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COLLEGE OF HEALTH SCIENCES

PROPORTION OF EMERGENCY VISITS WITH PROLONGED LENGTH OF

STAY AND ASSOCIATED FACTORS IN AL WAKRA HOSPITAL: A

RETROSPECTIVE COHORT STUDY

BY

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ABSTRACT

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Title: Proportion of Emergency Visits with Prolonged Length of Stay and Associated Factors in Al Wakra Hospital :- A Retrospective Cohort Study

Supervisor of Thesis: Mujahed, M, Shraim.

1. **Background:** Length of stay (LOS) in emergency department (ED) defined as “the time from patient’s registration in ED to discharge” is a key healthcare quality measure in ED. Prolonged LOS has been linked with adverse health outcomes and patient’s dissatisfaction. Several countries have implemented a maximum LOS targets ranging from four to six hours. However, several reports from different countries show that significant proportions of ED patients breach the LOS targets. Currently, the healthcare system in Qatar has a four-hour waiting time target in ED. The main aim of this thesis was to estimate the proportion of patients exceeding the four-hour LOS target in adult ED in AWH and identify associated factors. The objectives of the thesis were: (a) to identify the overall proportion of ED visits that breach the 4-hour LOS target between January and April 2019, inclusive; (b) to identify any variations in monthly proportions of ED visits breaching the four-hour LOS target between January and April 2019, inclusive; (c) to identify any differences in LOS time in main processes within patient flow in ED by breaching the LOS target status among discharged and admitted patients; (d) To identify the main factors (patient- level factors and throughput process factors in ED and the hospital) associated with breaching the 4-hour LOS target.

Method: A retrospective cohort study design was used to review all adult ED visits for patients aged 14 years or older in AWH from January 1st, 2019 to April 30th, 2019, inclusive. The computerized health information system (CERNER) was

used to extract study data. The main outcome variables were LOS in ED and the breaching status of the 4- hour LOS target on daily basis as a binary variable (not-breached= \leq 4 hours, breached = $>$ 4 hours), where the data were collected on daily basis. Process template and logistic regression were used to analyze the data.

Results: The proportion of patients exceeded the LOS was 37% with a median LOS of 423 minutes. Among longer stay patients ($>$ 4 hours), as compared to short stay patients (\leq 4 hours) visits, Visits that breached the target had higher 80th percentile LOS time from time seen by nurse to being seen by the physician, time from seen by the physician until discharge, x-ray time, US time, and CT time. Among the admitted patients, the same differences were observed plus longer 80th percentile times from seen by the physician to a decision to admit is made and from admission decision to actual admission to a ward between visits that breached and “not-breached” the target. Older age, male gender, non-Qatari nationality, arrival by ambulance, night shift, month of visiting the ED, triage acuity (less argent and urgent), increasing number of consultations with consultants, performing laboratory tests and radiologic examination, and inpatient admission were independent predictors of breaching the four-hour LOS target.

Conclusion: One (1) out of three (3) patients attending the ED at AWH breaches the four-hour LOS target. The main processes in patient journey that accounted for a major part of LOS in ED was waiting time to see the physician, time elapsed from seeing the physician until discharge or admission to a ward. These findings suggest that LOS in ED is mainly affected by organizational and modifiable factors. Enhancing the laboratory and diagnostic imaging results time, timely consultations, decision making, and employing cost-effective interventions to enhance patients flow in ED may reduce proportion of patients breaching the LOS target.

DEDICATION

I dedicate this work to all healthcare workers in the world, especially for those who care for patients in the emergency departments and those who dedicate their carrier to help adult children for better health

Amjad Hamad

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TABLE OF CONTENTS

DEDICATION.....	vi
ACKNOWLEDGMENTS	vii
LIST OF TABLES	xi
LIST OF FIGURES.....	xii
LIST OF ABBREVIATIONS	xiii
Chapter 1: INTRODUCTION.....	1
Implication of the Study.....	3
Aim and Objectives	4
Chapter 2: LITERATURE REVIEW.....	5
Introduction.....	5
Importance of LOS in Emergency Department	5
Proportion of ED Visits Breaching the Four-Hour LOS Target.....	6
Adverse Impacts of Increased LOS	6
Factors Associated with LOS in Emergency Departments	7
Determinants of Increased LOS in Emergency Departments in the Gulf Region and the Middle East	10
Patient Journey in Emergency Department	12
Diagnostic Procedures in ED	14
Summary.....	15
Chapter 3: METHODS	17

