Journal of Advances in Medicine and Medical Research

34(22): 91-99, 2022; Article no.JAMMR.91944
ISSN: 2456-8899
(Past name: British Journal of Medicine and Medical Research, Past ISSN: 2231-0614, NLM ID: 101570965)

Can Turn around Time Compliance in Hospital Laboratories be Set to Auto Pilot Mode? – A 2 Years' Experience

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Authors' contributions

This work was carried out in collaboration among all authors. Author CY researched the literature. Author AKH conceived the study and designed the experiment. Author VK worked on the data extraction from hospital server. Author AKH did the data analysis. Author CY jointly developed the structure and wrote the manuscript. All authors reviewed, edited and approved the final version of the manuscript.

Article Information

DOI: 10.9734/JAMMR/2022/v34i2231582

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/91944

Original Research Article

Received 09 July 2022
Accepted 14 September 2022
Published 19 September 2022

ABSTRACT

Background: A short Turn Around Time (TAT) is unanimously desired and equated to efficiency of a hospital laboratory. Despite automation, laboratories often find it difficult to meet the TAT demands. The major lacuna noticed was that our technicians did not know exactly when a sample was likely to exceed the TAT limit.
Methods: This prospective study was done to develop display screens giving real time information to the working staff and to assess their impact on the TAT compliance. Real time information on daily TAT status, color coded list of pending samples and technician's daily performance were displayed as screens and graphs using aspx/PHP script and data extracted from hospital database. The TAT outliers data was then compared before, during and after the study.
Results: The project was initiated in November 2017 and the modules were implemented by December 2018. The TAT compliance of urgent samples significantly improved from 80-85% in Oct-Dec 2017 to 90-95% in Jan-Mar 2018. After the implementation of the screens, more than 90%

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of urgent and routine samples were released within 105 and 180 minutes of receiving respectively. The corresponding figures before this study were > 120 minutes and 300 minutes for urgent and routine samples respectively.

Conclusion: By providing the staff actionable information, on a real time basis, we were able to achieve a high TAT compliance. As this was achieved by only displaying relevant information and not by policing, judicious use of technology can help laboratories achieve TAT targets on an auto-pilot mode.

Keywords: Turnaround time; workforce management; information; technology.

1. INTRODUCTION

Turnaround Time (TAT) is the most commonly talked word when it comes to the working of a clinical laboratory. For the laboratory staff, TAT indicates the efficiency of work flow process. For patients, it is important because availability of reports is the end point of patient-lab contract. It also helps the person to plan the next course of action including fixing up an appointment with a consultant. For the clinicians it marks the timeframe when they can expect results and plan the management of his patients. [1-3] TAT compliance is also used as one of the two yardsticks by the Hospital Management to evaluate the efficiency of the laboratory services [4] the other being the External Quality Assurance compliance.

Advances in the field of diagnostics and therapeutics coupled with surge in population have placed huge technical and financial demands on healthcare systems worldwide, laboratories being no exception to this increase in workload. [5-7] To compensate, organizations are leaning more towards automation rather than increasing the work-force. [1,8] Although very costly, Total Laboratory Automation (TLA) has contributed its bit in improving TAT with ample literature evidence suggesting the benefits of pneumatic tubes for sample transport, conveyer belt system for delivery, bar code scanners, auto-verification of reports etc. [2,5,9-11] However, despite automation, laboratories often find it difficult to meet the TAT demands[1,11] .

Despite having full end to end automation, the TAT compliance of our laboratory was poor, ranging from 60-70%. Hence, a thorough analysis was done and opportunities for improvement were identified. The key issue identified was lack of adequate information of the sample as to when it was likely to go out of TAT compliance or when the results were ready. With the help of the Information Technology (I.T.) Department of the hospital, we devised screens that would provide vital information to the laboratory technicians on sample processing. The present study was taken up to analyse the impact of these screens on the TAT compliance of our laboratory over a period of 2 years.

