Addis Ababa University
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Evaluation of laboratory performance and associated factors towards achieving turnaround time in clinical Chemistry and Hematology departments at Armed Force Comprehensive and Specialized Hospital, Addis Ababa, Ethiopia.

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A research thesis paper submitted to the Department of Medical Laboratory Technology, School of Nursing and Midwifery, College of Health Science, Addis Ababa University, in partial fulfillment of Masters of Science Degree in Clinical Laboratory Sciences (Clinical Laboratory management and quality assurance track)

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Department of Medical Laboratory Sciences,

This is to certify that the thesis paper by, Mebrat Gebreyesus, entitled: Evaluation of laboratory performance and associated factors towards achieving turnaround time in armed force comprehensive and specialized hospital, Addis Ababa, Ethiopia, and submitted in partial fulfillment of the requirements for Master of Science degree in Clinical Laboratory Sciences (Laboratory management and Quality assurance) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Table of Contents

List of table

List of Figures

Abbreviations:

AAU	Addis Ababa University
AFCSH	Armed Force Comprehensives and Specialized Hospital
ALP	Alkaline Phosphates
BF	Blood Film
CBC	Complete Blood Count
ED	Emergency Room
FMOD	Federal Ministry of Defense
HCT	Hematocrit
HGB	Hemoglobin
ISO	International Organization for Standardization
LIS	Laboratory Information System
SLMTA	Strengthening Laboratory Management Towards Accreditation
TAT	Turn Around Time
TTP	Total Testing Processes
QMS	Quality Management Systems
WHO	World Health Organization
WHOAFRO	World Health Organization Regional Office For Africa
KAP	knowledge, attitude and practice

ABSTRACT

Background: Establishing and maintain Turnaround time (TAT) for each test parameters is one of essential point for delivering quality laboratory services and client satisfactions. According to WHO recommendation, each laboratory should establish TAT to monitor and evaluate performance throughout of pre-analytical, analytical and post analytical processes.

Objective: To evaluate the laboratory performance and associated factors towards achieving turnaround time in CC and Hema test sat, AFCSH, Addis Ababa, Ethiopia.

Methods: A hospital based cross sectional study was conducted to evaluate the performance of TAT on clinical chemistry and hematology test parameters at AFCSH, laboratory from April2019 to June2019.A total of 422samples were collected, out of these samples 253 were from clinical chemistry test parameters169 were collected from hematology test parameters. In addition professional KAP for the Laboratory staffs with TAT has been assessed by using standard questionnaire. The data was entered; cleaned and analyzed using SPSS 24.0 Software. Descriptive statistics was applied in univariate analysis. Bivariate and multivariable regression analysis was done to find out statistically significant association and strength of association between dependent and independent variables at p-value <0.050 and OR with 95%CI.

Result: A total of 422 test results were systematically selected with 100% completeness rate. Of the total, 253(59.9%) were chemistry and 169(40.1%) hematology test. From the expected < 90min TAT clinical chemistry tests only 41(16.3%); and < 60min TAT for hematology tests37(21.6%) met the target. The mean +/-SD TAT for chemistry and hematology tests were 184.96±74.928 and 139.85±88.118 respectively. Also the level of knowledge, attitude and practices of lab staffs was assessed to support the output of TATshowed 60%, 85.7% and 62.9% respectively. This may have influence on the achievement of turnaround time of chemistry and hematology test reviled by current study which was 16.3% and 21.6% respectively.

Conclusion: Overall, the dalliance of Chemistry and Hematology tests TAT as determined in the current study was higher as compared to findings of other studies.

Key words:Turnaround time, performance, Quality indicator.

1. INTRODUCTION

1.1. Background

Laboratory turnaround time (TAT) is a parameters to measure performance of the laboratory, can be defined differently according to the test type (stat vs. routine), analytic, and institution, It is commonly defined as the time from when a test is ordered until the result is reported(1). Although, in many laboratory TAT is defined as the interval between ‘‘the time of sample collection’’ and the laboratory report is arrived to the physicians’’ this is called diagnostic turnaround time(2,3).It is subdivided into three phases pre-analytical, analytical & post analytical, the ‘‘total testing cycle’’ describes TAT as grouping of different steps, barcode printing, sample collection, transportation, preparation, analysis, verification and reporting Laboratories often give importance on accuracy and precision of the tests as their goals for quality service, However the clinicians prefer a faster TAT of the tests, which may help them to diagnose, treat and discharge their patients faster (3).

In medical laboratory activities production of quality laboratory test result plays a significant role on clinical diagnosis, decision, monitoring, and evaluating, studies indicated that up to 80% of medical decisions are also relay on medical laboratory results, with patient outcome evidence-based evaluation(4). So, timely delivering of laboratory results is the basic mainstays of a competent clinical laboratory, whose key goal is to deliver a better-quality service to its clients**,** this attribute can be monitored very efficiently by establishing a test parameter TAT(5).

As stated by the ISO 15189:2012,“The laboratory shall establish QIs to monitor and evaluate performance throughout critical aspects of pre-examination, examination and post examination processes”; and the institution "in consultation with its users based on setting; staffing; work load; equipment’s, material and supplies, the laboratory can establishes appropriate turnaround times for each of its test to determine whether or not it is meeting the established target with regular assessment of the laboratory quality result with TAT"(6).

The incidence of laboratory errors varies greatly depending on the steps of the TTP (total testing process) investigated the attention of laboratory professionals to the pre-analytical and post analytical phases, which have been demonstrated to be more susceptible to errors than the

analytical phase; the pre-analytical phase has the highest error rates, accounting for up to 70% of all mistakes in laboratory diagnostics(**7**).The total laboratory results turnaround time is influenced due to incompetency of phlebotomy, high workloads ,inappropriate work flow machine breakdown ,delay in the maintenance of analyzers, and computer shut down, as well as laboratories do not stress enough on its significance ,they give more Importance to the accuracy than turnaround time, (8). in addition, specimen transportation, shortage of resource , lack of knowledge and skills, power supply interruption, poor infrastructure and shortage of supplies also major factors that affecting condition of quality laboratory services as well as TAT(9).

Therefore, in assessing the laboratory services TAT is important tool for evaluations of established tests are the main one. The Working Group for Laboratory Errors and Patient Safety of the International Federation of Clinical Chemistry and Laboratory Medicine has recognized the TAT as a mandatory quality indicator(10).Routine Hematology tests includes (CBC, BF, HCT, HGB),Chemistry (Glucose, Urea, Creatnine, AST,ALT,ALP, Bilurubin total, and Cholesterol, The reason for the selected department because they are the most common tests requested by the physicians of the hospital, (11).

Ethiopian standards for comprehensive specialize hospital requirements **(**ES3618:2012), under section 5, defines that, Each service units of the hospital shall maintain a sufficient number of staff with the qualifications, training and skills necessary to meet patient needs as per this standard. The total number and types of staff currently available for the hospital as a whole and each service unit. The hospital shall develop monitoring and evaluation tools to assess activities including, Laboratory performance and workload. Also the laboratory facilities shall, meet at least the following, Continuous power supply and Working surface covered with appropriate materials. Based on this standard, hospital laboratories shall implement the standards to provide quality laboratory services. These tests are also the most significant rate-limiting step in patient management and discharge In light of this background the study has been determining the TAT from the sample collection-to-result releasing to physicians and evaluate the performance of TAT for the clinical chemistry and Hematology tests, in addition to the main complain areas. In addition the study was identified the factors that affect to the current turnaround time at the hospital laboratory during the study period.