Study Design	17
Study Setting	17
Population	18
Inclusion and Exclusion Criteria	19
Data Collection	19
Main outcome variables	19
Predictor variables	20
Data Analysis	20
Ethical Considerations	22
Chapter 4: RESULTS	23
Characteristics of Patients	23
Proportion of Emergency Visits Breached the 4-Hour LOS Target	25
Month-wise Variation in Proportions of Visits that Breached the 4-Hour LOS Target Between January and April 2019	26
Process Flow of Patient Journey in Emergency Department	25
Process Flow for Discharged Patients	25
Process Flow for Admitted Patients	26
Factors Associated with Breaching the 4-hour LOS Target	27
Input variables	27
Throughput variables	28

Abbreviations CI, Confidence interval; OR, odds ratio; SE, Standard error; P,

Probability	31
Chapter 5: Discussion.....	32
Implications for Clinical Practice and Future Research	36
Strengths and Limitations	38
Conclusion	39
References.....	40
Appendix	50
Appendix 1. Hamad Medical Corporation IRB approval	50
Appendix 2. Qatar University IRB Approval	51

LIST OF TABLES

Table 1. Characteristics of Patients	24
Table 2. Frequency and Proportion of Visits According to LOS Time in Hours	25
Table 3. Crude and Adjusted Association Between Included Variables and Breaching the 4-Hour LOS Target in Emergency Department	30

LIST OF FIGURES

Figure 1 Convectional Process Mapping in ED14

Figure 2. Median and 80th Percentile LOS Time: January to April 201926

Figure 3. The 80th Percentile Times of Processes Within Patient Journey in ED for Discharged Patients by Breaching Status of the 4-hour LOS Target.....26

Figure 4. The 80th Percentile Times of Processes Within Patient Journey in ED for Admitted.....27

LIST OF ABBREVIATIONS

LOS: Length of stay

ED: Emergency department

CTAS: Canadian Triage and Acuity Scale

CI: Confidence interval

EMR: Electronic Medical Record

CERNER: Computerized Health Information System

AWH: Alwakra Hospital

URV: Unexpected return visit

PTT: Partial thromboplastin time

PT: Prothrombin time

US: Ultra sound

CT: Computed tomography

HMC: Hamad Medical Corporation

ICU: Intensive care unit

HDU: High dependency unit

CCU: cardiac care unit

HGH: Hamad general hospital

EMS: Emergency medical services

P-value: Probability value

IRB: Institutional Review Board

MRC: Medical research council

UK: United Kingdom

CHAPTER 1: INTRODUCTION

Patient LOS in the emergency department (ED) is an essential measure to evaluate the quality of the health care services in any medical facility (1). LOS is defined by the time from patient's registration to discharge from ED (2). Over-crowdedness of the emergency healthcare settings has become a significant concern to the different stakeholders of the healthcare system (3).

The healthcare team in emergency departments usually deal with high-volume of patients within a fast-paced and a critical environment (4). Patients have to go through a process to receive appropriate emergency care are associated with a reduction in the proportion of patients with LOS greater than four hours, improvement in patients' flow, and reduction in the number of deaths in EDs (5). However, LOS in ED is still higher than four hours for significant proportions of patients (5). Both internal and external factors often affect patients LOS in ED (4).

Globally, over-crowdedness in ED represents a major challenge for the health care providers, which may affect health care outcomes in patients in need of emergency health care services (6,7). Prior research has shown that ED crowdedness is linked with significant adverse patients' health outcomes such as delays in administering intravenous antibiotics and analgesics (8), delay in giving thrombolysis agents to myocardial infarction and acute stroke patients (9). Such delays in providing emergency care promptly may result in severe complications to patients or even preventable death (10).

Prolonged LOS in EDs causes patients' dissatisfaction and affects the quality of health care activities (11–13). These challenges have led to a significant increment in the stress level resulting in low-quality care and patient dissatisfaction (14). To enhance the quality of healthcare in ED and improve patients' outcome and

satisfaction, many health care systems have introduced a maximum LOS targets in ED, such as six-hour waiting time in New Zealand, four-hour waiting time in Australia and England (15–17). However, for various factors, significant proportions of patients attending EDs still breach the LOS targets set by the healthcare policy makers (16,18).

There are limited evidences that such patient characteristics, ED staffing patterns, time of patient arrival, management practices and assessment, treatment strategies, triage level, investigations, and consultations are essential predictors that influence ED-LOS (19,20).

Another factor affecting LOS is the time interval between patients' triage time and initial physician evaluation (21). This time interval is one of the indicators that evaluate the quality of health care services in the emergency department and reducing this time will improve patient health outcomes and patient satisfaction (1). Prolonged initial physician evaluation is associated with an increasing number of patients left without being seen, and the best way to decrease without being seen is to minimize the initial physician evaluation (22). Gender and age are also associated with prolonged ED-LOS. For example, one study reported that LOS was shorter for patients aged between eighteen and fifty-four years as compared to those aged more than fifty-five years, and male patients tended to be seen and discharged sooner than females (23).

