



THE EFFECT OF LABORATORY TURNAROUND TIME IN EMERGENCY DEPARTMENT AT AL-NOOR SPECIALIST HOSPITAL IN MAKKAH, SAUDI ARABIA

Alzahraa K. Halabi^{1,*} and Hoda Z. Helmy²

¹Department of Health Services and Hospitals Administration, Faculty of Economics and Administration, University of King Abdulaziz

²School of Hospitals Administration, University of KAU

ARTICLE INFO

Article History:

Received 19th February, 2021
Received in revised form
24th March, 2021
Accepted 25th April, 2021
Published online 28th May, 2021

Key Words:

Emergency Department, Health information system, Length of Stay, Most Responsible Physician, Turn Around Time.

ABSTRACT

Background: Laboratory turnaround time is a periodic measure for improving hospital services and increasing the quality of care as well as patient satisfaction. The current study aims to evaluate the correlation between TAT and LOS at Al Noor Specialist Hospital ED. It also help policy makers to enhance the quality of services provided by minimizing the root causes of the problem. **Methods:** The retrospective cross-sectional research design uses ED Health information system data at Al Noor Specialist Hospital. Analysis of all laboratory tests (Hematology and Biochemistry) ordered by ED physicians from 05 October 2018 until 4 October 2019. The Regression analysis tests used to report the correlation in-between two TAT and LOS. The IBM SPSS "Statistical Package for the Social Sciences" version 21 used to generate the result. **Result:** The total number of ED visits is (181,704) and the average LOS is about 2 hours and most people using the services are the Saudi citizen, male, in 21-40 years old. The second in order is pilgrims of HAJJ and UMRA His more than 21% of visits. The Study indicated that there is a statistically insignificant result and weak relation between TAT and ED length of stay so, the study accepts the null hypothesis. **Conclusion:** The study has been proven that there is no relation between TAT and LOS. Further research is needed to assess and evaluate time to physician diagnosis with TAT to verify if there is a relation between them.

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Citation: Alzahraa K. Halabi and Hoda Z. Helmy. "The Effect of Laboratory Turnaround Time in Emergency Department at Al-Noor Specialist Hospital in Makkah, Saudi Arabia", 2021. *International Journal of Current Research*, 13, (05), 17402-17406.

INTRODUCTION

Emergency medicine is acknowledged as an ambulatory service, both globally and locally in Saudi Arabia. The dramatic increase in the number of unplanned visits for patients who require urgent medical attention needs to be highlighted. Back in 1972, emergency medicine was officially recognized as a separate specialty by the American Medical Association (Suter, 2012). However, emergency services and pre-hospital care in Saudi Arabia was officially granted a specialty status only in 2001 (Khattab *et al.*, 2019). The emergency department is one of the most vital units in the hospital structure, as it is considered the frontline and gateway to healthcare services. The department treats severely ill and injured patients who require urgent medical attention. Therefore, the Emergency Department (ED) must function efficiently to provide the safest, most adequate, and most effective care to maintain high patient satisfaction (Storrow *et al.*, 2008), (Carrier *et al.*, 2014), (Kaushik *et al.*, 2018).

*Corresponding author: Alzahraa K. Halabi,
Department of Health Services and Hospitals Administration, Faculty of Economics and Administration, University of King Abdulaziz.

Hospitals are facing a tremendous increase in the number of patients who are using ED services. The large number of patients accommodated by the ED often leads to overcrowding, which has become a serious global issue. The precise definition of crowding is still ambiguous. Some define it as a shortage of ED nursing and physician staff due to work overload. Others assess overcrowding in terms of quality of ED services, such as the number of accessible hospital beds, waiting and treatment times, and actual patient outcomes. ED overcrowding will greatly affect the overall quality of services provided by hospitals and patient satisfaction (Shin *et al.*, 2013), (Bicki *et al.*, 2013) In other words, the performance of various hospital departments will be highly affected by ED performance (Carrier *et al.*, 2014). Hospitals need to address ED overcrowding by identifying the root cause and choosing efficient strategies to improve patient flow and guarantee the quality of care provided. As mentioned earlier, ED congestion will reduce service quality, increase the mortality rate and lead to adverse effects on patients' lives (Shin *et al.*, 2013), (Bicki *et al.*, 2013), (Kawano *et al.*, 2014), (Almemari & Qayyum, 2020). Compared to other departments, time is crucial in the ED. A study conducted on the international perspective about ED crowding in 15 countries other than the United States reported how long wait times in ED affect patient flow and challenge the healthcare system (Pines *et al.*, 2011).

