Internship Training

at

KareXpert Technologies Pvt Ltd

(1st Feb to 30th April 2022)

ASSESSMENT OF LABORATORY TURNAROUND TIME IN TERTIARY CARE HOSPITAL

By

Dr Kirti Navoria

PG/20/025

Under the guidance of

Dr Anandhi Ramachandran

PGDM (Hospital and Health Management)

2020-2022

International Institute of Health Management Research

New Delhi

Internship Training

at

KareXpert Technologies Pvt Ltd

(1st Feb to 30th April 2022)

ASSESSMENT OF LABORATORY TURNAROUND TIME IN TERTIARY CARE HOSPITAL

By

Dr Kirti Navoria

PG/20/025

Under the guidance of

Dr Anandhi Ramachandran

PGDM (Hospital and Health Management)

2020-2022

International Institute of Health Management Research

New Delhi

91-90691 13330/+91-124-4006233
www.kareXpert.com
contactus@karexpert.com

Completion of Dissertation from KareXpert

The certificate is awarded to

Dr. Kirti Navoria

in recognition of having successfully completed his/her
Internship in the department of

Product Service Delivery

and has successfully completed his/her Project on

Assessment of Laboratory Turn-around time in a Tertiary care hospital

From
01/02/2022 - 30/04/2022
At
KareXpert

She comes across as a committed, sincere & diligent person who has a strong drive & zeal for learning.

We wish him/her all the best for future endeavours.

Training & Development

KareXpert-Human Resources

TO WHOMSOEVER IT MAY CONCERN

This is to certify that Dr.Kirti Navoria student of PGDM(Hospital and Health Management) from International Institute of Health Management Research New Delhi has undergone internship training at KareXpert Technologies Pvt.Ltd from 01 Feb 2022 till 30th April 2022. The Candidate has successfully carried out the study designated to him during internship training and his/her approach to the study has been sincere, scientific and analytical.

The Internship is in fulfillment of the course requirements

I wish him all success in all his/her future

.

Dr. Sumesh Kumar
Associate Dean, Academic and Student Affairs
IIHMR, New Delhi

Dr.Anandhi Ramachandran
Assistant Professor
IIHMR, New Delhi

Certificate of Approval

The following dissertation titled "**ASSESSMENT OF LABORATORY TURNAROUND TIME IN TERTIARY CARE HOSPITAL SETTING''** is hereby approved as a certified study in management carried out and presented in a manner satisfactorily to warrant its acceptance as a prerequisite for the award of **PGDM (Hospital & Health Management)** for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein but approve the dissertation only for the purpose it is submitted.

Dissertation Examination Committee for evaluation of dissertation.

Name	Signature
_____	_____
_____	_____
_____	_____

Certificate from Dissertation Advisory Committee

This is to certify that **Dr. Kirti Navoria,** a graduate student of the **PGDM (Hospital & Health Management)** has worked under our guidance and supervision. She is submitting this dissertation titled "Assessment of laboratory turnaround time in tertiary care hospital setting' 'at International Institute of Health Management Research" in partial fulfilment of the requirements for the award of the **PGDM (Hospital & Health Management).**

This dissertation has the requisite standard and to the best of our knowledge no part of it has been reproduced from any other dissertation, monograph, report or book.

Rajni Singh
Product delivery specialist
KareXpert Technologies Pvt.Ltd

Dr.Anandhi Ramachandran
Assistant Professor
IIHMR-Delhi

INTERNATIONAL INSTITUTE OF HEALTH MANAGEMENT RESEARCH, NEW DELHI

CERTIFICATE BY SCHOLAR

This is to certify that the dissertation titled Assessment of laboratory turnaround time in tertiary care hospital setting and submitted by **Dr. Kirti Navoria** Enrollment No. **PG/20/025** under the supervision of **Dr Anandhi Ramachandran** for award of PGDM (Hospital & Health Management) of the Institute carried out during the period from 01st Feb 2022 till 30th April 2022 embodies my original work and has not formed the basis for the award of any degree, diploma associate ship, fellowship, titles in this or any other Institute or other similar institution of higher learning.

Kirti Navoria
Signature

FEEDBACK FORM

Name of the Student: Dr. Kirti Navoria

Name of the Organisation: KareXpert technologies Pvt. Ltd

Area of Dissertation: Healthcare IT

Attendance: 100 %

Objectives achieved: She worked hard and smartly to achieve the client satisfaction. Went extra miles to support clients and adhered to timelines

1. Successfully handled client alone, with day-to-day technical issues and new enhancements
2. Successfully implemented the new modules at client site

Deliverables: She perfectly handled the clients, worked closely with the various team to deliver it with in timeline

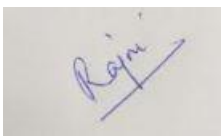
Strengths: Ownership, Fast learner, needs minimum support for anything

Suggestions for Improvement: NO suggestion on improvement, adding suggestion for career growth- make your technical part stronger in respect to product

Suggestions for Institute (course curriculum, industry interaction, placement, alumni):

Nil

Signature of the Officer-in-Charge/ Organisation Mentor (Dissertation)



Date: 25 June 2022
Place: Gurugram

Acknowledgements

As three months of dissertation period come to an end, I would like to thank everyone, without whose contributions, this project would have been impossible to complete, all those who helped me get an enriching experience.

First of all, I also want to thank KK Singh, CIO KareXpert Technologies Pvt.Ltd, Nidhi Jain (CEO), Rajni Singh (Healthcare Product specialist) mentor at KareXpert Technologies Pvt Ltd, Gurugram, for letting me part of this enriching journey as Healthcare Implementation Intern at KareXpert Technologies Pvt.Ltd.

I am very grateful to my mentor Dr. Anandhi Ramachandran, IIHMR Delhi for giving me constant support and guidance during my project.

I would also like to thank all my teachers without their support, my experience and my knowledge would have remained incomplete.

The completion of my dissertation training would not have been possible without tireless contribution and consistence of my friends and family.

Dr. Kirti Navoria

Table of contents

.

KAREXPERT TECHNOLOGIES PVT LTD.

About

The Reliance funded start-up *KareXpert* founded in 2018 provides artificial intelligence and cloud-based digital healthcare platform for hospital. Aimed at digitally transforming one lakh hospitals by 2026. Amid the COVID-19 crisis, healthcare, starting from doctor consultation and diagnostics tests to getting medicines, shifted online almost overnight. the lack of digital services for doctors, KareXpert pivoted to focus on building B2B solutions. It is aimed at digitalising hospitals by providing a **SaaS-based digital healthcare platform** to fulfil its mission of digitally transforming 100,000 hospitals in India and across the world in the next five years.