1.2. Statement of the problem

Over 80% of laboratories receive complaints about TAT yet. A College of American Pathologists Q-Probes study of 2,763 clinicians and 72 institutions that, in the Service to ED is a particular source of dissatisfaction with87% of institutions reporting complaints(1, 12). In addition physicians in the Maternity and Children Hospital in Saudi, are not satisfied with the efficiency of laboratory services, analysis showed the major area of respondents' negative perception of laboratory services was the TAT for stat and routine test for inpatient and outpatient(ranged 2.5-2.6) out of 5,and study indicates, the physicians at Emergency Department (ED)also not satisfied with laboratory services, since the laboratory TAT caused delayed treatment and increased length of stay in ED(13). Laboratories do not meet clinicians' expectations. Moreover, the rapid growth in point-of-care testing demonstrates that clinicians are looking for faster test results even though point-of-care tests may be more costly, subject to a variety of interferences, for the reason that improving turnaround time is a difficult task, as shown by data for the emergency departments of more than 600 hospitals, hemoglobin, potassium and inquiry for CBC count reports as an indicator, TATs have been unchanged for almost a many years, most reports for inpatients and outpatient tests ordered stat are reported within 4 hours(14).

Timely laboratory results are must be better observed with emergency tests such as cerebrospinal fluid (CSF) chemistry, Delayed CSF results may result in serious consequences, especially in the setting of acute neurological diseases, as data shown in the laboratory for CSF chemistry (147min) and routine glucose (170 min) exceeded, the study target TAT was 120min(15).Analytical TAT also affected by test volumes specially stat tests, Comparing with other tests, reporting of the troponin-I (Tn-I) test was the most severely delayed, This delay in reporting might put off clinical decision-making in the practice of critical care contributed to poor TAT (16).Poor laboratory performance in terms of test turnaround time (TAT) has a major impact on patient care, also, increases in emergency department length of stay, Moreover, increases in the TAT outlier percentage Delaying test report, particularly test TAT outliers, would have a major impact on the efficiency of diagnosis and management of patients in the critical care setting of the ED(17).

A lot of evidences have pointedly indicated certain situations such as operation theaters and emergency departments, where timely test results have had significant impact on the overall outcome, the importance of the TAT cannot be emphasized enough when the pertinent study of this parameter can provide valuable information, aiding in resolving the reason 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(18).

There is convincing evidence that slow turnaround time of routine tests increases the frequency of stat and duplicate testing , high proportion of stat tests ordered in large hospitals may be due to the slow turnaround time of routine tests in the same institutions, stat specimens account for a large proportion of the total laboratory workload in large teaching hospitals, shows that data ,In the late 1980s, stat requests accounted for 30% of hematology and chemistry tests at the University of Alabama Medical Center in Birmingham,29 32% at University Hospital in Stony Brook, NY, 36% at the Hospital of the University of Pennsylvania, 41% at University of Western Ontario Hospital in London,30 and 45% at UCLA Medical(19).

Poor laboratory performance that causes an error and delays in diagnosis, and treatment is a major problem to optimal patient care, particularly in high volume patient care areas. The study in the Clinical Chemistry Laboratory at the University of Gondar Hospital by Ambachew S, the frequency of errors in post-analytical phase was 9.3%, almost triple than the study conducted in India (3.2%), in this study, excessive TAT(8.6%) contributed to the majority of post-analytical errors. Electrical fluctuation, shortage of distilled water and workload could be the cause of delay in reporting results within a specified time(20). Study identified in Ethiopia by Alem g/tsadik at wukro hospital, long turnaround time of laboratory results causes dissatisfaction of patients and clinicians, unwanted wastage of money due to wait for long time, see on table(21).

1.3. Significance of the Study

This study will provide information on evaluation of laboratory performance by measuring of turnaround time at Armed Force Comprehensive and Specialized Hospital laboratory in Addis Ababa, Ethiopia. More over this study will try to identify factors affecting turnaround time (TAT).Basically to know where are the gaps and identifying factors that affecting turnaround time, followed by working constantly to achieving the outcomes of turnaround time with taking corrective measures over a period of time will definitely help to improve the quality of laboratory services and performance.

- ✓ It has significant outcomes mainly to make available timely reports by the laboratory to physicians and manage their patients through diseases diagnosing.
- ✓ To improve laboratory quality management system because turnaround time is considered an essential quality indicator for laboratory tests as well as ensuring physician and patient satisfaction
- ✓ Improve shorten patients' length of stay in emergency room(ER) and hospitals.

  The finding of this study, therefore, will help to identify how much samples are within appropriate TAT and delaying reports as well as factors affecting turnaround time for appropriate action and it will be significantly valuable source of basic information for Laboratory manager sand policymakers.

2. Literature review

A study was done in the laboratory of Central Referral Hospital, Gangtok, SikkimbyRoy AD on measuring TAT for blood chemistry test Maximum samples 31(62%) were reported within the threshold of 180mins. Rest 19(38%) samples had a TAT of more than 180mins. The study showed the turnaround times of the 19 samples which were reported beyond the threshold of 180mins. The highest TAT was 232mins which was 52mins beyond the threshold of 180mins. The various reasons for delay in reporting results was, mainly caused by delayed TAT, (47.4%) was due to broken down of the analyzer, followed by negligence on the partof doctors (21%). Lack of man power and delay in transcription contributed equally to the same (15.8%) (22).

Another study done in Korea by Chung H J. *et al* on Laboratory Information System based monitoring system that recorded the laboratory turnaround time in 3 phases and analyzed the time to complete each phase with relevant specimens. 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 pre-analytical, analytical, and post-analytical phases were 29.7±6.9, 13.9±4.1, and 0.02±0.13 min, respectively; 98.0% of the chemistry and 94.0% of the hematology specimens were reported within 90 and 60 min respectively. The remaining 2.0% and 6.0% were reported after 60 min with an average TAT of 68.7±11.3 min. They concluded that the pre-analytical phase delays were primarily responsible for the specimens reported between 60 and 90 min, the pre-analytical phase was found to need improvement in order to shorten TAT (23).

A study was done in Iran by Mohammad J. *et al* on measuring TAT of hemoglobin, potassium, and prothrombin time tests at metropolitan hospital. The outcomes were Median TATs for 132 hemoglobin tests were 170 min, 172 potassium tests were 225 min, and 128 prothrombin tests were 195.5 min. Generally the overall mean of TAT was 4136±7.7 drastically longer than Q- Probes reported and recommended TATs. The longest intervals were emergency department waiting time and order processing. Their conclusion was Laboratory TAT varies among institutions, and data are sparse in developing countries. In the emergency department, actions to reduce emergency department waiting time and order processing are top priorities (24).

Another study was done from India by Wankar A D (2014) on a total 232 samples, 183 samples (78.88%) were taken for analysis. 100 (54.65%) chemistry 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(25).

Another study was done in India by Goswami B *et al* on measuring TAT for all the samples collected for routine and emergency visited outpatient and hospitalized patients were evaluated for one year. TAT was calculated from sample reception to report dispatch. The average TAT for the clinical biochemistry samples was 5.5hrs for routine inpatient samples while the TAT for the outpatient samples was 24 hrs. The turnaround time for stat samples was 1 hrs. Pre- and Post-analytical phases were found to contribute approximately 75% to the total TAT (26).

The cross sectional study done in Benin revealed that the average TAT of chemistry was delayed up to 300min. and from the 62 samples collected only 12% achieved the established TAT. This study also identified TAT at different phases of the testing cycle, from which analytical phase have been highest. The mean TAT for the pre-analytical, Analytical and Post-analytical phase was 70min,185min, and 45min. respectively.(27).

A study was done in India by G.S Chandrasekhar *et al* A total of 51,702 samples were analyzed in Adarsha Hospital. Inpatient specimens accounted for 34,165 (66%) and outpatient specimens accounted for 17,537 (34%) of the total specimens. The average TAT for the OPD and IPD routine parameters is 65min and 85min respectively. Major contribution to TAT was from pre-analytical phase, around 62%, analytical 25-30% and by post-analytical phase by 7-12%. He concluded that TAT was an important parameter for the laboratory as well as for the hospital in assessing the laboratory services. It is an important quality indicator as well.TAT for both OPD and IP samples were excellent in the laboratory (28).