The unavailability of inpatient beds and delays in laboratory results are leading causes of extending patients' LOS and overcrowded in ED (24). Delay in reporting radiology (e.g. x-ray, ultrasound (US), computerized tomography scan (CT)), and laboratory results affect other ED timing like physician reassessment and consultation times (25–27). Also, the number of blood investigations affects the ED-

LOS; for example, the Troponin test may require to be assessed for many times during the patient stay in ED (28).

Specialty consultation is another significant factors associated with prolonged LOS (29). Lack of consultation guidelines and increasing number of specialty consultations can have a considerable side effect on the patients' outcomes and extend their Stay in the ED (30). Currently, the healthcare system in Qatar has a four-hour waiting time target in ED. So, 100% of patients in ED in public hospitals in Qatar should be seen and discharged or admitted within four hours of arrival to ED. The authors work in adult ED in AWH, where a significant proportion of patients wait in adult ED for more than four hours until they are discharged or admitted. Until now, no prior studies have comprehensively assessed factors associated the proportion of patients waiting greater than four hours in ED in Qatar, whereas the previous studies were very selective assessed specific factors associated with ED LOS which is differs compared to this study that included most of the process variables as input, throughput and output factors. Identifying the main characteristic of patients with LOS in ED of more than four hours and contributing factors in hospitals in Qatar may shed light on potential quality improvement interventions or strategies to meet the Qatari national target of 100% for shorter LOS in ED target. This has important implications for improving patients' outcomes and satisfaction.

Implication of the Study

Prolonged patients' LOS can affect and jeopardize patient safety and increase the risk of complication (11). Prolonged LOS can reduce the quality of care and expand adverse events in the ED (31). Medical, nursing, and other allied health staff are working hard to improve patient outcomes, enhance healthcare safety, and improve patient experience and satisfaction, but achieving these outcomes in the face

of over-crowdedness and prolonged LOS represent a major challenge for healthcare teams in ED (32). Decreasing ED-LOS will enhance patients' timely access to healthcare, will improve patient outcomes and satisfaction, and will enhance the safety and quality of emergency healthcare services (33).

While many factors still influence the LOS in ED, changes in the health care process may reduce patients' waiting time and improve patients' health outcomes (34). Exploring the sources of delay during patient's journey in AWH ED and identifying contributing factors amenable to quality improvement interventions may result in substantial improvement in patients' healthcare outcomes and satisfaction.

Aim and Objectives

The main aim of this thesis is to estimate the proportion of patients exceeding the four-hour LOS target in adult ED in Alwakra Hospital (AWH) and identify associated factors.

The objectives of the thesis are:

- 1- To identify the overall proportion of ED visits that breach the 4-hour LOS target between January and April 2019, inclusive.
- 2- To identify any variations in monthly proportions of ED visits breaching the four-hour LOS target between January and April 2019, inclusive.
- 3- To identify any differences in LOS time in main processes from patient's registration in ED to discharge, admission, or transfer to another hospital.
- 4- To identify the main factors (patient- level factors and throughput process factors in ED and the hospital) associated with breaching the 4-hour LOS target.

CHAPTER 2: LITERATURE REVIEW

Introduction

This chapter presents a summary of previous studies reporting on ED-LOS in term of the importance, adverse impact of LOS, factors associated with extended LOS in ED worldwide, the characteristics of extended LOS in the Middle East. This chapter also provides an overview of patient journey and flow process in ED, especially the influence of the diagnostic procedures on patient journey and LOS in ED.

Importance of LOS in Emergency Department

The emergency department is one of the most essential parts of any hospital. Due to the uniqueness of this department, and the complexity of care provided for patients with various conditions, ED should provide fast, effective, and high-quality services (35). Recently, ED crowding and increased patient LOS in ED have become issues of concern for emergency clinicians, policymakers, and hospital administrators (31). The LOS in ED is defined as the time from the patient's arrival or registration to departure or discharge from ED (2).

ED-LOS is considered an essential indicator of efficiency, timeliness, patient-centeredness, and safety of emergency care (1,31). The LOS, the time between registration in ED and time of initial doctor assessment, is also considered an accepted indicator for the quality of emergency care provided by health care institutions (36). Reducing the LOS in the ED can improve the quality of patient care and accessibility to ED treatment (33). To reduce the negative impacts of the long stay in EDs, the UK National Health Service proposed a waiting times target of no longer than four hours in 98% of patients from initial assessment in EDs to leaving the department (37). This target could differ between countries. For example, the New Zealand

government introduced a waiting times target of no longer than six hours in 95% of patients to be discharged or treated (38). However, many countries worldwide fail to achieve such standards. For example, in a meta-analysis and systematic review of 17 articles to assess waiting time in the emergency departments in Iran, the mean waiting time for 15,943 patients was found to be higher than the four hours which is the international standard (35). Many interventions were reported in previous research to reduce LOS and improve patient flow in EDs including triage interventions (i.e. team triage, fast track, and bedside testing) (15), doing some diagnostic tests during the triage process (39), and doing assessment by clinicians shortly (40).