Besides disruptive technology and SaaS-based commercial model, KareXpert has also built the holistic Managed Services model for the Hospitals serving both onsite and offsite support needs bringing complete peace of mind to the customer

With 50+ modules and 450+ applications, KareXpert is the first Indian company to offer a most exhaustive portfolio for hospitals. The service includes advanced HIMS, EMR/EHR, LIMS, RIS/PACS, pharmacy, connected ambulance, advanced BI, MIS, e-Claim, telemedicine, inventory & SCM, queue management, counselling, and branded mobile apps as a pre-integrated stack.

Using its Patient-First and Mobile-first approach, the Digital Healthcare Platform will revolutionize the Hospital IT as it brings the speed of business with innovation using most

modern software technologies at a fraction of cost. The platform is already being used in some of the top hospitals across India, helping them streamline their operations.

KareXpert Works with All Labs -This medical laboratory management software is specialized in delivering safe and secure sample processing in different types of labs.

LMS for Pathology-Innovative system software for clinical pathology manages the sample collection and test run.

Software for Microbiology -Medical laboratory management software facilitates better management of samples and related data.

LIS for Histopathology -Medical laboratory management software for histopathology labs puts forth accurate results in time.

LIMS for Haematology-Automates inefficient manual processes to get results on EMR or patient portal.

LIS for Serology Lab-A Next-generation medical lab management software can be used to order tests.

LMS for Immunology Laboratory -Easy to deploy and integrate with in-house lab or outsource lab.

KareXpert is a First Asian health tech company incepted in 2018 to offer the largest solution portfolio to hospitals to help them streamline patient data, improve operational efficiency and optimize cost.

Location- Gurugram

Domain- Digital Healthcare

Founder- Nidhi Jain

Total team strength- 100+

Total funds raised – Rs 30 crore

Investors- Jio Partners

Revenue generated since inception- Rs 25 crore

In a remarkable development, KareXpert, the Reliance Jio-backed, SaaS-based, Cloud-based digital healthcare platform with 50+ pre-integrated modules enabling hospitals their digital transformation, is selected by the Google Accelerator program. Touted as "Suite for Hospital" by Google as an analogy emphasizing one-stop-shop for hospitals of any size for all their present and future digital needs, KareXpert is among the top 16 start-ups selected from over 700 companies.

KareXpert cloud-native, AI-ready, and mobile-first solution brings 50+ modules facilitating hyper-collaboration and hyper-coordination among all stakeholders of Hospital and Patients using workflow and event driven architecture where Patient care and Patient experience is enhanced by a magnitude. The platform requires minimal human intervention as the system becomes highly automated.

KareXpert, have fast-emerged as India's #1healthtech platform for hospitals to digitize their end-to-end operations, reduce operating cost, accelerate revenue, and enhance Patient experience using single data lake. The Hospital is truly transformed into a 'SMART Hospital".. We are thrilled to be a part of the Google Accelerator Program and build deeper integration with Google AI technologies for healthcare.

KareXpert clientele includes some of India's best hospital chains and healthcare clinics, such as Tata Steel group of Hospitals, Mahindra Group CFS, Reliance group Sir HNH, Paras Group of Hospitals. KareXpert platform has its customers ranging from Nursing Homes to Large Corporate chains with 100+ medical facilities which are Life or under Implementation. Customers simply have to pay a fixed monthly fee with everything managed by KareXpert resulting in complete peace of mind for their Software application side of IT. KareXpert

platform is available for customers globally especially focusing on USA, Canada, UK, Middle East, Africa, and South East Asia currently. This Reliance-funded start-up is aimed at digitally transforming one lakh hospitals by 2026.

VISION

- To enable the digital transformation of 100,000 hospitals in India and across the globe in the next five years
- USP lies in its integrated, SaaS-based, and platform-based approach that enables seamless digitalisation of hospitals
- Built an cloud in-house no-coding engine to bring the 3X speed for new features

After realising the lack of digital services for doctors, she pivoted to focus on building B2B solutions. In 2018, Nidhi launched **KareXpert**, which is aimed at digitalising hospitals by providing a **SaaS-based digital healthcare platform**.

The Gurugram-based start-up provides artificial intelligence and cloud-based digital healthcare platform for hospitals. The start-up raised to fulfil its mission of digitally transforming 100,000 hospitals in India and across the world in the next five years Speaking about the SaaS platform KareXpert is aimed at solving the clinical and billing problems of hospitals.

“Hospitals generally purchase digital solutions from third party providers and integrate them in the hospital. For example, with the covid breakout, one may need telemedicine software or mobile applications so they might need to reach out to different vendors to get the solutions. Hospitals might not have pre-integrated solutions, which can result in a broken experience for the patients.

KareXpert, however, offers an **integrated solution with over 50 applications** such as Advanced HIMS, EMR/EHR, LIMS, RIS/PACS, pharmacy, connected ambulance, e-Claim & insurance, inventory & SCM, queue management, MIS Reports, business intelligence, and hospital branded mobile apps.The KareXpert SaaS platform helps hospitals to streamline patient data flow across geographies and devices. It also helps them achieve a higher degree of collaboration between all stakeholders in the healthcare system.

LEARNINGS

During the period of internship for two months, working as Account manager provided great knowledge about the IT field in healthcare sector. Learnings during internship;

1. Handling role of product Implementation expert
2. . Successfully completed implementation of HIS at 56 Facilities in span of 3 months of one hospital. Leading the Designed patient portal app Registration, Appointment, OPD, MRD, Bill flow SME for - Opthal HIS, Patient portal App Experience working on Advanced HIMS, EMR/EHR, LIMS, Pharmacy, MIS, Inventory management Modules etc
3. Participating in the Machine integrations, PACS, HL7.
4. Scrum preparation, Demo to the clients.
5. Performed in-depth investigation on the live issue & have fixed issues logged by the end user.
6. Working with the different departmental colleagues (Developers, Product, QA, UAT, Operations).
7. Experienced in system level, account level and Facility level, configurations for HIMS in coordination with developing and UAT Team
8. Requirements gathering and Use case stories Creating Roadmaps to detail feature delivery and timelines and Project planning and management
9. Experienced in creating Use case stories, test specifications and business rules

LIST OF ABBREVIATIONS

TAT	**Turnaround time**
HIMS	**Hospital information management system**
LIMS	**Laboratory information management system**
OPD	**Outpatient department**
IPD	**Inpatient department**
mint	**Minutes**