In a study by Mahdaviazad H. *et al*Iran teaching hospital, on measuring TAT for all the samples collected (62.5%)for chemistry tests (FBS,BUN,Cr, Na, and K) and (37.5%)

hematology tests (CBC,PT, and PTT),on emergency visited, out of the aggregate samples 90% of the tests was completed within 3.5hrs and the mean total TAT of all the tests ranged from 1.3 to 3.1hrs, with a median of 2.0hrs (IQR = 1.5 - 2.8). The contribution of the laboratory phase to the total TAT was significantly higher than the pre-laboratory phase. The laboratory phase comprises the sum of the laboratory office to sorting, sorting to laboratory, laboratory to analysis, and analysis to verification intervals. In conclusion, this study suggests that the mean TAT in this university hospital is longer than available benchmark (29).

A study was done in Pakistan, Aga Khan University to find out the average TAT of chemistry tests of 495 samples. The result showed majority of reporting was delayed for more than 60mins, average analysis of the excess TAT tests showed on 185(45.3%) of samples. Overall delay in reporting in morning shift was found to be of 242(59.3%) samples and in the evening and night shift 83(20.3%) and 82(20.1%) samples were found to be delayed respectively (30).

A study was done in Nepal by Bhattarai K. *et al* on 1737 retrieved LIS clinical chemistry report samples. The 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 sample billed or collected during night shift was 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. They concluded that the analytical turnaround time and delay in the present study were appreciably greater than in many studies (31).Study done in Canada (2016) showed that the mean turnaround time for hematology test (CBC) was 95±111. (32).

The following conceptual framework explains the relationship between dependent and independent variables.

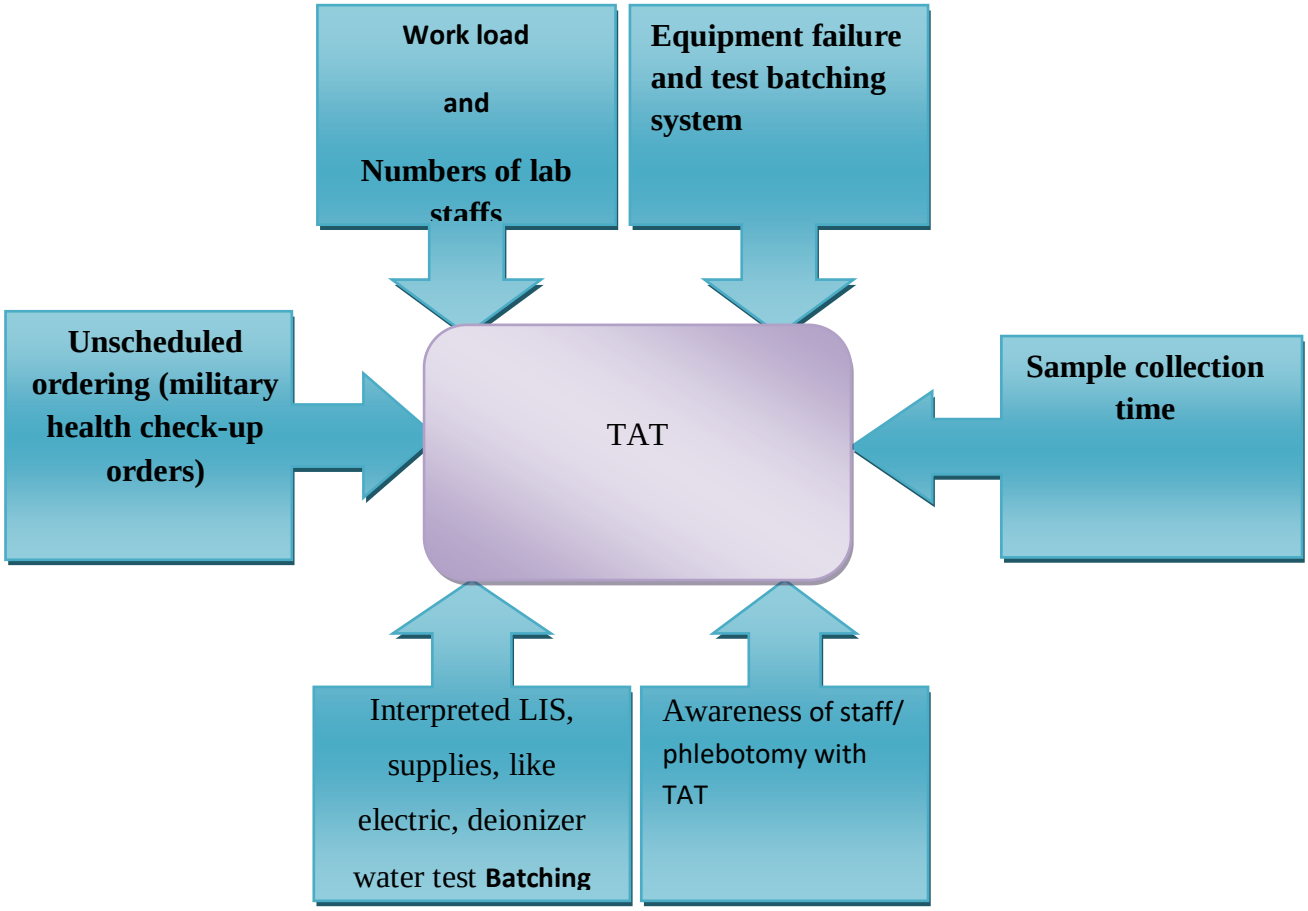


Figure 1: Conceptual frame work for this study Addis Ababa, Ethiopia December 2019

3. Hypothesis

- HO; The current turnaround time in Armed force comprehensive and specialized hospital laboratory is longer than the established TAT by the laboratory.

4. OBJECTIVES

4.1 General objective

To evaluate the laboratory performance by measuring turnaround time in Clinical chemistry and Hematology departments and assess associated factors in AFCSH, Addis Ababa, 2019.

4.2 Specific objective

- To determine performance level of TAT in Clinical chemistry and Hematology tests
- To identify factors contributing for performances of TAT in Clinical chemistry and Hematology departments.
- To assess the Knoeledge Attitude and Practices of of laboratory staffs with TAT.

5. Material and methods

5.1. Study Design

A hospital based cross sectional study was conducted at Armed Force comprehensive and specialized Hospital laboratory, in Clinical chemistry and hematology departments.

5.1. Study Area

This study was conducted in the Clinical Laboratory, Armed Force Comprehensive Specialized Hospital, Addis Ababa, It is owned by the government under the Federal Ministry of Defense (FMOD) which is situated at western part of Addis Ababa, the capital city of Ethiopia. The hospital has 15 wards with a five hundred ninety four bedded Which is a tertiary level super specialty hospital, It provides medical service to members of the defense force with their family, civil servants in the institution and private wing customers give regular health services for inpatient and ambulatory patients and serves as a referral center, for different hospitals under the ministry of defense. The hospital has Facilities for Laboratory Services that's helps in diagnosis, treatment and monitoring of diseases across different Departments.