ED laboratory tests are an essential diagnostic tool in patient management. They contribute to improving the provided services by improving the time spent in diagnosis and emergency performance as well (Lee-Lewandrowski *et al.*, 2003), (Robert C Hawkins, 2007), (Sheppard *et al.*, 2008). Turnaround time (TAT) is the amount of time taken to complete or fulfil the tests. TAT is used as an indicator of laboratory service performance and ED workflow. In addition, laboratory TAT highly impacts patient management and discharge.(Robert C Hawkins, 2007)It is significant to evaluate the effect of hematology and biochemistry TAT on ED LOS. First, both are routinely requested in the ED. Second, they provide general information on patient health and help health care practitioners in patient diagnosis. The relationship between laboratory TAT and patient LOS in the ED is still ambiguous. A previous study suggested that decreased TAT could improve ED efficiency and reduce LOS (Li *et al.*, 2015). The TAT measurement process is a periodic improvement process that is reflected in the quality of care and patient satisfaction. This study aims to assess the relationship between TAT and LOS at Al Noor Specialist Hospital ED and examine whether there are other factors affecting TAT in order to improve ED performance.

METHODS

The study is conducted at Al-Noor Specialist Hospital in Makkah, Saudi Arabia. It's the main tertiary hospital with 300 beds capacity. The average ED visits are estimated at 450 visits per day. The retrospective cross-sectional research design uses qualitative and quantitative data to examine the relation between LOS and TAT at the ED by using regression analysis. The study used ED Health information system at Al-Noor specialist hospital to retrieve ED laboratory tests detail in Excel sheet. All laboratory tests requested by ED physicians at Al-Noor Specialist Hospital ED were included. Total Number of tests was 1,372,283 from 5th of Oct. 2018 until 4th of Oct. 2019. 552,333 for biochemistry and 819,953 for hematology. The hematology include (CBC, PT, PTT), biochemistry is (RBS, Blood urea nitrogen, Cr, Na, and K) and Cardiac profile (Troponin T, Creatinine Kinase, Creatinine Kinase-MB). The data will be excluded based on the type of discharge for instance; (DAMA, LAMA, Dead, Absconded and patient's advice to go to UCC as well as missing data) and the TAT beyond the seventy minutes. Around ten percent excluded from the total sample size as sates in the literatures. ED laboratory tests data collected according to the type of the test whether hematology or biochemistry. The study will examine the relation between ED arrival day and time to identify peak time. Based on the study hypothesis, the TAT result will affect by patients' triage level, laboratory tests type and discharge types. Therefore, we will examine the relationship between these variables and TAT. IBM Statistical Package for the Social Science (SPSS) version 21 will be used to analyze the study result. Ethical approval number (H-02-K-076-0920-371) granted on October 04th, 2020 by Makkah Institutional Review Board.

RESULTS

Total number of ED visits is 181,704 from 5th of October 2018 until 4th of October 2019, mean is 2.05, mod is 0.48, median is 1.45 and standard deviation is 2.00. this indicates that the data is normally distributed around the mean. The upper limit of LOS is 8.00 hours and lower limit is -118.68 refer to 43 second. Table1 demonstrates that the total number of ED visits equal 181,704 and the average LOS is about two hours and most people using the services are the Saudi citizen, male, in 21-40 years old. The second in order is pilgrims of HAJJ and UMRAH, and that expresses how much care is delivered from the government of Saudi Arabia for pilgrims. Moreover, the highest average LOS of 3 hours was for CTAS-1 "life threatening cases". The greatest number of visits is on Sundays among the weekdays and Saturdays come after. The majority of ED visitors discharge home and long LOS in the ED is for admitted patients, and it is about four hours in average. Dead, DAMA and absconded will be excluded from TAT datasheet.