CHAPTER 1

INTRODUCTION

Laboratory turnaround time can be defined in different ways depending on the type of test (statistics and routines), analytes, and facility. This is usually defined as the time between ordering a test and reporting the results. The total TAT of a clinical test includes the entire interval from the time the test is ordered until the doctor notices the result (that is, the "brain of the brain"). It consists of the interval from order to sample collection and transportation to the lab, access to the lab, centrifugation, dispensing and other pre-analytical steps, internal and inter-analytical transport times. Laboratory, analysis time, time from completion of analysis to validation of results, and time to notify clinical team of results. The effects of TAT have been extensively studied and there is a correlation between emergency department treatment and length of stay. As a result, TAT is often regarded as the most important measure of laboratory service and is used by many physicians to assess its quality. In addition to accuracy and reliability, timely delivery of laboratory results is now recognized as an important aspect of laboratory services. Patients and their doctors want to report as soon as possible, regardless of whether faster turnaround times can make a medical difference. Timely reporting of laboratory results has also been shown to affect results in certain settings such as operating rooms and emergency rooms. Traditionally, lab TAT is determined by the temporal progression of the three test phases. Pre-analytical, analytical, and post-analytical reality of these individual phases by manual recording**.** However, there are no previous reports of using Laboratory Information Systems (LIS) to record and analyse TAT. Therefore, we have developed a new LIS that automatically records TAT data and analyses the time taken for the three phases, including the entire lab TAT for each test. Therefore, rapid turnaround time in the laboratory

is important from both a medical and commercial point of view. The goal is to determine if there are delays, determine the reasons for the delays, and develop actions to deal with them. About 80% of all diagnoses are based on blood analysis. It is often important to wait for the results. Patients suffer from intolerable waiting times and expensive bedtime as they wait to be told what treatment they need. Hawkins, “Laboratory Turnaround Time.”(1)

For this reason, laboratory time (TAT) is a hot topic in clinical chemistry. Turnaround time is often measured only for laboratory clinical analysis, but TAT now includes all phases from requesting a sample to receiving test results from a physician. increase. The process starts when a request is made. A nurse or phlebotomist will identify the patient and take a blood sample. The next step is to ship the sample to the lab and register the sample when it arrives at the lab. The sample is then analysed and the final result is returned to the doctor. Clinical laboratories take pride in being extremely data driven. Many quality indicators are continuously monitored(1), analysed (Placeholder1), and used to allocate resources and improve service. These quality indicators include the turnaround times (TATs) necessary to report laboratory results to clinical staff. The total TAT for laboratory assays includes the entire interval l from ordering of the test to the clinician's awareness of the result (ie, “brain-to-brain”). It consists of the intervals from order placement to specimen collection, as well as the time necessary for transport to the laboratory, accessioning in the laboratory, centrifugation, aliquoting, additional preanalytical steps, if necessary, transport times within and between laboratories, analysis time, the time after completion of analysis until result verification, and the time it takes for the clinical team to be informed of the result.(2)

CHAPTER 2

RATIONALE

Laboratory Turnaround Time

Laboratory Turnaround time can be defined in different ways depending on the test type (statistics and routines), analyte, and institution. TAT is often regarded as the most important measure of laboratory service and is used by many physicians to assess its quality. Timely reporting of laboratory results is now recognized as an important aspect of laboratory services. TAT is a metric used to monitor the efficiency and productivity of your laboratory. Hence, as it is an important aspect of lab management, we must know its significance and attributes that contribute to making our services better for end-users. Secondly, using TAT to measure different laboratory aspects as well as optimizing it holds huge benefits on both operational and financial fronts. This study uses a laboratory information system to evaluate the time required for testing in five categories of tests recommended by the OR and IP departments of tertiary care hospitals to find out the reason or cause of the delay and how to improve it .SaaS Based LIS model is being maintained by KareXpert for XXX hospital (name hidden to protect privacy) The XXX hospital wants a study being conducted to evaluate the current turnaround times for our inpatient, outpatient samples because the assessment and improvement of turnaround times is essential for laboratory quality management as well as ensuring patient satisfaction to monitor the variabilities in TAT helps us get insights on the causes of delay and can be useful in making improvements in different areas of our end-processes and also resolve dependent problems that hamper lab efficiency and staff productivity. Thus, reviewing TAT can help reduce delivery time, customer satisfaction & reduce costs in a significant manner.

CHAPTER 3

OBJECTIVES

1. To assess the laboratory turnaround time in a tertiary care hospital (*Name hidden to protect privacy*)

2. To identify the reasons/causes for delay of laboratory turnaround time

3.To suggest appropriate ways to reduce the delay in turnaround time.

Methodology

Study location -This study is conducted based on the data obtained from Laboratory Information System (LIS) of tertiary care super speciality hospital (XXX) located at Model Town New Delhi. The hospital laboratory provides services related to haematology, clinical chemistry, clinical pathology and serology and immunology.

Study duration -03rd Feb2022 till 30th April 2022

Study Type- Observation study (Primary study)

Data Type: Primary Data extracted from LIS

Sample size

Data of 3000 test samples submitted in the LIS during the period 03.02.2022 to 21.04.2022 who were advised by consultants including OPD & IPD between 8 am to 7 pm. Only 50% of the samples were considered for the study which includes all 5 categories of test i.e., clinical pathology, clinical chemistry, haematology, serology and immunology. Rest was excluded from study due to abnormal results and no-show results. The test category includes clinical pathology, haematology, immunology, serology, clinical chemistry.

Data Collection Tool

A program was developed to record and manage the time points entered into the Laboratory Information System (LIS), the time taken to fulfil each phase, the testing instruments, the operators, retesting, and verification, such as delta value, panic value, and critical value checking. During laboratory test processing, 4 time points were automatically recorded in LIS: i.e., “barcode printing” when the barcode was printed by an authorable and the specimen was accessed simultaneously; “scanning” when the barcode was scanned in the autoanalyzer; “result to LIS” when the result was transmitted from the instrument to the LIS after the analysis; and result to HIS when the verified result was transmitted from the LIS to the Hospital Information system. In this study, the TAT was classified into 3 phases on the basis of these 4 time points, i.e., preanalytical phase (barcode printing scanning), analytical phase (scanning result to LIS), and postanalytical phase (result to LIS report to HIS).

