer/patient satisfaction and long-term trust. Our AED department is very busy and caters around 150 to 200 patients per day. Average parametric data of tests profile of UCE and LFTs reported to AED is average 23,600 per month, as of 2023, sum up to around 259,000 till 30th November 2023. Total parametric reports (e.g. UCE, LFTs, Cardiac markers, Ions, Bone, iron, muscle, and metabolic profiles) were 421,200.

Present study described the comparison and assessment of benefits of Total Laboratory Automation and its impact on Turnaround Time for Accident and Emergency Department requested chemistry and liver function profile tests.

2. Materials and Methods

It's an observational study based on Total lab automation with integrated system of Cobas p471, p512, e801, c503 and p501 in clinical chemistry work flow and effectiveness of targeted TAT of AED requested chemistry profile tests viz, urea, creatinine, electrolytes (tagged as Profile UCE), and Liver function tests (tagged as profile LFTs), on urgent basis, STAT. Target assigned TAT was within 40-45 minutes from receiving within Bio lab to report for selected fixed volume of 25 samples per day. Average flow is 75 to 100 samples in morning shift from AED for mentioned profile. To sustain the target of within 40-45 minutes reporting, workflow on TLA with dual bar code reader, dedicated chemistry analyzers TLA Cobas c503, standardized methods reported earlier [1,2,3], trained technical staff analysis and Infinity® integrated lab reporting system were prescribed as the operational policies. Study period was 1st January 2023 to 30th November 2023, data recorded in Timeliness (minutes) and presented as line chart of mean of 25 samples for both UCE and LFTs. Present data of 2023 was also compared to data obtained in 2022 for same time period using Mann-Whitney U statistical analysis test with $P < 0.05$ as significant.

3. Results

Results are summarized in Figures 1 to 4 and Table 1. Comparative analysis of TAT years 2022 and 2023 (Jan to November) for AED routine chemistry profile, of Urea, Creatinine, Electrolytes (Cl, Na, K, HCO3) and that of liver function (Bilirubin, Alkaline Phosphatase, Aspartate aminotransferase, Alanine aminotransferase, gamma-glutamyl transpeptidase) tests analyzed on Total Lab automation system, manifested 25.41% improvement in UCE-TAT, 2022 (Fig 1) vs 2023 (Fig 2) with Statistical significance difference of $P < 0.00004$ (Z score 3.9199, time line of 54.73 ±1.272 minutes down to 40.82 ±1.72 minutes) whereas that of LFTs-TAT, 24.47% improvement with statistical significance of $P < 0.00008$ (Z score 3.9399, timeline of 41.64 ± 1.02 minutes in 2022, Fig 3, down to 31.45 ± 0.93 minutes in 2023, Fig 4). Performing STAT chemistry profiles on TLA modular system for ICUs, CCUs, HDUs, AED, Paediatrics and Stroke showed effective pre-analytical, intra-analytical and post-analytical efficiency, proficiency, accuracy with dedicated staff performance.

Table 1: Percentage (%) improvement and comparative statistical analyses of TAT 2022 vs 2023 regarding UCE and LFTs profile for Accident and Emergency department

Clinical Biochemistry Parameters for AED	2022	2023	% improvement in TAT	P < 0.05
UCE	54.73 ±1.272 min	40.82 ±1.72 min	25.41%	P < 0.00004
LFT	41.64 ± 1.02 min	31.45 ± 0.93 min	24.47%	P < 0.00008

min = minutes; 2022-mean of 11 months TAT compared with mean of 11 months TAT 2023 UCE, LFT