The clinical laboratory in the hospital has different departments, including Clinical chemistry and Hematology departments. There are, laboratory coordinator and vise coordinator, with 31military and civil professionals with different levels and field of training,13phlebotomy's and 3 runners, the laboratory has equipped with fully automated Clinical chemistry Analyzers, M-200E M-200, coagulation analyzer, Mini vidas for hormonal assay ,fully automated hematology analyzers and LIS. Clinical Chemistry and Hematology performs a large number of tests .These include Lipid profile, Renal function, Liver function, measurement of Glucose and hormonal assays.CBC Coagulation panels, blood morphology, BF, and ESR. According to 2010ec annual reports of AFCSH, on average, 128 and 100 samples are run per day respectively (33). These tests are manipulated in clinical chemistry with three medical laboratory technologists and one laboratory technician and one Msc with two technologists in Hematology tests.

5.2. Study design and period:

A hospital based prospective cross sectional study design was conducted from April to May 2019**,**to evaluate performance of the laboratory towards achieving turnaround time for chemistry and hematology tests at Armed Forces Comprehensive Specialized Hospital, Laboratory.

5.3. Population:

5.3.1. Source population

Chemistry and hematology

- All test requests from armed force comprehensive and specialized hospital in Addis Ababa, Ethiopia.

KAP assessment

- All laboratory staffs working in AFCSH laboratory department.

5.3.2. Study population

- ✓ All Chemistry and Hematology test requests ordered by physicians
- ✓ All laboratory professionals and phlebotomies, for assessment of KAP with TAT, during the study period.

5.4. Inclusion and exclusion criteria

5.4.1. Inclusion criteria

All Chemistry and Hematology test requests ordered by Health professionals analyzed by the AFCSH laboratory, routine lab tests having standard turnaround time and all laboratory professionals and phlebotomies were included in the study

5.4.2. Exclusion criteria

Rare tests which are not having standard turnaround time and samples which are not doing in the laboratory temporarily/ Referral samples and cleaners in the laboratory were not included in this study.

5.5. Study variables

5.5.1. Dependent variables

The dependent variable is

- Total average TAT

5.5.2. Independent variables

The Independent variable is

- Work load
- Insufficient laboratory staffs
- Interrupted LIS and supplies
- Un scheduled test ordered
- staff awareness with TAT

5.6. Sample size calculation and Sampling method

5.6.1. Sample size calculation

A single population proportion formula was used for determination of the sample size considering the following assumptions: proportion of 50% taken due to absence of similar previous study, level of significance = 0.05, Marginal of error (d),Assuming the margin of error between the sample and the population = 5%, Z (α/2) = Z-score at 95% confidence interval = 1.96, therefore

$n=\{\frac{(Z\alpha/2)^2 p(1-p)}{n}\}$ Where n = calculated sample size

$(d)^2 Z\alpha/2$ = 1.96 at 95% Confidence Intervals (CI)

n = final sample size with 10% contingency

$\{(1.96)^2 \times 0.5\ (0.5)\}$ p= proportion 50%

$(0.5)^2$ d = margin of error

N = 384 + 10% contingency, n= 422

From specimens who were came to Army comprehensive specialized hospital Laboratory from outpatient and inpatient sample requests within the study period.

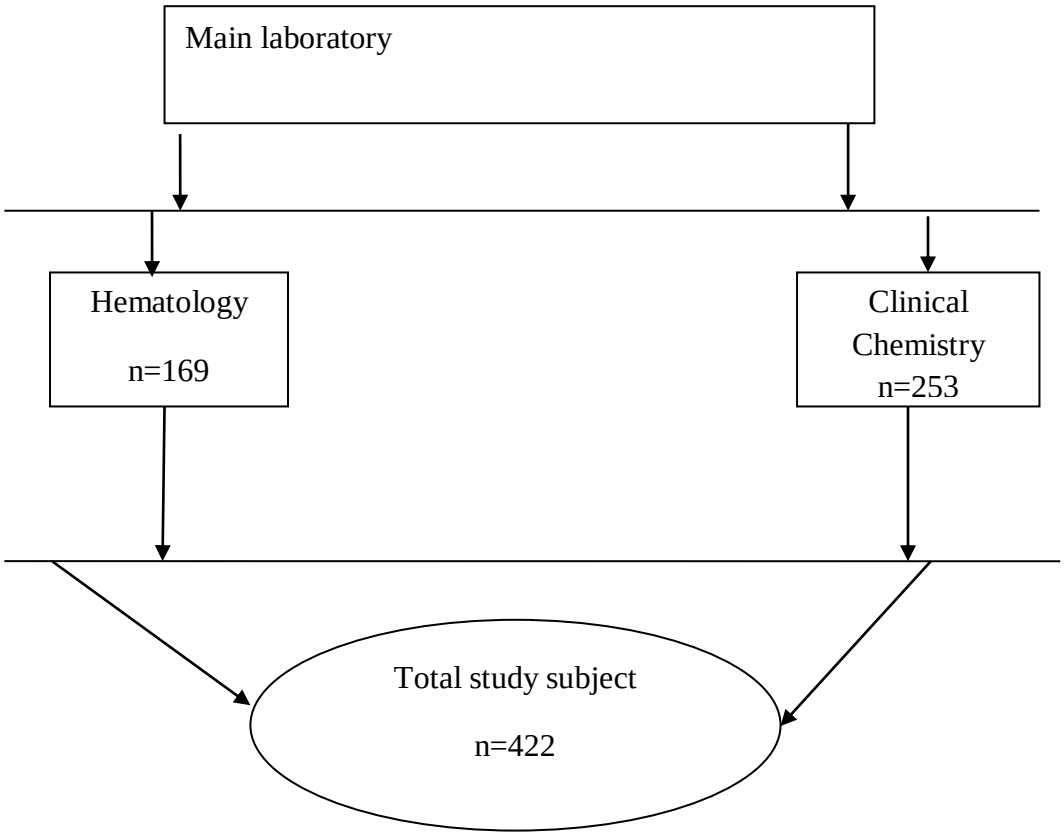
Regarding KAP assessment a total of 35 laboratory professionals working at Army comprehensive specialized hospital Laboratory were participated.

5.6.2. Sampling Method

Considering 10% of non-response rate, the sample size for chemistry and Hematology tests was 422. Finally sample was allocated proportionately for Chemistry and Hematology departments and eligible test requests according to number of tests ordering b/n the two departments by using annual report in the laboratory (60% and 40% respectively). Systematic sampling technique was employed to collect the sampled test results. After identifying the random start by lottery method, data was collected in every five samples. In addition, all

laboratory professionals and phlebotomist was participated in KAP assessment on TAT since the number of staffs was small in number.

Proportional probability sampling



5.7. Measurement and Data collection

5.7.1. Data collection procedure

The data was collected by 3 trained data collectors. TAT was classified in to 3 phases, Pre analytical phase, analytical phase, and post analytical phase. Then the data was collected by using sample collection check list and,(see annex I, II and III)**.** Each blood sample was collected every five samples. Structured questionnaire was employed to collect data related with Knowledge, attitude and practices of lab professionals and phlebotomist of TAT.

5.7.2. Measurement of variables:

- TAT less and equal to 90 minute is termed as good performance of the lab(34).
- TAT greater than 90 minute is termed as poor performance of the lab(34).
- TAT less and equal to 60 minute is termed as good performance(34).
- TAT greater than 60 minute is termed as poor performance(34).
- Target TAT for chemistry and hematology pre analytical phases less and equal to 40min& 30min respectively(34).
- Target TAT for chemistry and hematology analytical phases less and equal to 20 min and 10 minrespectively(34).
- Target TAT for chemistry and hematology post analytical phases less and equal to 30min and 20min respectively(34).
- Good knowledge: participants those answer the provided 10 questions to measure knowledge score 6 and above
- Good attitude: participants those answer the provided 10 questions to measure attitude score 6 and above
- Good practices: participants those answer the provided 10 questions to measure practices score 6 and above

5.8 Data Quality Assurance

Prior to the actual work, training was given to data collectors by principal investigator and the questionnaire was pre-tested in Air Force Hospital at Bishoftu to assure that it is proper and understandable. The collected data was checked daily for reliability of the data. Each activity was control to ensure data quality.