2. METHODS

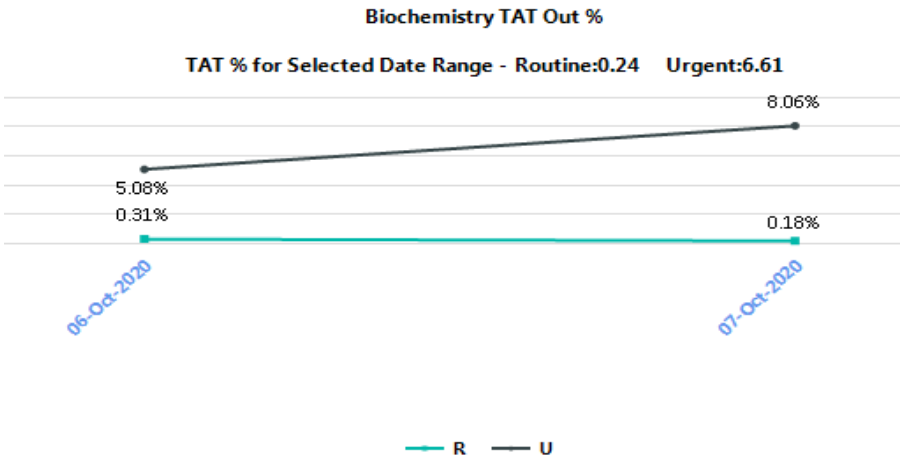
This was a prospective study conducted in the Department of Laboratory Medicine at Medanta Super-specialty Hospital over a period of 2 years. The hospital laboratory caters to approximately 3000 OPD, IPD and emergency samples daily; TAT for all of these were included for the purpose of this study. As all the laboratory processes are time stamped and the data is readily available on the Hospital Information System (HIS), it was possible to extract this data and display it in a real-time format. Help of the I.T. department of the hospital was sought to develop these screens for display of necessary information to the laboratory staff regarding the sample processing and TAT status. These were developed in aspx/PHP language after connecting with the SQL database of the hospital. The screens developed included:

a) Display of dynamic TAT status for each day: A screen was developed where Real Time compliance was shown. The TAT compliance failure of routine samples (green) and urgent samples (black) were displayed separately (Fig. 1).

The screen had an option of selecting the time frame for which TAT compliance failure was needed to be seen. Using this option, a summary of the week's TAT compliance (Fig. 2) was generated every Monday and discussed with the Laboratory Staff in a formal meeting. Reasons for failure were identified and corrective actions were instituted.

b) Sample processing status: As soon as a result was generated in an analyser, the information was available to the hospital LIS. This information was then displayed in a table

indicating the sample numbers which were in process; and the ones for which the results were ready so that the technicians could validate it and release the report for consultant verification. (Fig. 3) The sample ID's were arranged in the ascending order as per the receiving time of samples.



Black dot/line: Date-wise percentage of TAT outliers in case of urgent samples; Green dot/line: Date-wise percentage of TAT outliers in case of routine samples