Data analysis

The pre-analysis phase consists of the following

steps: Barcode printing by simultaneous sampling. Waiting for phlebotomy. Phlebotomy; Transport of samples from the blood collection site to the laboratory. The analysis phase consists of the following steps: Bar code scan. Order search from LIS. Analysis; Results are sent to LIS. The post-analysis phase consists of the following steps: The result is received by LIS. Validate the results automatically or manually and send the report to HIS.

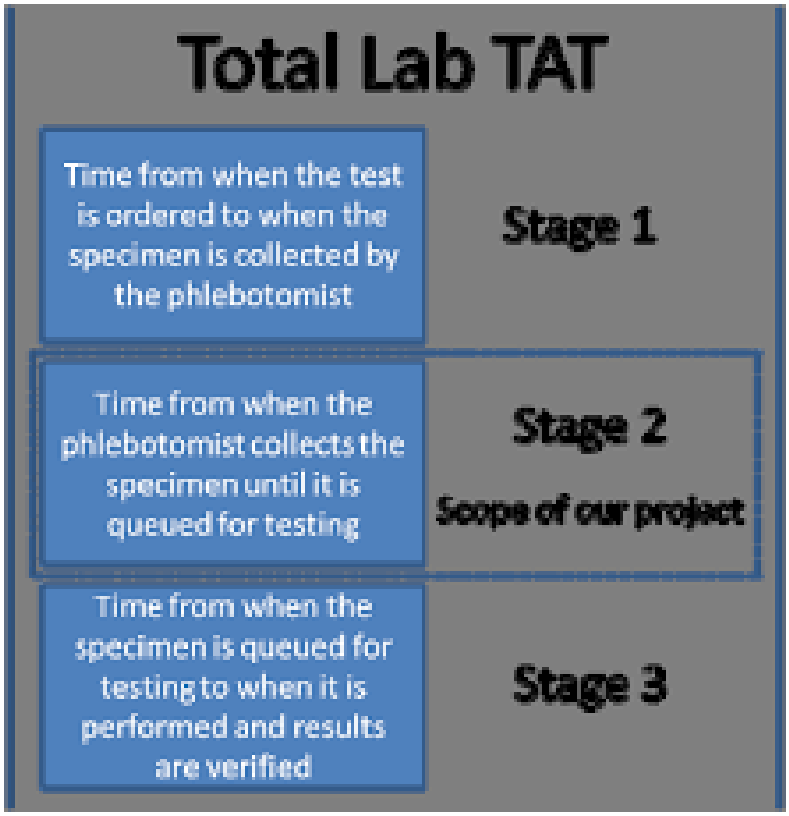


Fig.1.Total Lab turnaround time

MS-Excel has been used to do the analysis to find out the mean TAT, proportion of acceptable tests (% of TAT within critical Tat alert of 30 -60 min) for clinical chemistry, clinical pathology, haematology, serology and immunology.

CHAPTER 4

REVIEW OF LITERATURE

1. According to the study by Bilwani., et. al thirty to sixty minutes is reported as the threshold recommended. The laboratory shall periodically evaluate whether or not it is meeting the established TAT. This is quite difficult because attending doctors consider TAT from the time the test is ordered to results reporting, whereas laboratory personnel usually use specimen receipt to reporting of results as the TAT. However, when the attending physicians were asked about what ideal waiting time was expected for the most commonly ordered tests, 96% of 330 respondents considered the ideal turnaround time for the laboratory results should be less than 120 minutes, while 4% consider the ideal to be 180 minutes. Joan Howanitz and Peter Howanitz suggest 60 minutes or less from sample registration to reporting for all common laboratory tests under optimal conditions, aim of this study was to evaluate whether or not the laboratory is meeting the established TAT and to identify reasons for delay. Taking into account the major source of customers' complaints which is unsatisfactory TAT, we hypothesize that the measured laboratory TAT is greater than the expected or suggested TAT. This alternative hypothesis will be confirmed in case of rejection of the null hypothesis which TAT that the measured laboratory TAT is equal to the expected or suggested TAT. (3)

2. In a study conducted by Steven J. Steindel, PhD; David A.Novis, MD uses Outlier Events to Monitor Test Turnaround Time: A College of American Pathologists Q-Probes Study in 496 Laboratories reported in excess of 70 minutes from the time the test was ordered (ie, outliers). Hundred ninety-six hospital laboratories returned data on 218551 TAT tests, of which 10.6% had TATs in excess of 70 minutes. Ten percent of TAT emergency department tests and 14.7% of TAT intensive care unit tests were outliers. Major areas in which delays occurred were test ordering, 29.9%; within-laboratory (analytic) phase, 28.2%; collection of the specimen, 27.4%;

post analytic phase, 1.9%; and undetermined, 12.5%. The leading cause (37.8%) for delay in the order-to-collection phase (Table 3) was attributed to lack of staff to perform the phlebotomy. Specimen transport problems accounted for 56.3% (51.4% due to personnel; 4.9% due to breakdowns in mechanical transport systems) of the delays in the collection-to-receipt phase, delays in the analytic phase were attributed to personnel shortages (33.7%), delays in the post analytic phase were few, with the leading cause (54.8%) attributed to the category of clerical delays–technical.(3)

4. In a study by JJ Westbrook, Georgiou Dimos, T Germanos to assess the impact of computerised pathology order entry system on laboratory turnaround times and test ordering within a teaching hospital. Comparisons were made of laboratory turnaround times, frequency of tests ordered and specimens taken, proportions of patients having tests, average number per patient, and percentage of gentamicin and vancomycin specimens labelled as random. Computerised order entry systems are an important element in achieving faster test results. These systems can influence test ordering patterns through structured order screens, manipulation of order sets, and analysis of real time data to assess the impact of such changes, not possible with paper-based systems. A potentially limiting factor is clinicians' capacity to respond to, and make use of, faster test results. Intervention wards experienced an average decrease in turnaround of 15.5 minutes/test assay (range 73.8 to 58.3 minutes; $p<0.001$). Reductions were significant for prioritised and non-prioritised tests, and for those done within and outside business hours. There was no significant change in the average number of tests ($p=0.228$), or specimens per patient ($p=0.324$), and no change in turnaround time for the control ward ($p=0.218$). Use of structured order screens enhanced data provided to laboratories. Removing three test assays from the liver function order set resulted in significantly fewer of these tests being done.**(4)**