5.9. Data analysis and interpretation

Data generated was entered in to the Microsoft-Excel spreadsheet 2010 (Microsoft Cop., USA). And the data was analyzed by Statistical Package for Social Sciences (SPSS) software version 24.0.(IBM, USA). Descriptive statistics was applied in univariate analysis. Bivariate and multivariable regression analysis was done to find out statistically significant association and strength of association between dependent and independent variables at p-value <0.050 and COR and AOR with 95%CI.

5.10. Operational definitions

- Turnaround time (TAT): This indicator/parameter refers to the percentage of clinical chemistry and hematology tests that do not meet a reporting time limit. The target of TAT in AFCSH laboratory for clinical chemistry and hematology tests 90 min and 60 min respectively (4).
- TAT is defined as the interval between ‘‘the time of sample collection’’ and the report is dispatched to the physicians’’ (28).
- Scheduled test refers: Clinical chemistry and hematology test orders for patients.
- Unscheduled test refers: Clinical chemistry and hematology test orders for medical checkup.
- High patient flow refers; Number of patient flow more than one hundred per day
- Normal patent flow refers: Number of patient flow less than one hundred per day.

5.11. Ethical considerations

The study was conducted after ethical approval was obtained from Medical laboratory Science Research and Ethics Review Committee. Written permission was obtained from the armed force comprehensive and specialize hospital (AFCSH) administrator. Participants were recruited after they become informed about the objectives and use of the study and after they gave informed consent. Samples were coded and confidentiality of patient data was maintained throughout the study.

5.12. Dissemination of the result

The result was submitted to Addis Ababa University College of health science, school of allied health science, department of medical laboratory science, armed force comprehensive and specialized hospital (AFCSH) and it will also be presented in many national and international scientific conferences. The findings will be also sent to reputable journal for publication.

6. RESULTS

6.1 Frequency Distribution

A total of 422 laboratory test results were systematically selected with 100% completeness rate. Of the total, 253(59.9%) were chemistry and 169(40.1%) were hematology test. From the expected below 90 minutes TAT set clinical chemistry tests only one sixth achieved the target time 41(16.3%); whereas from the established less than 60 minute TAT for hematology test only one fourth met the target; The mean +/-SD TAT for chemistry and hematology tests it was 184.96±74.928 and139.85±88.118 respectively (Table 1).

This study was aimed to evaluate the performance of Laboratory TAT in the lab department of AFCSH. As indicated in figure 2, the laboratory performance level of chemistry and hematology test turnaround time was 16.3% and 21.6% respectively. More than three fourth (83.7%) of chemistry test result was delayed more than the defined TAT; similar result was exhibited in hematology test which is78.4% (Figure 2).

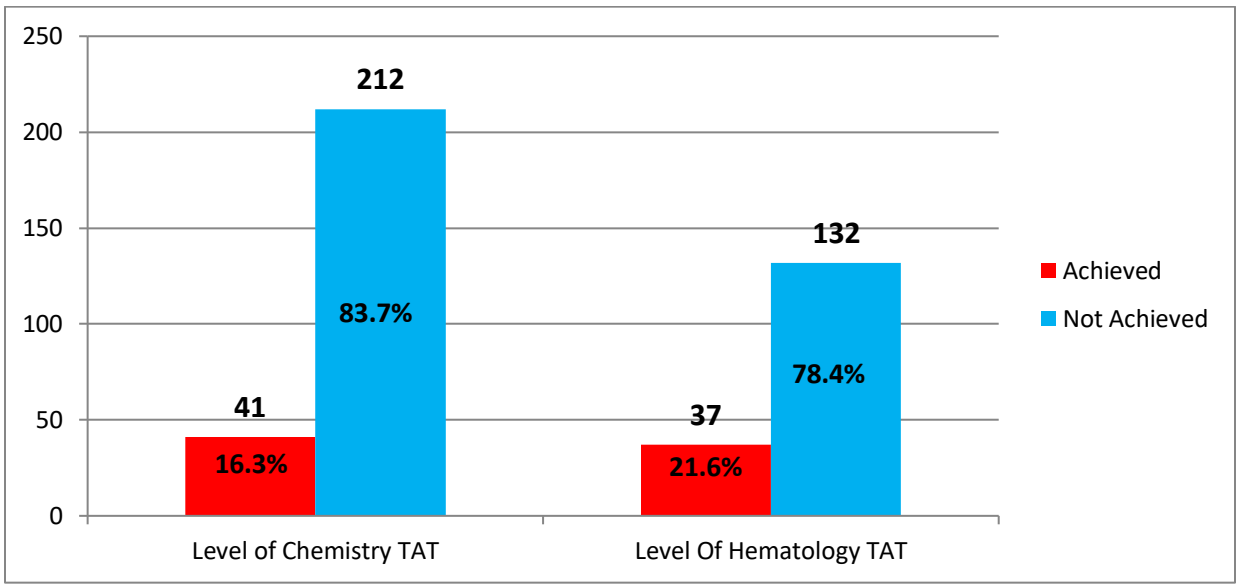


Figure 2: A bar chart showed the level of chemistry and hematology test of turnaround time in AFCSH, Addis Ababa, Ethiopia, 2019.

One hundred sixty nine (40.1%) of total sample was hematology test. Regarding the achievement of desired TAT (≤ 60 minute), only 37(21.6%, CI:15.5- 27.7) tests orders by physicians achieved it. The rest of hematology test took more than desired TAT. The mean

hematology test TAT was 139.85±88.118. One hundred nineteen (70.4%) of hematology test interrupted due to computer system problems, and about 117(69.2%) of test was collected earlier than four hour the rest 52(30.8%) samples collected from 4 to 6 o'clock. (Table-1)

Table 1: Frequency distribution of TAT for chemistry test result and variables which may influence the achievement of TAT standard in AFCSH, Addis Ababa, 2019 (n=35).

Variables		Chemistry test sample		Hematology test sample	
		Frequency	Percentage	Frequency	Percentage
IQC	Passed	246	97.2%	169	100%
	Failed	7	2.8%	0	0.0%
	Total	253	100%	169	100%
Daily work load	Usual	65	25.7%	73	43.2%
	High	188	74.3%	96	56.8%
	Total	253	100%	169	100%
Computer system related	Uninterrupted	39	15.4%	68	40.2%
	Interrupted	214	84.6%	101	59.8.4%
	Total	253	100%	169	100%
Test order	For Patient	115	45.5%	84	49.7%
	For screening	138	54.5%	85	50.3%
	Total	253	100%	169	100%
Power supply interruption	Uninterrupted	181	71.5%	144	85.2%
	Interrupted	72	28.5%	25	14.8%
	Total	253	100%	169	100%
Time of collection	2:00 – 3:59hr	204	80.4%	117	69.2%
	4:00 – 6:00hr	49	19.6%	52	30.8%
	Total	253	100%	169	100%

As table 2 showed the result of correlation analysis identified daily work load was significantly contributed 86.3% and 62% of delay during pre-analytical and post analytical of chemistry test respectively.

Table 2: Showed correlation between pre analytical, during analytical, post analytical with daily work load, (n = 253).