Table 1. Total number of Emergency visits with average length of stay

Nationality	Number of ED Visits = 181,704	Average LOS (H) = 2
Saudi	111161 (61%)	2.04
Non-Saudi	70543 (39%)	2.12
Gender		
Female	73529 (40.4%)	2.07
Male	108125 (59.5%)	2.04
Missing	50 (.02%)	1.83
Patients Age		
1Month - 20 year	34810 (19.1%)	1.63
21-40 year	66963 (36.8%)	1.98
41-60 year	46983 (25.8%)	2.11
61-80 year	28759 (15.8%)	2.53
81 and above	4189 (2.3%)	2.92
Patient Type		
CITIZEN	111054 (61.1%)	2.04
GCC-CITIZEN	366 (0.2%)	2
HAJJ	5230 (2.875)	2.12
UMRAH	33470 (18.42)	1.98
RESIDENT	70 (0.03%)	3.59
Illegal RESIDENT	11607 (6.38%)	1.99
UNKNOWN – CRISIS	396 (0.21%)	2.26
OTHER	18623 (10.24%)	2.09
MISSING	888 (0.48%)	1.3
Triage Level		
CTAS-1	2030 (1.1%)	3
CTAS-2	8904 (4.9%)	2.16
CTAS-3	64942 (35.74)	2.26
CTAS-4	72769 (40.04%)	2.08
CTAS-5	16478 (9.06%)	0.35
Missing	16581 (9.12%)	3.37
The Day of the week		
Sunday	27746 (15.2%)	2.04
Monday	25742 (14.16%)	2.02
Tuesday	25967 (14.29%)	2.01
Wednesday	25960 (14.28%)	2.04
Thursday	25022 (13.77%)	2.06
Friday	24090 (13.25%)	2.07
Saturday	27177 (14.95%)	2.09
Type of Discharge		
Admitted	13179 (7.25%)	4.01
Referred	1310 (0.72%)	2.49
Advice to go to UCC	17487 (9.62%)	0.24
Absconded	2260 (1.24%)	3.37
DAMA	3713 (2.04%)	3.29
Discharge Home	117090 (64.43%)	1.91
Other	22952 (12.63%)	1.95
Dead	2335 (1.28%)	0.51
Missing	1378 (0.75%)	3.1

Table-2demonstrates TAT values in minutes versus the LOS values in hours to examine the correlation between them by using liner regression. The data is normally distributed; value of relationship is (0.140) that means week relation between TAT and LOS. Adjusted R Square is (-.070), standard error for estimation is (.08869) and p value = (0.648) the study accepts null hypothesis so there is no relation between TAT and LOS. Table-3 demonstrates that the highest volume of visits was for Sundays followed by Saturdays, but the TAT average is highest on Saturdays as it is the weekend in Saudi Arabia. The multi liner Regression test reveals that there is statistically significant result for modeling of fitting equal .000 and R-Square mean that model explain by .010 out of variance in dependent variables. Using standardized coefficient, Beta value to comper between triage level and weekday and the result is much greater for triage level than weekday's variable. Regarding the p values, all variables are statistically significant. Under ANOVA table, the study rejects the null hypothesis. Moreover, table-3 demonstrates that the highest volume of visits was related to CTAS-4 followed by CTAS-3, but the long TAT in average is for CTAS-5 as the TAT is equal to 50.10 minutes. Table-4 demonstrates that the TAT is different between hematology and biochemistry. The average is 45.60 for hematology and 53.26 for biochemistry around 10 minutes more between them. Table-5 demonstrates that the lowest time in average is 46.54 minutes for morning shift followed by night shift.