Fig. 1. Daily TAT compliance monitoring in biochemistry laboratory

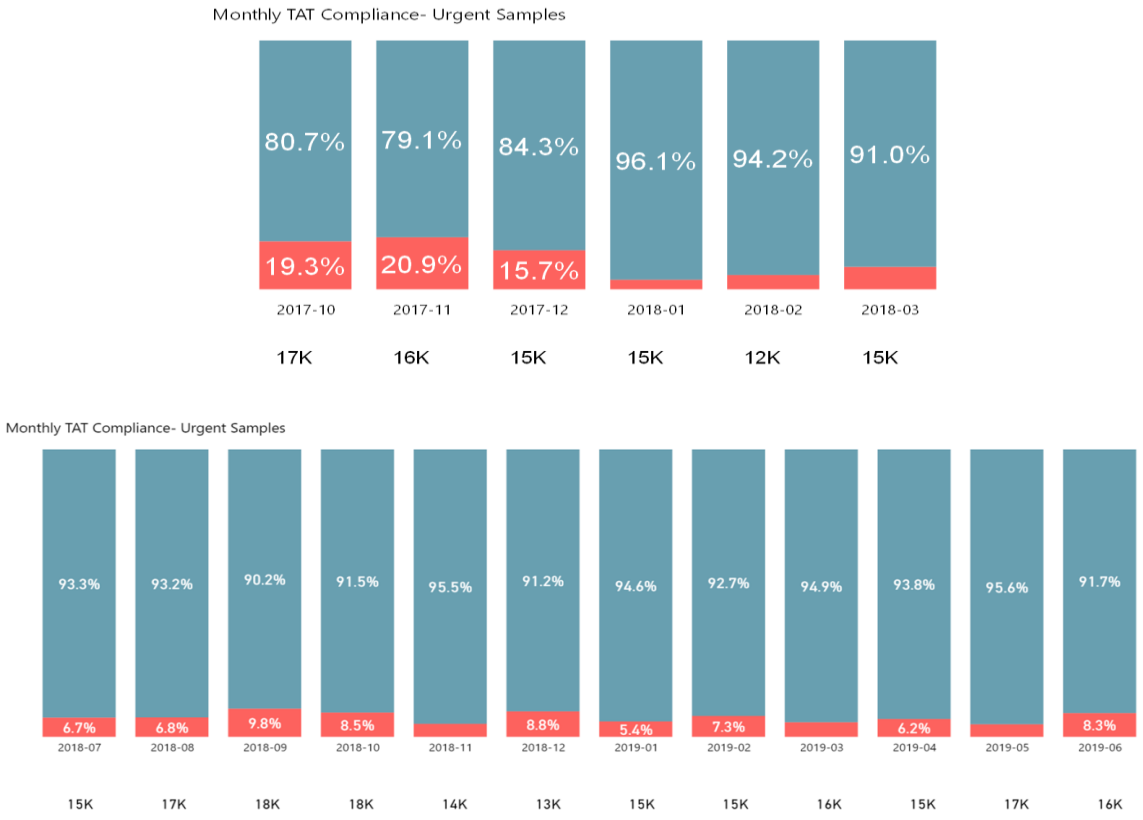


Fig. 2. Impact of implementation of screens on TAT compliance

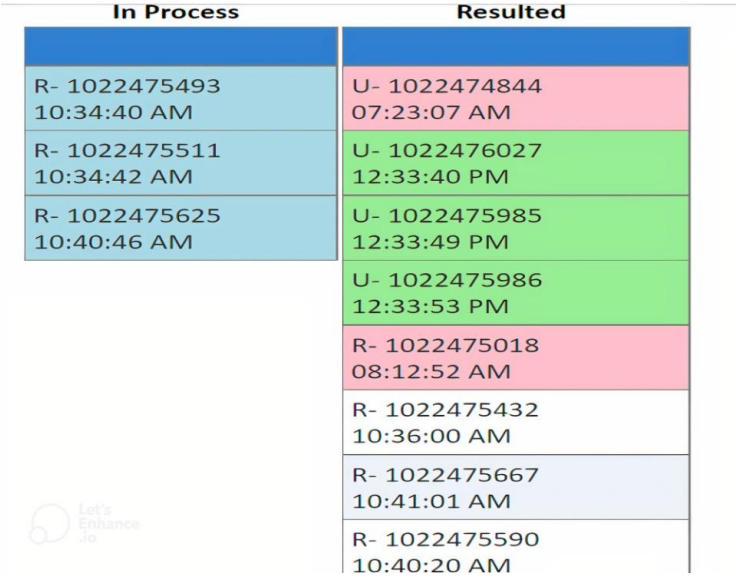


Fig. 3. Screen displaying sample processing status

All urgent samples were displayed first followed by routine samples. A three colour coding system was used to prioritize further as shown in Table 1.

Table 1. Colour coding used for demonstrating sample ID

Nature of sample	Time (current time – sample registration time)	Colour code
Urgent	< 80 min.	Green
	81 – 100 min.	White
	> 100 min.	Red
Routine	< 3 hours	Green
	3 – 4 hours	White
	4 hours and more	Red

c) Pending samples: A sample which had been registered in the Laboratory but for which result was not generated in a reasonable time (within 80 minutes of sample registration for urgent and within 2 hours for routine samples) was considered as "pending" and needed to be highlighted separately. These were those samples which usually had some issue with routine processing and proactive intervention was required. The time frames were selected in such a way that the samples could be traced, tested and report released within the TAT limits.

d) Work done by each individual staff in sample processing: A graphical representation of the number of sample reports a technician released into the LIS was made and displayed concurrently with the TAT graph (Fig. 6). This was done with the intention of improving transparency of work output of all the technicians.

3. RESULTS

The project was initiated in November 2017. After a detailed discussion with the I.T. department on our requirements, and a few subsequent meetings and fine tuning, all the modules were rolled out and implemented by December 2017. Daily TAT monitoring screen is shown in Fig. 1. The weekly TAT outliers can be seen from the graph in Fig. 2. The sample processing status reflecting on the pending samples is shown in Fig. 3. The laboratory technicians were educated on how to use these screens effectively. They were encouraged to regularly monitor the TAT graph and list of pending samples and take actions accordingly.

The impact of implementing the screens can be seen from Fig. 4. There was a significant improvement in the TAT compliance of urgent samples from around 80-85% in the months of Oct-Dec 2017 to 90-95% in Jan-Mar 2018 which has consistently been above 90% throughout the year.