Variables		Chemistry								
		TAT for Pre analytical			TAT for analytical			TAT for post analytical		
		Achi	Not Achi	P-value	Achi	Not Achi	P-value	Achi	Not Achi	P-value
Daily work load	Normal	10(29.4%)	24(70.6%)	0.019	171(94.5%)	10(5.5%)	<0.01	24(70.6%)	10(29.4%)	<0.01
	High	30(13.7%)	189(86.3%)		48(66.7%)	24(33.3%)		78(35.6%)	141(62.4%)	
Hematology										
		Achi	Not Achi	P-value	Achi	Not Achi	P-value	Achi	Not Achi	P-value
Daily work load	Normal	49(67.1%)	24(32.9%)	<0.01	49(67.1%)	24(32.9%)	0.03	37(50.7%)	36(49.3%)	<0.01
	High	13(13.5%)	83(86.5%)		42(43.8%)	54(56.3%)		14(14.6%)	82(85.4%)	

*Note: *Achi – Achieved; Not Achi – Not achieved*

**P-value <0.05 indicate the association between variables real and came not bychance.*

6.2. Factors associated with dalliances in TAT of chemistry and hematology test;

To identify the associated factors for not achieving targeted TAT for chemistry, both bivariate and multivariable logistic analysis were done on different selected variables. The bivariate analysis result showed that four variables were statistically significantly associated with level of TAT performance. After adjustment made only daily work load and test order for clients were showed significant associated. TAT of chemistry test with more than standard (90 minute) had significant differences. Daily client flow more than 100 were 12 times significantly more likely to be not achieved TAT standard compared to the days with 100 clients [AOR: 12.45(95%CI: 4.78 – 22.44)]. Test ordered for medical screening actually not ill 6 times significantly more likely to not achieved TAT standard than test for patients [AOR:6.016(95%CI:2.19 – 12.523)] (Table 3).

Concerning TAT of hematology, both bivariate and multivariable logistic analysis was done to find associated factors which had statistically significant association. In bivariate analysis, most of predictors had statistically significant association with unable to achieve TAT standard. After adjustment more two variables were left statistically significantly associated at AOR. Extended TAT have seen in test results of patients 7 times more likely than peoples tested for only medical screening apparently they were not ill with p-value = 0.003, [AOR:7.55(95%CI:2.01 – 12.33)]. Similarly, hematology sample collected after four to six hour significantly associated with extended TAT with p-value = 0.049 (Table 3)

Table 3: Bivariate and multivariable logistic regression analysis of chemistry and Hematology tests, and factors associated with delayances of TAT standard in AFCSH, Addis Ababa. 2019.

Items	TAT for Chemistry					TAT of Hematology				
	Not achieved (n=253)	COR (95%CI)	p-value	AOR (95%CI)	p-value	Not achieved (n=169)	COR (95%CI)	p-value	AOR (95%CI)	p-value
work load at Pre										
Usual	24(70.4%)	1		1		24(32.9%)	1		1	
High	189(86.3%)	2.62(1.14 – 6.03)*	0.002	2.89(1.13 – 7.45)*	0.006	83(86.5%)	13(6.90 – 22.92)**	<0.001	8.98(2.01 – 21.47)**	<0.001
work load at Ana										
Usual	10(5.5%)	1		1		24(32.9%)	1		1	
High	24(33.7%)	8.55(3.83 – 19.11)**	<0.001	1.03(0.14 – 10.28)	0.995	54(56.3%)	2.62(1.39 – 4.94)	0.985	0.929(0.005 – 1.026)	0.892
work load at Post										
Usual	10(29.4%)	1		1		31 (42.5%)	1		1	
High	141(62.4%)	4.39(1.97 – 9.54)**	<0.001	1.76(4.78 – 12.45)*	0.024	85 (88.5%)	6.02(2.90 – 12.48)**	<0.001	5.14(1.26 – 19.68)*	0.036
LIS system										
Uninterrupted	15 (38.5%)	1		1		14 (28.0%)	1		1	
Interrupted	197 (92.1%)	18.54 (8.22 – 41.82)**	<0.001	3.19(1.14 – 8.92)*	0.027	119 (100%)	14.57(5.82 – 36.49)**	<0.001	6.21(1.57 – 24.53)*	0.009
Test order										
For Patient	62 (63.9%)	1		1		53 (63.1%)	9.36(3.42 – 25.60)**	<0.001	7.55(2.01 – 12.33)*	0.003
For screening	150 (96.2%)	14.11 (5.65 – 35.24)**	<0.001	6.02(2.190– 16.52)**	<0.001	80 (94.1%)	1		1	
Power interruption										
Uninterrupted	143 (79.0%)	1		1		122 (77.2%)	1		1	
Interrupted	69 (95.8%)	6.11 (1.82 – 20.49)*	0.049	0.998(0.64 – 28.205)	0.962	11 (100%)	7.34(1.68 – 32.07)*	0.008	3.03(0.46 – 23.27)	0.244
Time of collection										
2:00 – 3:59hr	174 (85.3%)	1		1		101 (86.3%)	1		1	
4:00 – 6:00hr	38 (77.6%)	0.59 (0.27 – 1.29)	0.294	0.899(0.001 – 0.994)	0.999	32 (61.50%)	3.94(1.83 – 8.50)**	<0.001	3.01(0.87 – 10.36)*	0.049

Note:- * Statistically significant at p-value <0.05; ** statistically significant at <0.01.
Pre- pre analysis; Ana – Analysis; Post –Post analysis

6.3. Assessment of Knowledge, Attitude and Practices

A total of 35 lab department work forces were participated in KAP assessment towards TAT performance. They had different in qualification under laboratory profession. Most of participants (40.0%) were lab technologists and 34.3% were phlebotomists. Regarding work experience, 34.3% were ≤ 5years, 31.4% were 6 – 10 years and 34.3% were more than 10 years of experience in laboratory practices. The overall KAP assessment indicated that knowledge, attitudes, and practices was 21(60%), 30(85.7%), and 22(62.9%) respectively (Figure 3, Table 4).

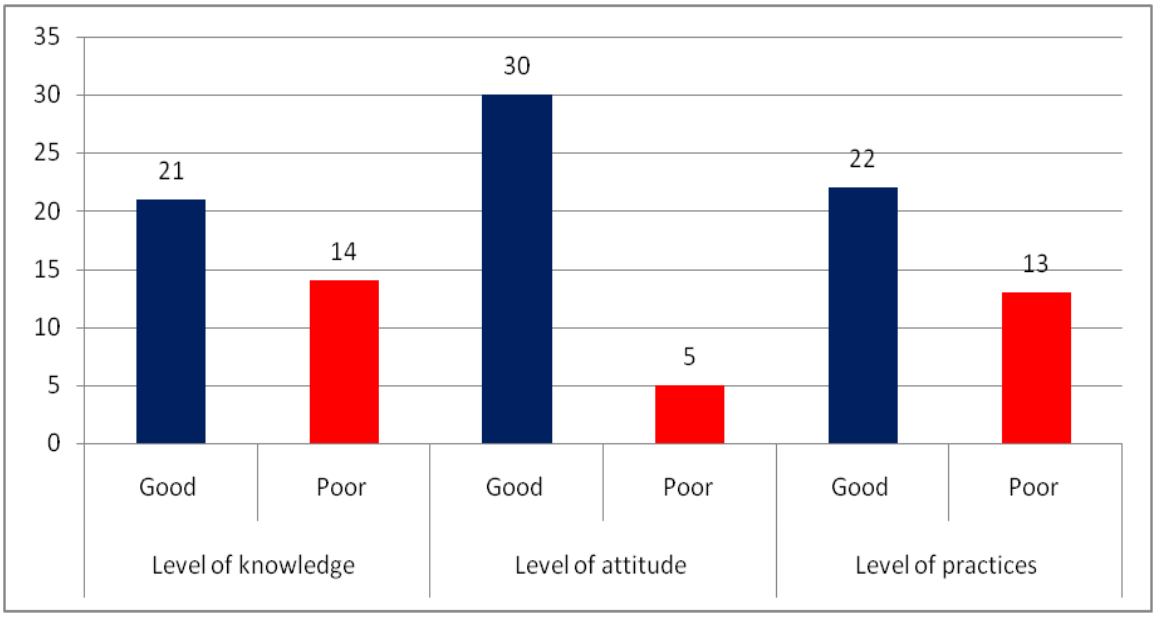


Figure 3: A bar chart showed the level of knowledge, attitude and practices among lab staff AFCSH towards TAT (n=35)

Table 4: Table showed the level of Knowledge, Attitude, Practices and some characteristics of laboratory department staffs, in AFCSH, Addis Ababa, 2019. (n=35).