5. A research conducted by SJ Steiendel, PJ Howanitz on Physician satisfaction and emergency department laboratory test turnaround time for determining the length of time for the components of the emergency department (ED) turnaround time (TAT) study in 1998 and to ascertain physician satisfaction concerning laboratory services to the ED. Six hundred ninety hospital laboratories (72.4% response rate) returned data on up to 18 230 haemoglobin and 18 259 potassium specimens. Half of these laboratories responded that 90% of potassium tests were ordered and reported in 69 minutes or less, whereas the TAT for 90% of haemoglobin results was 55 minutes or less. Factors found to statistically contribute to faster TATs for both tests were laboratory control of specimen handling and rapid transport time. When whole blood specimens were used for potassium determination, TAT improved. TATs have remained unchanged for almost a decade. Emergency department physicians are not satisfied with laboratory services. Although it appears that one issue may relate to the other, the interaction between the laboratory and the ED is quite complex and has been evolving for at least 30 years. Improvement in interoperability between the departments is essential for operational efficiency and patient care. Effective communication channels need to be established to achieve these goals**.**(5)

6.)In a 2001 report of CAP Q-probe study of Physician Satisfaction and Emergency Department Laboratory Test TAT , emergency department physicians chose the study-defined lower satisfaction categories of Often, Sometimes, Rarely, and Never for the questions concerning the laboratory being sensitive to TAT testing needs (39.1 %) and meeting physician needs (47.6 %).Many of the physicians surveyed (42.9 %) believed that laboratory TAT was not satisfactory and caused delayed treatment and increased ED length of stay more than 50 % of the time .But this believe has not been proved to be correct. A 5-week study by Parvin et al. using hand held point of care device for measuring Na, K, Cl, glucose and blood urea nitrogen

did not find any significant difference in length of stay (LOS) in emergency department when compared to this test done in laboratory. Perception by physician need not be true and reflect in management of patients. In a CAP Q-probe analysis, Using Outlier Events to Monitor Test TAT in a study in 496 laboratories, it was observed that analysing outlier gave new insights into the reason for delay in TAT. It was also suggested that the laboratories monitoring TAT should use these outlier events as an adjunct to routine TAT monitoring to find out causes unique to each laboratory. In conclusion, TAT is an important parameter for the laboratory as well as for the hospital assessing the laboratory service. The hospital needs to evolve their own TAT/more than one TAT in consultation with both the laboratory personnel and the clinicians (the users) for using TAT as a quality parameter for the lab services. Computerization, speedy transport would further help in reducing TAT. Review of TAT outliers is equally important to reduce cause of delay in TAT.(5)

7. Binira Goswami, Bhawna Singh, Ranjana Chawla, V.K Gupta and Mallika conducted a study on Turn Around Time (TAT) as a Benchmark of Laboratory Performance to evaluate laboratory analytical turnaround time in our laboratory and appraise the contribution of the different phases of analysis towards the same. The study demonstrates that the average TAT for the emergency and the outpatient PT samples is being maintained at 1 h. The analytical and the pre- and post-analytical phases confer equally towards the TAT in this case. On the contrary, reporting of the stable in patients as well as the patients attending OPD services takes 4.5–5 h on an average; when the pre- and the post-analytical phases contribute up to 76.25% as compared to 50% in the above situation. This suggests that when the pre- and the post-analytical phases are streamlined, then TAT can be controlled in a better way as compared to the present scenario where the analytical phase is bestowed with the responsibility of ensuring speedier reporting. It is clear from our critical self-appraisal of laboratory services that we have improvised the analytical phase by automation, elaborate documentation and communication

of critical values and recruitment of trained laboratory personnel. There is a scope of further improvement in our turnaround time by initiating administrative machinery for acquiring state of the art pneumatic tube delivery system and LIS. (6)

8. Laboratory Turnaround time for biochemistry investigations in emergency department of tertiary care hospital of North by Zaffar N, Rashid H. Hussain S. and Hakeem A was a prospective, descriptive, single enter study of therapeutic TAT for biochemistry investigations in accident and emergency of a tertiary care hospital. The study was conducted for a period of 3 months from August 2020 to Oct 2020. During the present study period, all biochemistry investigations ordered from emergency department were studied and the Lundberg definition of TAT meaning that the pre-analytical TAT used was from the point of order of tests to the receipt of samples at the laboratory. Similarly, the post-analytic phase started from the time results were available at the laboratory to the point where clinicians could access it for action. The turnaround time (TAT) has been monitored in total of 7515 samples for biochemistry evaluation with mean TAT of 169.6 min. It was noted that the mean pre analytical time period was 120.6 min, Analytical time period 34 min while post analytical time period was 15 min. In our study of the pre-analytical phase 37.7%, 39.3%, and 22.9% tests were completed within 60, 60-120 and above 120 minutes, respectively. With respect to the analytical phase, 80.4% and 19.6% tests were completed below 45 minutes and above 45 minutes, respectively. Conclusion: Despite efficient analysis of results, the pre analytic period contributed the most delay in TAT. Collecting the blood samples under standard conditions, filling the test request slips, marking the samples with bar-codes contributed to long TAT.(7)

9. Evaluation of Clinical Laboratory Tests' Turnaround Time in a Tertiary Hospital in Democratic Republic of the Congo (DRC) by Chyabo Byalne Alain, Mabel Makengo, The delay in the delivery of laboratory results can be fatal and can even lead to the death of patients

so this s study was conducted at the clinical laboratory of the University Hospital of Kinshasa (UHK) from October 2020 to April 2021, aimed to evaluate the laboratory tests' turnaround time (TAT) and to identify reasons for delay. TAT was quantified using a time and motion analysis approach. The evaluation of TAT consisted of comparing the overall intra-lab TAT with the suggested TAT using student t-test at 95% confidence intervals. Brainstorming was the root cause analysis tool used for identifying reasons for delay. In this study, the laboratory tests' TATs were significantly higher ($p < 0.001$) comparing to international guidelines (60 minutes) and customers' suggested TAT (120 minutes). Only 0.98% of the samples were reported within 60 minutes of patient reception and 1.47% within 120 minutes, i.e. an outlier rate of 98.5%. Root causes of delay related to Machinery, Management, Manpower, Materials, Method and Milieu. Because of many reasons, the laboratory is not meeting the established TAT. Preventive and curative measures must be undertaken to reduce the delay and improve the TAT.***(8)***