The comparison of TAT compliance failure can be better analysed from the weekly graph of TAT outliers as shown in Fig. 2. The first graph shows the TAT compliance failure of around 28% for urgent samples and around 4% for routine in the month of March 2017. The second graph (around the same time period two years later) shows TAT outliers for urgent samples were around 4% and that of routine samples around 1%. This significant improvement in the TAT compliance (to the tune of 10 times) has been consistent over the past two and half years. The spike of 12% on 10th Mar 2020 as seen in the second graph was the point of discussion in the weekly review meeting. If there was a reason, it was addressed. If no reason was identifiable, then just highlighting the issue had impact on the TAT in the remaining days of the week.

Fig. 3 shows dynamic data on the status of samples received in the lab. The sample ID in the right column indicates samples which are pending as per the definition already mentioned. These samples were proactively searched, problems with processing identified and rectified so that TAT compliance could be achieved. A technician was earmarked for this job. This can be appreciated from the histogram of the time taken for release of samples (Fig. 5). After the implementation of the screens (2019 graph in (Fig. 5), more than 90% of the Urgent samples were released within 105 minutes of receiving the sample. For routine samples more than 90% of the samples were released within 180 minutes. This corresponding figures for urgent and routine samples before implementation of the screen was > 120 minutes and 300 minutes respectively (2017 graph in Fig. 5). It is apparent from the above data that display of the screen brought about a focused effort on release of samples and an improvement of TAT of samples as well as TAT compliance.

With a view to improve transparency and ensure uniform distribution of laboratory work, a work output graph was developed which displayed the number of samples a technician released into the LIS on a daily basis (Fig. 6). Visual display of this information in itself induced cultural changes in work ethics of the staff.