Characteristics		Distribution	
		Frequency (n)	Percentage
Level of knowledge	Good	21	60%
	Poor	14	40%
	Total	35	100%
Level of attitude	Good	30	85.7%
	Poor	5	14.3%
	Total	35	100%
Level of practices	Good	22	62.9%
	Poor	13	37.1%
	Total	35	100%
Qualification	Masters	3	8.6%
	Lab technologist	14	40.0%
	Lab technician	6	17.1%
	Phlebotomist	12	34.3%
	Total	35	100%
Work experience	≤ 5 years	12	34.3%
	6 – 10 years	11	31.4%
	> 10 years	12	34.3%
	Total	35	100%
Sex	Male	17	48.6%
	Female	18	52.4%
	Total	35	100%

Table 5: Table shoed the percentage relationship between the level of KAP and some related characteristics of participants, AFCSH, Addis Ababa, Ethiopia 2019

Characteristics		Level of knowledge		Level of attitude		Level of practices	
		Good	Poor	Good	Poor	Good	Poor
Qualification	Masters	3(100%)	0(0.0%)	3(100%)	0(0.0%)	2(66.7%)	1(33.3%)
	Lab technologist	10(71.3%)	4(28.7%)	11(78.6%)	3(21.4%)	9(64.3%)	5(35.7%)
	Lab technician	4(66.7%)	2(33.3%)	6(100%)	0(0.0%)	4(66.7%)	2(33.3%)
	Phlebotomist	6(50.0%)	6(50.0%)	10(83.3%)	2(16.7%)	7(58.3%)	5(41.7%)
Work experience	≤ 5 years	5(41.7%)	7(58.3%)	10(83.3%)	2(167%)	7(58.3%)	5(41.7%)
	6 – 10 years	8(72.7%)	3(27.3%)	11(100%)	0(0.0%)	7(63.6%)	4(36.4%)
	> 10 years	8(66.7%)	4(33.3%)	9(75.0%)	3(25.0%)	8(66.7%)	4(33.3%)
Sex	Male	12(70.6%)	5(29.4%)	16(94.1%)	1(5.9%)	12(70.6%)	5(29.4%)
	Female	9(50.0%)	14(40.0%)	14(77.8%)	4(22.2%)	10(55.6%)	8(44.4%)

The above table showed the relationship of KAPs and level of qualification, work experience and sex of respondents. Among lab technologists 10(71.3%) of them had good knowledge. The level of knowledge showed relatively decreased from those who had master degree to phlebotomists, whereas, good attitude was very high among those who had masters and lab technicians than phlebotomists and lab technologists. Level of good practices was nearly similar through different level of qualification. Distribution of good knowledge and good practices increases along with increasing work experience, whereas, good attitude was 100% among those work experiences between 6 to 10 years (Table 5).

7. DISCUSSION

Turnaround time is one of laboratory performance indicator in any health service facility. The current study tried to measure the level of TAT in chemistry and hematology test in AFCSH, Addis Ababa. The study find out the level of TAT in chemistry and hematology test was 41(16.3%, CI: 11.5% – 20.5%) and 37(21.6%, CI: 15.2% - 27.7%) respectively. Delayance in chemistry test was significantly associated with daily work load and type of test ordered. Whereas, delayance in TAT of hematology test result was associated with daily work load, test ordered and time of sample collection at p-value <0.05. In addition the level of knowledge, attitude and practices was 60%, 85.7% and 62.9% respectively.

In current study the performance of laboratory in achievement of TAT in clinical chemistry and hematology sampled test was considerably very low, the achievement of chemistry tests was 41(16.3%) lower than the achievement of TAT of reported in Korea 98.0%, India 59.3% and Pakistan 54.6% respectively (23, 25, and 30). In comparison average TAT of current study was delayed very high 184.96±74.928 and this was higher that of the study conducted in Republic of Korea, which was 43.6±7.7 (23). And study done in Nepal also revealed that the mean TAT of chemistry test was 54.6±8.4 minutes (31). The very significant different between current study and others was due to high daily patient flow, type of laboratory machine, LIS interruptionand the time of data collected.

The same study done in Nepal also reviled that the mean TAT of chemistry test was 54.6±8.4 minutes. The current study TAT of chemistry was much delayed more than two folds than the studies conducted in Nepal and Karnataka (31, 28). This difference occurred may be due to the deference in daily work load which was responsible for TAT delaines about 86.6%.

In our study the level of hematology turnaround time of sampled test considerably very low, 37(21.6%). This is lower than the level of TAT of reported in Korea and India 79.0% and 54.6% respectively. And also lower than study done by Gungtok which was 62% (23, 22, and 25). The mean turnaround time of hematology test sampled for current study was 139.85±88.118 minutes. Whereas, other study conducted in Iran indicates that mean TAT of hematology was 43.6±7.7 minutes (24) and 90 min in Canada(32). Possible reasons for this difference were similar with the explanation given for the deference for chemistry part which was due to high daily patient flow, type of laboratory machine, and the time of data collected.

Daily work load or number of clients came to laboratory for chemistry test was between 2:00 -3:59hrs, one of the most significant factors for the delay of turnaround time at a p-value <0.0001. The same finding in India study was that most of the delay in TAT of the tests occurred in the morning shift Increase in workload at this time could be a reason for delay in TAT at this time of the day. Additionally, the test requested to chemistry lab test for medical screening purpose was significantly associated with dalliances of lab result from the recommended time, p-value <0.0001. Other study resulted which have been found to affect TAT of any laboratory, it is the size. It has been reported that results were available sooner in non-teaching than teaching and in smaller rather than larger institutions (25).

Current study identified that hematology test was more delayed in TAT observed on test requested for the patients seven times more likely than those who came for medical screening. Sample collected 2 to 4 hours were three times more likely delayed in TAT than sample collected after 4 to 6hours. Both were significant at p-value <0.0001. Whereas study conducted in Kenya and Iran reviled that daily work load and interruption in LIS was significantly predict the extended TAT of hematology test at a p-value <0.05 (24, 30).

Awareness of laboratory related work force is the one of very important factors that influences the overall turnaround time in achieving defined time interval. This study was reviled the level of knowledge, attitude and practices was 60%, 85.7% and 62.9% respectively. These have influence on the level of turnaround time of chemistry and hematology test reviled by current study which was 16.3% and 21.6% respectively.

In addition, the overall average TAT was more delayed in our observational study, it may be due to, instrumentation failure,(occurred one times for chemistry and Hematology analyzers) Shortage of data encoder in morning hours, accumulation samples on sample collection site commonly greater than 10 samples in one round, not enough sample collectors in morning hours and lack of exposure to the new LIS, shortage of deionizer water for chemistry machines and un interfaced the system with the auto analyzers.

In our study the total Laboratory TAT for chemistry and hematology tests was affected by these variables such as high work loud, LIS and power interruption, unscheduled test order and sample collection time. The pre analytical and post analytical phase also significantly affected by these two variables, LIS interruption and high work loud) at p-value <0.05.