10. A Cross sectional study by Manasij Mitra1, Dipak Sinha2, Maitraye Basu on the Determinants of Laboratory Turnaround time in Tertiary Care Teaching Hospital in Bihar done in the Biochemistry department of a 600-bed tertiary care multi-speciality teaching hospital in Bihar. 2600 samples from patients admitted over a period of 6 months from 1st April 2019 to 30thOctober 2019 were analysed using descriptive statistics. The average TAT from test advise by physician to report despatch is 10.68 hours (±4.16 Standard Deviation) while the average TAT from receipt of samples in the laboratory to report despatch was 7.54 hours (±2.28 Standard Deviation) This study did a detailed analysis looking into the reasons for delay and bringing forth feasible recommendations towards rectification also looked into the "Critical tests" and the "Critical results" TAT and the reasons for delay therein which was not highlighted in many studies done in Indian settings earlier. According to the study Pre analytical phase and

post analytical phase delays contribute to delayed TAT in hospital settings. Recommendations with an aim to reduce the delays with active involvement of the management can be fruitful.(9)

11. Study of determination of laboratory turnaround time in tertiary care hospital in India by Abhinav Dileep Wankar, out of total 232 samples, 183 samples (78.88%) were taken for analysis. 100 (54.65%) samples were within TAT time and 83 (45.35 %) samples were delayed. Out of total 83 samples which were delayed, 48 (57.83%) samples had TAT between 60 minutes to 90 minutes, 22 (26.51%) samples had TAT between 90 minutes to 120 minutes, 9 (10.84%) samples had TAT between 120 minutes to 180 minutes, and 4 (4.82%) samples had TAT over 180 minutes. Average time between sample collection and lab reach was observed to be 15 min. 38 sec. Transport delay was observed. Instrumentation failure was observed in biochemistry - 2 times and thyroid - 1 time. Hence this study aims to evaluate the delay and reason of delay of turnaround time (TAT) of stat tests in section of clinical chemistry of the clinical laboratory.(10)

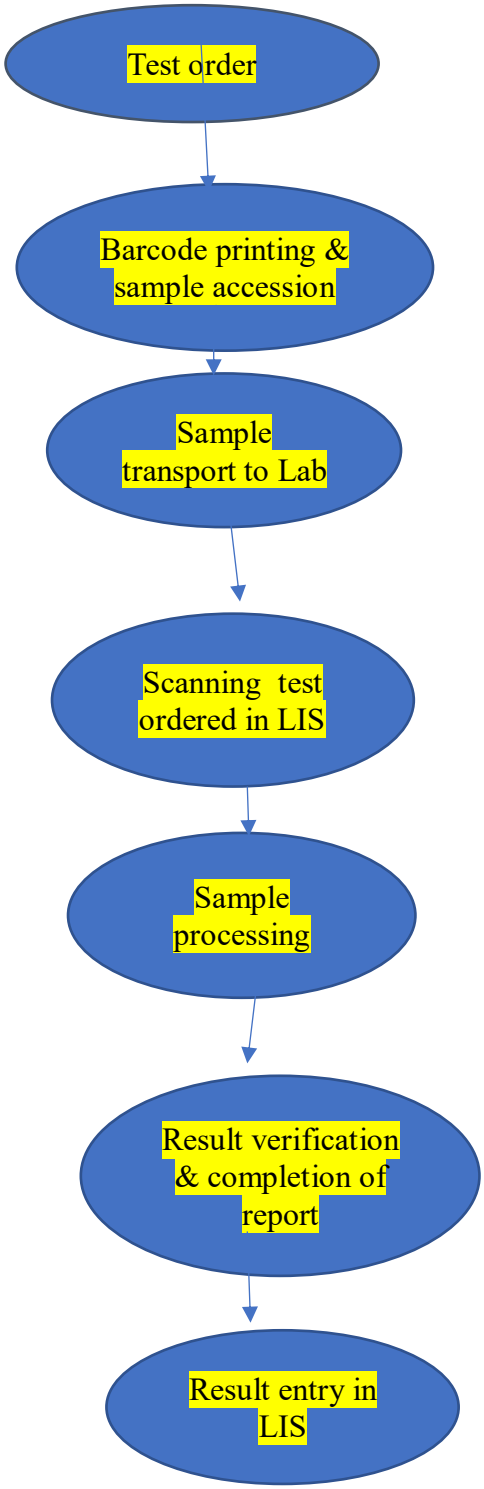
12. Analysis of turnaround time by subdividing three phases for outpatient chemistry specimens by Hee -Jung Chung, Woochang Lee, Sail Chung, Hae-II developed a new Laboratory Information System (LIS)-based monitoring system that records the laboratory turnaround time (TAT) in 3 phases and analyses the time to complete each phase with relevant specimens. TAT is subdivided into preanalytical, analytical, and postanalytical phases based on the 4 time points when data are entered automatically into the LIS. The average TAT for 13,594 outpatient routine chemistry specimens with the one-stop service was 43.6+/-7.7 min. Completion times of the preanalytical, analytical, and postanalytical phases were 29.7+/-6.9, 13.9+/-4.1, and 0.02+/-0.13 min, respectively; 98.0% of the specimens were reported within 60 min. The remaining 2.0% were reported after 60 min with an average TAT of 68.7+/-11.3 min. Preanalytical phase delays were primarily responsible for the specimens reported between 60 and 90 min, and analytical phase delays were largely responsible for the few specimens

(0.2%) reported after 90 min. For specimens reported between 60 and 90 min, the preanalytical phase was found to need improvement in order to shorten TAT; the main target for improvement was identified as the "waiting time for phlebotomy" step**(11)**

13. Determination of Turnaround Time in the Clinical Laboratory “Accessioning-to-Result” Time Does Not Always Accurately Reflect Laboratory Performance “Accessioning-to-Result” Time Does Not Always Accurately Reflect Laboratory Performance by Brie A. Stotler, MD, MPH, and Alexander Kratz, MD. This study assesses limitations of “accessioning-to-results” times and details ways in which to evaluate laboratory-controlled TAT. Samples were sent via pneumatic tube and times from arrival to accessioning were determined. Staffing was increased and the delay between sample arrival and accessioning was measured again. Significant delays were seen between specimen arrival and accessioning, which were not captured with computer-generated TAT reports. When TAT was calculated to include these delays, the TAT goal was not achieved. Increasing the number of employees significantly decreased delays. Laboratories must ensure that TAT reports encompass all laboratory-controlled parts of the testing processes. Analysis of causes for discrepancies between computer reports and clinician perceptions, combined with targeted measurements and well-designed interventions, can decrease TAT and improve service.**(2)**

CHAPTER 5

WORKFLOW OF LAB TESTS



CHAPTER 6

RESULT

Out of the total 1500 test taken for analysis, they were divided into 5 category tests i.e., haematology, clinical chemistry, clinical pathology, serology, immunology. TAT analysis of each category test was done individually and mean turnaround time was found out. The specimens for each categorial test were divided into 5 groups; TAT within 30-60 min, TAT between 60 and 90 min, TAT between 90 min and 120 min, between 120 min and 180 minutes and over 180 min. The average time taken to fulfil each phase was measured, and the contribution of each phase to the overall TAT was calculated. The mean standard duration of 60 minutes was taken, as the system sent an alert of critical alert intervention of duration of more than 60 minutes. When specimen results were reported after 60 min, each phase was investigated to determine the underlying reason for the lack of timeliness.