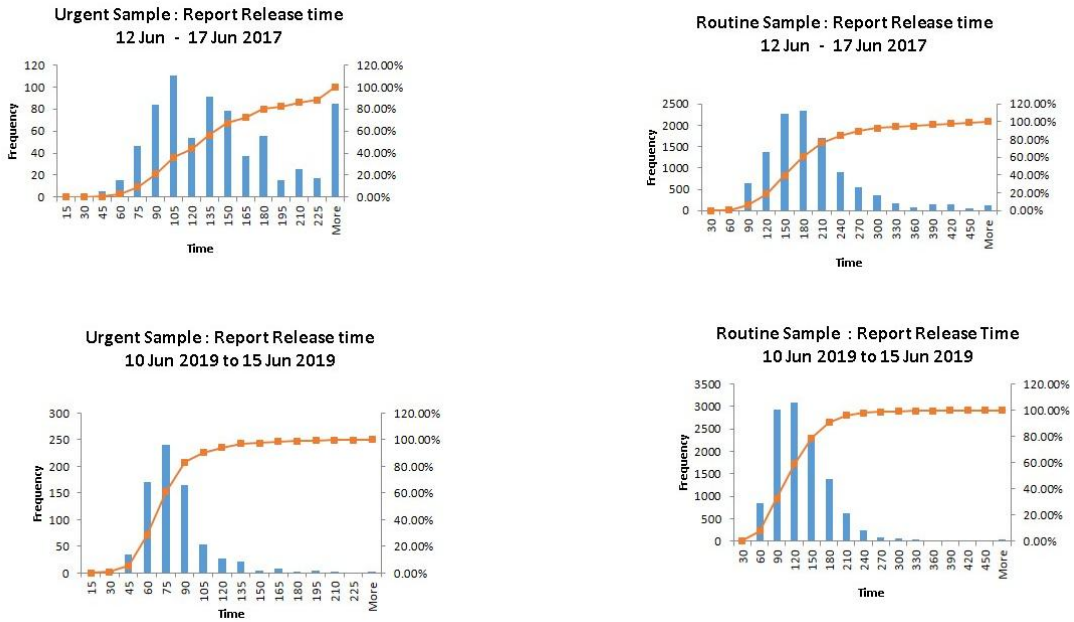


Fig. 4. Histogram analysis of TAT improvement

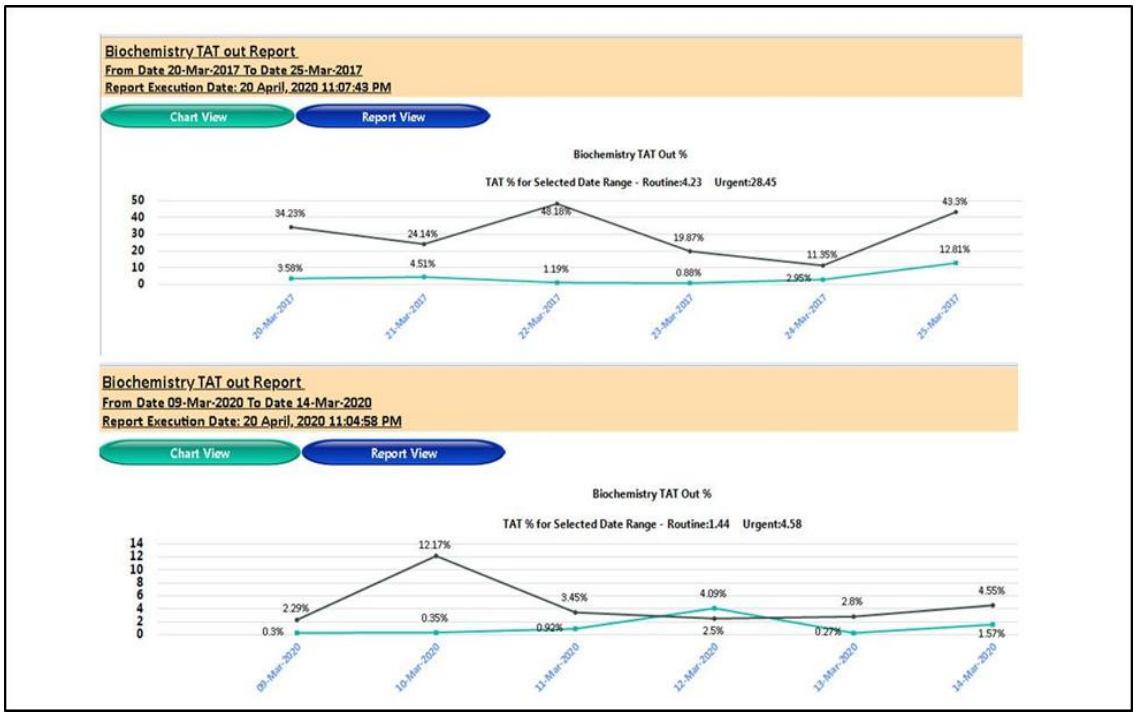


Fig. 5. Comparison of weekly "out of TAT" data in March 2017 and March 2020

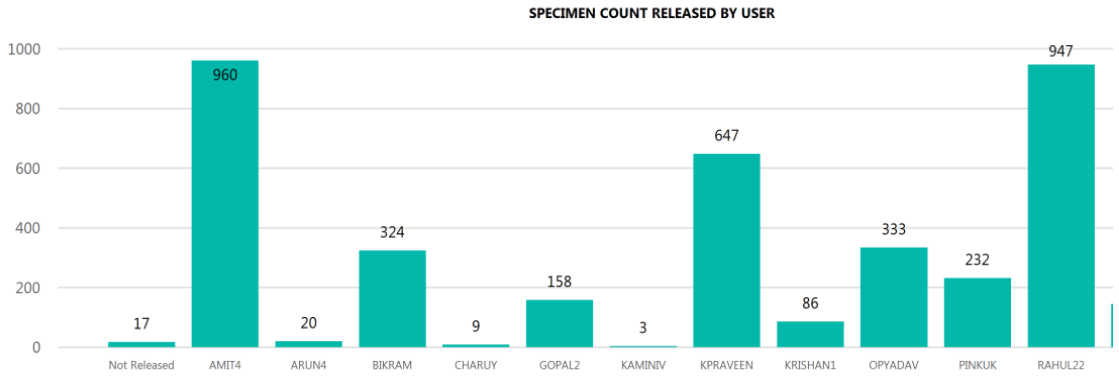


Fig. 6. Technician workload graph

4. DISCUSSION

TAT is an important word when it comes to laboratory services. Although different stakeholders hold different importance for this word yet the common unifying feature to all is expectation of keeping TAT to as low as possible. Automation has always been put up as a tool for improving the TAT. [4,6,8] Failure to have a good TAT compliance even with automation is usually perceived an inefficient work staff [1].

This project was undertaken to see if it was the personnel or processes that contributed significantly to poor TAT compliance. On the back drop of full end to end automation, a poor TAT compliance in our lab served as an ideal situation for evaluating this question.