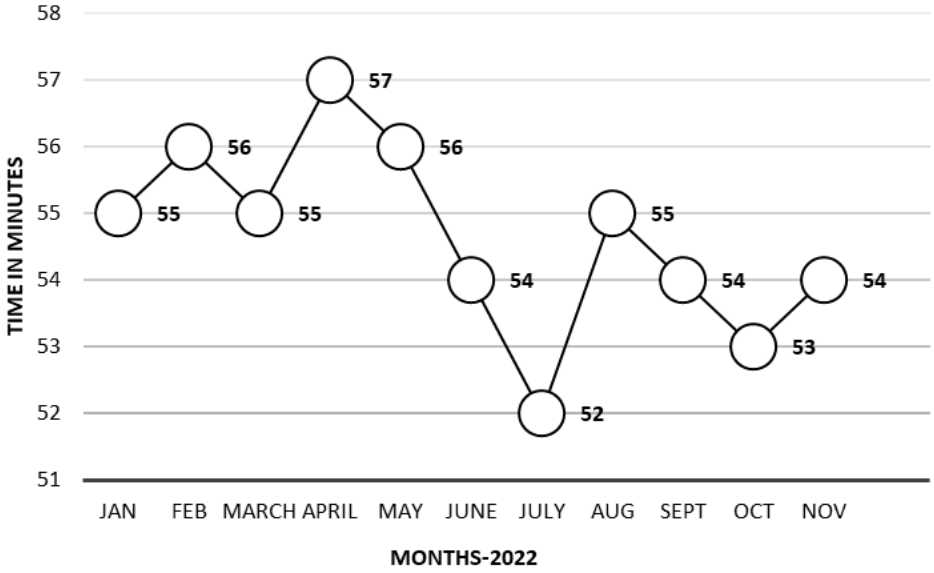

Figure 1: TAT for UCE profile of AED

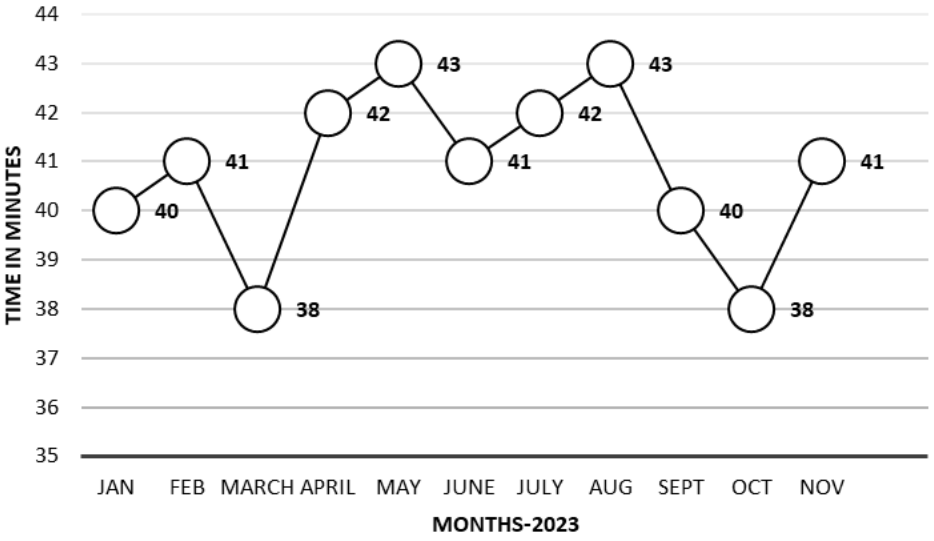

Figure 2: TAT for UCE Profile of AED

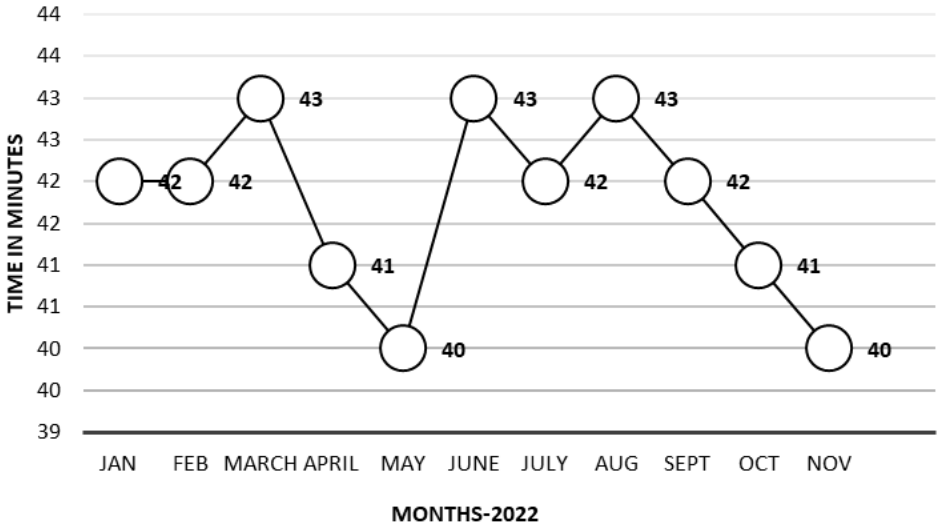

Figure 3: TAT for LTFs Profile of AED

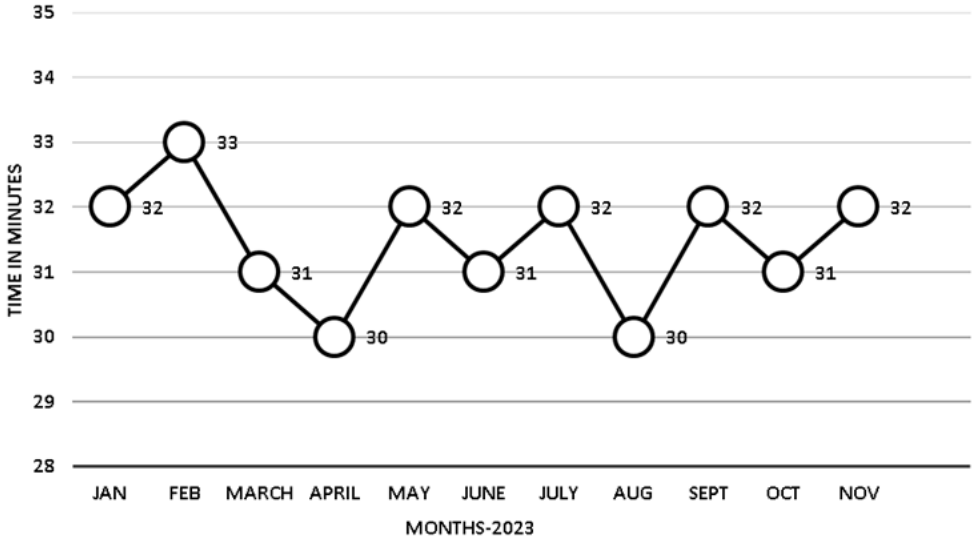

Figure 4: TAT for LTFs Profile of AED

4. Discussion

It is well known fact that TAT is directly correlated with patient wellbeing, on time, swift and prompt especially in case of patients in AED. Having efficient, standardized, advanced TLA system, such as presented here, facilitates the achieving goals of improving TAT. Patients required their lab profile tests within shortest period of time, mostly between 30 minutes to 60 minutes: the tests which are related to organ functions, metabolic components and/or pathophysiology such as indicated in our current study, as Urea Creatinine, electrolytes and LFTs. We were and still, with the support of most advanced TLA system, providing AED chemistry profile within 60 minutes time, and improved by 24% on average down to within 45 minutes, thus facilitating AED physicians to take medical decisions swiftly, promptly and without any delays. Present study, in this regard, manifested sustainability of effective and prompt TAT for AED chemistry profiles by utilizing TLA system and able to provide proficient and prompt reports within 45 minutes. Strategies such as dedicated trained staff, dedicated TLA instruments, and efficient standardized methods and policies were employed to have a sustainable turnaround time for timely medical decisions and treatments.

5. Conclusion

Present study manifested sustainability of effective and prompt TAT for AED chemistry profiles by utilizing TLA system and able to provide proficient and prompt reports within 45 minutes. Strategies such as dedicated trained staff, dedicated TLA instruments, and efficient standardized methods and policies were employed to have a sustainable turnaround time for timely medical decisions and treatments.

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