Table 2. The relation between TAT and LOS

Average from order until receive	TAT in minutes (48.89)	LOS in Hour (2.05)
2018-Oct	47.70	2.10
2018-Nov	48.22	2.08
2018-Dec	48.04	2.04
2019-Jan	46.53	2.08
2019-Feb	47.60	2.06
2019-Mar	46.87	2.15
2019-Apr	49.79	2.04
2019-May	51.35	1.96
2019-Jun	51.30	1.95
2019-Jul	49.20	2.20
2019-Aug	48.82	2.06
2019-Sep	43.99	1.87
2019-Oct	42.26	2.00

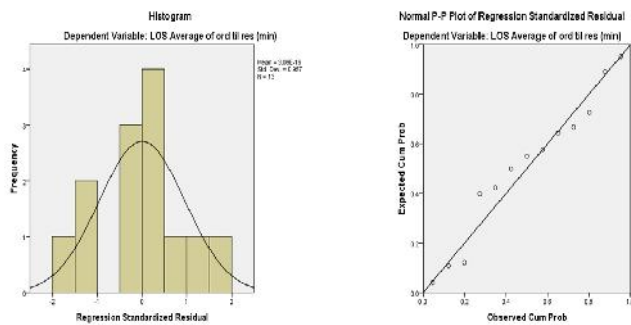


Figure 1. The normality & linearity between TAT and LOS

Table 3. The relation between TAT, Weekdays, and Triage Scale

WEEKDAY	No. Visits	Percentage	TAT in min				
Sunday	27746	15.2%	47.67				
Monday	25742	14.1%	49.42				
Tuesday	25967	14.2%	48.03				
Wednesday	25960	14.2%	46.47				
Thursday	25022	13.7%	47.31				
Friday	24090	13.2%	46.14				
Saturday	27177	14.9%	49.43				
Triage Level							
CTAS-1	2030	1.11%	47.98				
CTAS-2	8904	4.9%	47.32				
CTAS-3	64942	35.74%	47.62				
CTAS-4	72769	40.04%	47.14				
CTAS-5	16478	9.06%	50.10				
Missing	16581	9.12%	47.35				
Independent variable	¹ R	¹ RSquare	² F	² Sig.	³ B	³ T	³ Sig
WEEKDAY	.101	.010	55.817	.000	-.047	-3.503	.000
Triage Level					.129	9.529	.000

1 = From Model summary table.
 2= From ANOVA table.
 3= From table coefficients table.

Table-6 demonstrates that the lowest LOS average between admitted and discharge patient is 1.91 for patients discharge home.

DISCUSSION

The present study proved that there is no statistical relation between TAT and ED LOS.

Table 4. TAT based on the type of test during one-year period in between 2018-2019 at Al-Noor specialist Hospital

TAT for each Test Type		
Test Type	BIOCHEMISTRY	HAEMATOLOGY
18-Oct	57.63	46.50
18-Nov	58.01	47.00
18-Dec	54.60	47.71
19-Jan	53.30	45.99
19-Feb	55.56	46.85
19-Mar	55.27	45.99
19-Apr	53.05	44.85
19-May	53.79	45.28
19-Jun	54.18	45.64
19-Jul	52.36	44.19
19-Aug	51.77	43.25
19-Sep	50.20	43.52
19-Oct	60.40	40.57
Average	53.26	45.60

Table 5. TAT for working shifts at Al-Noor Specialist Hospital

Working hour	TAT (min)
Morning Shift	46.54
Afternoon Shift	47.84
Night Shift	46.85

Table 6. LOS for Type of Discharge at Al-Noor Specialist Hospital

Discharge Type	LOS in Hours
Admitted to the hospital ward	4.01
Non-Urgent Referred to UCC	0.24
Cases Referred to Other Healthcare Facilities	2.49
Discharge Home	1.91