8. Limitations

8.1. Limitation

- Not included patient waiting time on the laboratory before collection
- The finding was not supported by qualitative study
- Not enough available materials /Literatures

9. CONCLUSION AND RECOMMENDATION

9.1. Conclusion

Overall, the level of chemistry and hematology turnaround time as determined in the current study was very low, which is 16.3% for chemistry and 23.6% for hematology. Daily work load, unlimited flow of medical screening test, Interruption of LIS, and pick time (2:00 – 3:59hr) was significantly influence the achievement of recommended turnaround time of chemistry and hematology test in the hospital. Daily work load have significant influence on pre analytical phases of chemistry and hematology lab tests than on analysis and post analysis turn over time.

9.2. Recommendation

Achieving the recommended TAT is very crucial even to save the life of patients. So, based on the findings of current study, the following recommendations are made.

- Scheduled time for clients those came to hospital for only medical fitness separately from patients.
- The interruption of LIS should be managed to resolve its potential effect on the delay of result reporting.
- Assign additional personnel /work force in laboratory in the morning time when flow is picking.
- 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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11. Annexes

Annex I:

Information sheet for study subjects (English version)

In this particular study we would like to use the Response you gave during study for research.

Principal Investigator: MEBRAT G/YESUS

Addis Ababa University, College of Health Sciences, Department of Medical Laboratory Sciences

Purpose: the purpose of this study is to evaluate laboratory performance towards achieving turnaround time AT ARMED FORCES COMPREHENSIVE SPECIALIZED HOSPITAL, ADDIS ABABA, ETHIOPIA.

Procedures to be carried on: you are invited to participate in the study after giving your consent by giving your sign below

Risks associated with the study: There is no risk and serious invasive procedure at the beginning as well as at the end of the study and there is no additional time required from you to stay during study.

Benefits of the study: There will be no financial or other direct benefit to you.

Compensations: There will be no compensation for using your information.

Confidentiality of your information: The results of the findings will be kept confidential and could only be accessed by the researcher. There will be no personal information to be attached to your data.

Based on the above information I agree to participate in the research

Signature: _____ Date: _____

Coordinating organization: Addis Ababa University, College of Health Sciences, Department of Medical Laboratory Sciences

If you have any question you can ask the following individuals

Persons to contact**:** (Mob: +251911479274, Email:(gebreyesusmebthit@gmail.com)

Annex II

KAP assessment questionnaires on Turnaround Time (TAT)

Part1: Socio demographic	
Sex	1. Male 2. Female
Age	_____ Years
Responsibility	1. Lab head 2. Section head 3. Q. officer 4. Safety officer 5.Others
Qualification	1. Master degree 2. Bachelor degree 3. Diploma 4. Phlebotomy 5. Data encoder
Work Experience	1. 0-5 year 2. 6-10 year 3. Above 10 year

KAP Assessment Questions

S No	**Part 2: Knowledge questions**	Options		
		Ye	No	N. sure
1	Do you have document in the lab, which use for applying and monitoring of TAT			
2	If yes for Q No 1, do you read the document?			
3	Do you say that applying of TAT is the responsibility of all lab personnel?			
4	Is it the only responsibility of quality officer to apply TAT?			
5	Did you take quality management training to apply TAT in the lab?			
6	Did you take sample collection training to apply TAT in the lab?			
7	Did you take laboratory information system (LIS) training to apply TAT in the lab?			
8	Do you have a basic knowledge to enter client's lab result in the computer?			

Continued from part 2

1.Does the unreleased of result on time lower the service quality?

1. Yes
2. No
3. Not sure

1. The quality control (QC) routinely works in the laboratoryYes it works
2. No it did not work
3. It works sometime

3. If your answer for Q # 2 is ''yes it works'' Does it passed in the first round/?

1. Most of the time, it passed (yes)
2. Most of the time, itwasrepeated (no)
3. Not sure

S. No	Part 3: Attitude questions	S Da	Da	N	A	Sa
1	The Lab results, which is not released on time decrease the lab performance	1	2	3	4	5
2	Applied of TAT in laboratory service, increases client's satisfaction	1	2	3	4	5
3	Applied of TAT on time can make a problem on quality control (QC)	1	2	3	4	5
4	Application of TAT used more to clients than the laboratory	1	2	3	4	5
5	The priority service of the laboratory should be giving an accurate result	1	2	3	4	5
6	Correct applied of TAT is the one and the main issue for the computation of the laboratory	1	2	3	4	5
7	Application of TAT is not create influence on laboratory service quality	1	2	3	4	5
8	Correct applied of TAT not only used for laboratory but also for hospital	1	2	3	4	5
9	The priority service of laboratory should be release of result on time	1	2	3	4	5
10	Release of result on time highly used for patient as well as for the hospital laboratory	1	2	3	4	5
11	One of the reason for recollection of sample is due to use of syringe	1	2	3	4	5
12	Samples collected by using vacationer helps for correct application of TAT	1	2	3	4	5
13	Looking client's full information and investigation type, collecting samples and entering result has contribution for client satisfaction	1	2	3	4	5

Strongly disagree (S.Da) 2. Disagree (Da) 3. Neutral (N) 4. Agree (A) 5. Strongly agree(Sa)

S.No	Part 4 □ work practice questionnaires	Options
1	Do you check materials like reagent, distilled water, reading control, computer and electrical power access before staring a procedure?	1. It is Good(yes) 2. It is not good(no)
2	How many samples collected and distribute to each lab personnel?	1. up to 5(yes) 2. Greater than 5 (no)
3	Is there an insufficient blood sample taken for doing investigation?	1. Yes 2. No
4	How many results send to the computer at on one occasion?	1. up to 5 (yes) 2. Greater than 5 (no)
5	How the results release to the physicians at the end of procedure?	1. Just as reached(yes) 2. Collected(no)
6	How many test tube used during request of more than one investigation like chemistry and serology tests?	1. One(yes) 2. Two(no)
7	How the laboratory results sent to physicians?	1. by runners 2. by computer (LIS)
8	How do you see the starting time of TAT in the majority of laboratory test?	1. It is Good(yes) 2. It is not good(no)
9	Experience on release of all results based on their appropriate time	1. It is Good(yes) 2. It is not good(no)
10	Regarding to TAT, does the release of test results depend on samples entered in to the machine (for chemistry, per patient / per test)?	1. Yes 2.No

S.No	Questions regarding on man power and materials access	Options
1	Access of necessary materials	1. It is good 2. It is not good
2	Access of electrical power, distilled water and laboratory information system	1. Interrupted 2. Not interrupted
3	Access of man power compared to work activity	1. Adequate 2. Not adequate

Sample ID:_____

Annex III:

1. Patient Type
    a. Outpatient &In patient (code = 1)
    b. Emergency (code =2)

2. Type of test
    a. Chemistry (code =1)
    b. Hematology (code =2)

3. Time of test (s) requested from request paper

    Date (DD/MM/YYYY):_____
    Time (HH:MM:SS):_____

4. Time of specimen (s) collected at phlebotomy (brief expected activities)

    - Registration and bar coding time_____
    - Blood sample collected time_____

5. Time of specimen received at main lab

    - Date (DD/MM/YYYY):_____
    - Time of sample delivery on main lab _____
    - Time of sample distribution to respective dept._____

6. Time of result delivered room

    - Date (DD/MM/YYYY):_____
    - Result production time on auto _____
    - Time of verification and releasing/printing result _____

7. # of tests requested:_____
8. Tester service year:_____
9. IQC-performance:
    a. Done as early as possible, and passed in the first episode
    b. Done as early as possible, and failed in the first episode

10. TAT
    a. Laboratory TAT [HH:MM:SS]: _____ code=T4
    b. Pre-analytical time [HH:MM:SS]: _____ code= T1
    c. Analytical time [HH:MM:SS] :_____ code =T2
    d. Post analytical time [HH:MM:SS]: _____ code =T3

12. Declaration

1. The under signed, declare that this MSc thesis is my original work and it has not been presented for a degree in any other University. All sources of materials used of this thesis and institutions who gave support have been acknowledged.

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