By showing the TAT in real time [12-14], we observed a significant improvement in the TAT compliance (Figs. 2,4,5). A similar improvement by utilising dynamic monitoring was also reported by Lou et al[5] and Angeletti et al[7].

The fact that all laboratory processes are time-stamped in TLA, it makes it convenient for the management to identify gaps in performance and make people accountable for it. [7,12] We used

the same information to identify our lacunae and used it as a leverage to improve our performance. The major lacuna that we found was that our technicians did not have any information regarding when the sample was likely to exceed the TAT limit. This resulted in them releasing a lot of results which had a long TAT while missing out on the priority samples.

After the display screens were provided, the technicians were encouraged to release the reports of "urgent" samples as soon as the results are generated, irrespective of the time of receiving the sample in the lab. Visual display of pending samples with colour coding brought about the required transparency ensuring that the technician earmarked for this could proactively work on these samples (Fig. 3). The colour codes were defined in such a way that they had enough time to react and ensure that TAT compliance was ensured at all times [Table 1]. Similar activity was shown to yield beneficial result by Shilpasree et al. [1] and Gupta et al. [4] in their studies on TAT compliance. Colour coding strategy for urgent samples was also experimented successfully by Novis et al. [15].

By simply making the staff aware of the adverse trend in the TAT compliance and their daily performance, spontaneous introspection and auto-correction was done by them without requirement of supervision. This was reflected well in the histogram showing the time taken to release the reports (Fig. 5). For example, when it was observed that there was a significant deterioration in TAT compliance during the lunch and coffee breaks, the staff automatically started staggering their time for taking breaks. And as this was done spontaneously from their side, no policing was required.

In addition, a closer monitoring of the pending samples also highlighted critical issues which were subsequently dealt with. The most frequent being the pre-analytical factors [2,16] like hemolysed samples for which repeat were requested, inadequate samples etc which was then communicated with the nursing staff for remedial action. If delay was found to be on account of equipment failure, the same was escalated to the manufacturers for corrective action.

A feature evident in our results was that our overall TAT compliance was around the 93-94% range and not near the desired 100% (Figs. 2,4). The module evaluating the TAT took into consideration the nature of the sample (routine or urgent), the time that the sample was received in the laboratory and the time in which the results were released. Inherent sample processing issues [7,17] like when a repeat sample was required or when a test needed to be run in dilution or the fact that some non urgent tests had longer incubation time being sent as urgent etc. were not considered and were inadvertently reflected as TAT compliance failure. Considering the above limitations, we felt that the maximum TAT compliance that we would be able to achieve was around 95% and this had been conveyed to the management in review meetings. Our data suggests that we were very close to our target.

The laboratory processes are now very streamlined ensuring TAT compliance consistently. And this was done spontaneously, without the requirement of moral policing. Human contribution in corrective action application, awareness and training of technicians, psychological adaptation were also suggested as useful strategies by authors like Angeletti et al. [7], Chien et al. [18] and White et al. [19] in their studies on TAT improvement. However we feel that that, by nature, every person would like to finish the task assigned to him at the earliest and as efficiently as possible. And if real time actionable information is provided to the staff, high TAT compliance can be effortlessly achieved. We have data to suggest that TAT compliance can actually be set to Auto Pilot mode.

5. CONCLUSION AND CLINICAL IMPLICATION

Advances in the field of healthcare have placed huge workload on the hospital laboratories where the keyword "TAT" holds utmost priority. This study thoroughly analysed the lacuna of poor TAT compliance despite total laboratory automation. Identification and catering to the key issue like lack of real-time information remarkably streamlined the functioning of lab. Visual display of pending samples brought about the required transparency. Our results proved that by making information display screens of pending samples and providing the staff actionable information, on a real time basis and in an easily understandable format, we were able to achieve a high TAT compliance without the requirement of policing. This study postulate the use of information and technology and human contribution in corrective action application in

improving TAT. This improvement has directly and indirectly benefitted all the four stake holders; the Laboratory, the Clinicians, the Patient and the Management.

CONSENT TO PARTICIPATE

It is not applicable.

ETHICAL APPROVAL

The study does not involve any experiment on samples or patients. It is a data based study; the data is freely available on the lab server and the same was obtained with the prior permission of the Head of Department and the Director of the Laboratory.

ACKNOWLEDGEMENTS

We would like to thank the Information Technology (I.T.) department of Medanta Hospital for their technical expertise and support rendered for the conduction of this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/91944