Table1.1. ANALYSIS OF CLINICAL CHEMISTRY TAT

TAT time (minutes)	no of samples	% of samples
30-60	200	27.4
60-90	181	24.8
90-120	168	21.8
120-180	129	23.04.
>180	51	6.99

Mean standard TAT for clinical chemistry is 20 minutes from sample collection till process and 30-60 minutes from sample process till report completion. A total of 729 samples analysed out of which 200 samples were within TAT duration of 30-60 minutes (27.4.%). 529 samples were in delayed TAT duration; out of which 181 samples (24.8%) were within 60-90 minutes, 168 samples (21.8%) were within 90-120 minutes, 129 samples (23.04%) were falling under 120-180 minutes and 51 samples (6.99%) were under category of TAT duration of more 180 minutes or more. Mean average of samples under TAT duration of 30-60 minutes was 37 minutes 4 seconds.

Table1.2. ANALYSIS OF HAEMATOLOGY TAT

TAT time (minutes)	no of samples	% of samples
30-60	140	29.
60-90	151	31.5
90-120	86	18.02
120-180	84	17.61
>180	16	3.35

Mean standard duration for haematological test is 60 minutes. A total of 477 samples were analysed out of which 140 samples (29.4%) were within TAT duration of 30-60 minutes. 327 samples were in delayed TAT duration, out of which 151 samples (31.5%) were in 60-90 minutes, 86 (18.02%) under 90-120 minutes, 84 (17.6%) under 120-180 minutes and 16 (3.35%) were under TAT duration 180 minutes or more. Mean average of samples falling under TAT duration of 30-60 minutes was 21 minutes

Table1.3. ANALYSIS OF CLINICAL PATHOLOGY

TAT time (minutes)	no of samples	% of samples
30-60	10	16.3
60-90	12	19.6
90-120	23	37.7
120-180	110	16.3
>180	6	9.8

Mean standard TAT for clinical pathology test is 60-90 minutes. A total 61 samples were analysed out of which 22 samples (35.9%) were within TAT duration of 30-60and 60-90 minutes, minutes, rest 139 samples were in delayed TAT duration. 110 (16.3%) 6 samples (9.8%) were beyond 180 minutes TAT duration.

Table1.4. ANALYSIS OF IMMUNOLOGY TEST

TAT time (minutes)	no of samples	% of samples
30-60	25	27.7
60-90	20	22.2
90-120	15	16.6
120-180	20	22.2
>180	10	11.11

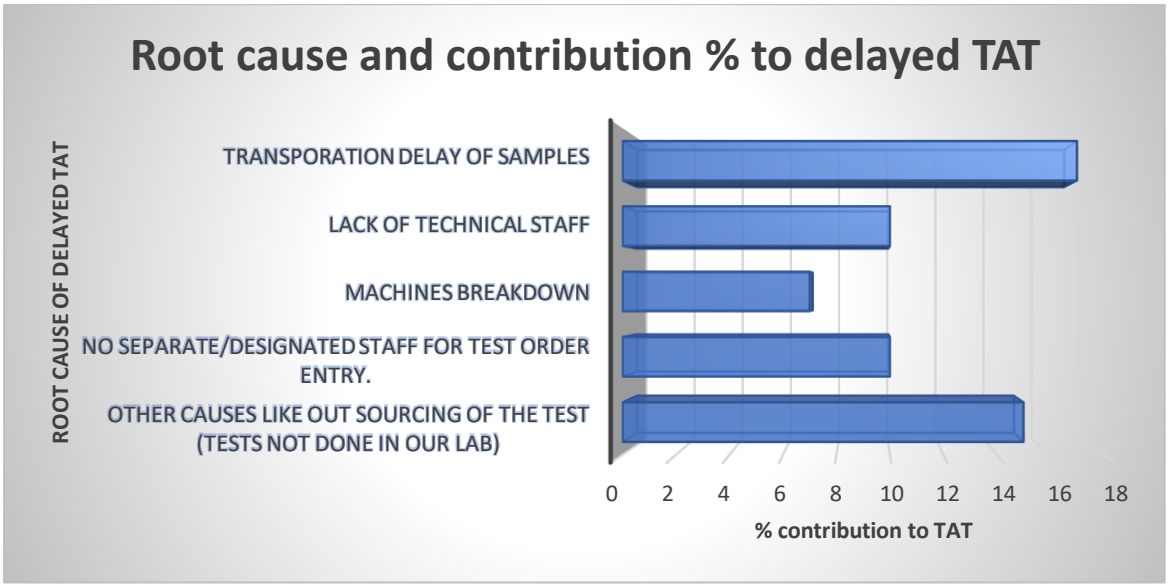
Average tat for immunology test considered is 30-120 minutes. Total samples analysed were 90 out of which only 60 samples (66.5%) were within TAT duration of 30-120 minutes, remaining 30 samples were within delayed TAT duration; 20 samples (22.2%) were under TAT duration of120-180minutes 10 samples (1.11%) under TAT duration of 180 minutes or more.

Table1.5. ANALYSIS OF SEROLOGY TEST

TAT duration (minutes)	no of samples	% of samples
30-60	83	58
60-90	13	9.9
90-120	12	8.3
120-180	14	9.7
>180	21	14.6

Mean turnaround time duration used for serologic al tests is 60-90 minutes. A total of 143 samples were analysed out of which 83 samples (58%) were under TAT category of 30-60 minutes, and60 samples were in TAT duration. 13(9.9%) were under 60-90 minutes TAT duration, and remaining samples were under delayed Tat duration ;12 (8.3%) under 90-120 minutes duration,14 (9.7%) under 120-180 minutes and 21 samples (14.6%) were under TAT duration of 180 minutes or more.