This finding is not consistent with other studies that reported that there is a statistical relation between them (Holland *et al.*, 2005), (Kaushik *et al.*, 2018). The current study result will follow the result indicated the decreases in TAT led to time physician diagnosis decreases not length of stay (Lee-Lewandrowski *et al.*, 2003), (Robert C Hawkins, 2007), (Sheppard *et al.*, 2008). The current result of this study accepts the null hypothesis which is no relation between TAT and LOS. This might indicate that due to pneumatic tube system the relation affected since the system applied long time or due to other reasons state before in the literature as MRP, Nursing staff, separated ED lab etc. So, more investigation might be needed to study the relation between TAT and physician diagnosis. The results of multi liner regression analysis prove the statistically significant relation between TAT with two variables, weekday and triage level. This result matches with what have been documented in the literature (Duvald, 2019) and due to different attitude for the patients attending ED in different countries, the relation will changed. As the common preference for patients is different, this has led to different peak time in some countries from others. Their preferences make them visit hospitals on some days more than others as well as most of CTAS-1,2 attend ED out off duty hours when the hospital has fewer workforce who are covering the services. The regression analysis of the present study indicates that there is a significant relation between TAT and triage level. The TAT for CTAS 2 ranked second (47.32 minutes), while TAT for CTAS 5 was the longest (50.1 minutes). Results of another study showed that high risk cases took less time until laboratory result appear on the Health information system so the physician could make a quick decision based on their level of urgency (Asaro *et al.*, 2007). The present study indicated that the ED LOS for CTAS 1 is 3 hours on average which is the longest duration, contrary with other studies, as sever cases have short LOS (Bukhari *et al.*, 2014), because the critical cases need high attention until vacant bed is found for them. This was presented automatically as one of the reason behind patient delay at ED in the study conducted previously. As noted, in other studies (Steindel & Howanitz, 2001),

(Henneberry *et al.*, 2012) TAT average is highest on afternoon shift. This is similar to the results of the current study, so the null hypothesis is accepted because the night shift has a lower value than the afternoon shift. The decision makers must change the work schedule upon the patients demand or volume of visits, which will surely help them to deliver a good quality of services in a timely manner. The peak time is on afternoon shift as the TAT is equal to 47.84 which is the highest average. This high average might be due to shortage in staff as stated in the previous studies (Steindel & Howanitz, 2001), (Henneberry *et al.*, 2012) or due to high volume of visits or less movement. The average ED LOS for admission and discharge both do not match with literature because the time in pervious study was from 4-8 hours (Bukhari *et al.*, 2014), (Asaro *et al.*, 2007), (Carrier *et al.*, 2014). The current results indicated that admitted patients took around 4 hours and discharge took about 2 hours in average. Average LOS is less than the target state before for admission and discharge patients (Bukhari *et al.*, 2014), (Asaro *et al.*, 2007), (Carrier *et al.*, 2014) that also means that the services deliver in a timely manner.

Conclusion and recommendation

The summary of the study findings is that there is no relation between TAT and LOS, so we need further investigations to see if there is an association between TAT and a clinician's diagnosis. As the physician's diagnosis has an important role in patient service efficiency and LOS. The researcher can set another hypothesis to know the root cause and decrease the timeframe. The research has missing data related to services providers type (phlebotomy staff) which has an impact on the result analyzed. The data used was extracted from electronic system as calculation of the time consumed was the result of the pneumatic tube "automation for TAT cycle". The time spent at afternoon laboratories specimens is more than other shifts; this result indicates poor workforce distribution with rush hours. In addition, no dedicated personnel and equipment for ED Satellite lab, which in turn affects the ED TAT and quality of services provided. The compete staff should be recruited to enhance the drawing process in the laboratory department, as this may improve TAT. Furthermore, the healthcare organization should dedicate personnel and equipment to operate the ED Satellite Laboratory to maintain time and accuracy of services. No unified policy for TAT time frame or target in each test type or in different departments as outpatient inpatient departments to follow national standards. For this reason, Hospitals need to set up an appropriate policy to follow national and international standards and agree on the targets set for TAT in order to improve the healthcare services provided. The study proves that there was no relationship between TAT and LOS that lead to evaluate other factors affecting TAT with aim of improving the healthcare delivered. Further research is needed to assess other factors that affect TAT and evaluate the association between TAT and physician diagnosis

Acknowledgement

Thanks to Allah who guided and enabled me to complete the research requirements and finish the learning journey. Thanks to Professor Huda for the valuable research notes in preparing the thesis. This dissertation is dedicated to my parents, the source of ultimate support and inspiration. I dedicate it also to all medical laboratory workers for their contributions to spreading knowledge as well as emergency staff.

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