Table1.6. Root cause of delayed TAT



After analysing the categorical samples, we found that the main reason for the delay in sample collection to reach the lab was due to delay in transition of samples (17%) Another reason is the delay is lack of technical staffs, shortage of manpower. which in turn leads to delay in sample processing till reports verification and entry int LIS. Equipment /machines breakdown was another delay observed. Other cause of delayed TAT was the outsourced tests which were not done in Inhouse lab sample delays, laboratory accidents, delays related to data entry, etc. In our study, the average time from validation of results to completion of the report was 60 minutes. Most of the TAT delays in most tests occurred in the morning shift when the section was at maximum staff level. An increase in workload at this point and no separate dedicated staff for sample collection can be a reason to delay TAT at this time.

CHAPTER 7

DISCUSSION

In our study we have used the time from sample collection till sample verification and report completion to monitor our TAT of laboratory tests; 458 samples (30.53%), were within TAT duration of 30-60 minutes, and 1042 (69.46%) samples were in delayed TAT duration of more than 60 minutes. In line with the international guidelines, Bilwani., *et al.* reported 60 minutes as the recommended threshold. Joan Howanitz and Peter Howanitz suggest 60 minutes or less from sample registration to reporting for all common laboratory tests under optimal conditions.(12) Most common delay was found to be delay in transportation, technical staff being overlooked , machine breakdown. The standard time considered in our study is 30-60 minutes. According to the study by Abhinav Dileep Wankar the delayed 83 (45.35 %) samples out of which (57.83%) samples had TAT between 60 minutes to 90 minutes, 22 (26.51%) samples had TAT between 90 minutes to 120 minutes, 9 (10.84%) samples had TAT between 120 minutes to 180 minutes, and 4 (4.82%) samples had TAT over 180 minutes, the reason of delay was found to be transport delay. In our study 377 (25.13%) samples had TAT between 60-90 minutes ,304 samples (20.26%) under TAT 90-120 minutes, 357 samples (23.8%) under TAT of 120-180 minutes and 104 samples (6.9%) are under TAT of more than 180 minutes. In our study 35 % of specimens having exceeded TAT was due to various non-analytical delays and almost 50 % were due to all phases delay. Bilwani had reported that most of the delays in TAT of short turnaround time (STAT) tests were more than 60 mint. The major reasons for delay in TAT was found to be delayed transportation of samples to concerned laboratory person and technical glitches in the LIMS system during result entry which in turn leads to delay in completion and verification of reports, lack of technical staff.

.

CHAPTER 7

CONCLUSION

From our study we concluded that 529 clinical chemistry samples (72%),27 haematological samples (73.15%), 65 immunological samples (72.2%), and 41clinical pathology samples (67.2%) are under category of delayed TAT duration while only 83 (58.03%) serological samples were under TAT duration of 30-60 minutes. Major delay was found in sample collection to laboratory reach, due to transport delay which might be because of machines breakdown or technical staff. Other reasons for delay in receipt to verification time reported in other studies are due to technical delays i.e., difficulty with instrument, specimen delay, laboratory accidents and clerical delay which involves data entry etc. Average time from result verification to completion of report was 25 minutes 4 seconds in our study. Another interesting finding in our study was that most of the delay in TAT of most tests occurred in the morning shift, while maximum staff strength is available at the disposal of the section. Increase in workload at this time could well be a reason for delay in TAT at this time of the day. Thus, we conclude that most of the delay in TAT of the tests advised in our laboratory occurred for more than 60 minutes and was frequently seen in the morning shift. It was observed that most of the delay in TAT was due to transportation failure of samples and technical glitches in LIMS system during result entry and lack of technical staff in the hospital.

CHAPTER 8

RECOMMENDATIONS

Major concern for delayed Lab TAT in our study is Sample Transportation. Samples cannot be tested without receiving them. An important factor in pathology TAT is the time spent transporting the specimen from the patient's bedside to the pathology. Therefore, using a pneumatic tube system to transport the sample, the sample can be transported safely and quickly. The shorter the time it takes for the sample to reach the technician, the shorter the time required. Another cause was lack of technical staff which can be overlooked by using multitasking training to staff as an approach. If TAT has to be maintained, managing manpower shortages from time to time needs to be tackled smartly. This approach would help reduce the overtime costs for the hospital as well as cover up for the manpower shortage efficient. The study found that easy-to-implement management procedures significantly reduced TAT and improved the quality of service at Laboratories which includes setting up sampling counters in the outpatient department (OPD) and inpatient department (IPD), printing directions to the laboratory on OPD tickets, initiating a single puncture policy,

The management of the section, regular quality assurance, meeting with the technical staff and strict vigilance is required to reduce such delay in lab turnaround time. Regular audit of such data helps in the evaluation of the efficiency of the laboratory and hence corrective measures taken accordingly would be helpful in providing better service to the physicians and patients.

BIBILIOGRAPHY

(1) Westbrook et al., "Computerised Pathology Test Order Entry Reduces Laboratory Turnaround Times and Influences Tests Ordered by Hospital Clinicians."
2.Alain et al., "Evaluation of Clinical Laboratory Tests' Turnaround Time in a Tertiary Hospital in Democratic Republic of the Congo."
3. Hawkins, "Laboratory Turnaround Time."
4. "Turn-around-Time in Laboratory."
5. Steindel and Novis, "Using Outlier Events to Monitor Test Turnaround Time."
6. Steindel and Howanitz, "Physician Satisfaction and Emergency Department Laboratory Test Turnaround Time."
7. Pati and Singh, "Turnaround Time (TAT)."
8. International Journal of Advanced Research. "Article Detail." Accessed June 14, 2022. https://www.journalijar.com/article/
9. Mitra, Sinha, and Basu, "A Study of the Determinants of Laboratory Turnaround Time in Tertiary Care Teaching Hospital in Bihar."
10. Wankar, "Study of Determination of Laboratory Turnaround Time in Tertiary Care Hospital in India."

11. Chung et al., "Analysis of Turnaround Time by Subdividing Three Phases for Outpatient Chemistry Specimens."
12. Stotler and Kratz, "Determination of Turnaround Time in the Clinical Laboratory."
13. Goswami B, Singh B, Chawla R, Gupta VK, Mallika V. Turn Around Time (TAT) as a Benchmark of Laboratory Performance. Indian J Clin Biochem. 2010/09/14 ed. 2010 Oct;25(4):376–9.
1.
14.Bilwani F, Siddiqui I, Vaqar S. Determination of delay in turn around time (TAT) of stat tests and its causes: an AKUH experience. JPMA The Journal of the Pakistan Medical Association. 2003 Feb 1;53:65–7.
15. 1.
15.Wankar A. Study of determination of laboratory turnaround time in tertiary care hospital in India. 2014;