Proportion of ED Visits Breaching the Four-Hour LOS Target

Several studies revealed that many visits were breached the 4- hours target in EDs, such as the visits in Qatar in which 46.6% of ED visits breached the 4-hour LOS target (18). One study was conducted in United Kingdom (UK) over two years (2014 to 2016; n= 232,920) showed that < 10% of ED visits breached the four-hour LOS target (2). Whereas another retrospective cohort study from the UK was conducted between April 2008 and April 2013 (n=374,459) revealed that 9% of all ED visits breached the four-hour target (16). Another recent study conducted in Australia showed that 30% of patient waiting time breached the 4- hour target (41). A recent report by the National Health Services (NHS) in UK in 2020 indicated that the proportion of ED visits that breached the four-hour target has increased from 5.5% in 2014 to 15.3% in 2019 (42). Another study in Indonesia showed that 61% of ED visits breached the four-hour LOS target (43). One study was conducted in Sothorn – Ethiopia revealed that 37.2% of the patients breached 4 hours ED LOS (25).

Adverse Impacts of Increased LOS

There is substantial evidence that increased LOS in EDs has adverse impacts on patients (32,44–46). Increased LOS in ED is associated with mortality, increased complications, overcrowding in EDs, and leaving the EDs without receiving adequate treatment (32,44–46). It has been previously demonstrated in the literature that increased LOS in ED is associated with the risk of complications or adverse in-hospital events, poor quality of care in EDs, and a longer hospital stay at the subsequent admission to hospital (47–49). Furthermore, crowdedness in ED is associated with delays in administering the necessary analgesics, intravenous antibiotics, or thrombolytic agents to patients (8,9). For patients with appendectomy, especially children, the increased LOS in ED can elevate the risk of perforation of the appendix (50). Patients who spend a long time in the ED report dissatisfaction with the quality of emergency health care services and high-stress levels (11–14). Also, increased waiting time and poor service efficiency lead to an increase in the operating cost. Patients who spend more time in the ED need extra beds which are responsible for enormous costs for hospitals (51–53). Therefore, it is worthy to investigate the factors associated with LOS in the ED to reduce these negative impacts and improve the quality of patient care.

Factors Associated with LOS in Emergency Departments

In general, LOS is influenced by an interaction between the ED demand and capacity or resources (34). It can also be influenced by the ability of the hospital ER administrators to manage attendance to ER, throughput, and discharge (44).

ED-LOS could be associated with some factors that are not under the control of the hospital including a sudden increase in the number of patients who attend the EDs (54), and small capacity in the EDs or wards to which patients will be transferred (55). Health care providers in EDs could receive a large number of patients with

critical conditions within a short period and these patients have to go through a lengthy process to receive adequate emergency care (4).

Additional factors that could increase the LOS in EDs including limited access to treatment from other sources and visiting emergency to receive non-emergency care (56). Further possible factors that increase the LOS in EDs include reluctance in making some clinical decisions, doing some consultations, lack of a specific plan to discharge, or inadequate follow-up preparations (32,57). For example, a study from Turkey, with a sample of 603 patients in EDs, the average length of patient stay was 6.5 hours. Also, 15.4% of patients stayed 12 hours or more. The common reason for LOS for 24 hours or more is the unavailability of empty beds in the critical care units, while common complaints of these patients were pain, dyspnea, and tachycardia (55).

Many studies assessed factors associated with increased LOS in Western countries. In a study conducted in the USA, with patients with hip fractures who visit the ED, the average ED-LOS was about 7.5 hours. Most common associated risk factors with ED-LOS were history of Coronary artery disease (hazard ratio 1.5), and ED shift (hazard ratio 1.6 and 1.9 for evening and night shift respectively) (58).

In a prospective study of patients with minor trauma in New Zealand, the mean patient LOS in ED was 238 minutes (59). Besides, a study conducted in the United Kingdom to identify predictors of breaching the four-hour target LOS in ED reported various factors including the number of patients visiting ED ($\chi^2= 3546.1$), visiting ER on the night shift ($\chi^2= 944.2$), triage category ($\chi^2= 815$), previous ER visit in the last 7 days ($\chi^2= 302.7$), ED capacity ($\chi^2= 181.1$), and unclear complaints by patients ($\chi^2= 802.4$) (23).

In a study conducted with a sample of 1028 elderly patients in the Netherlands to assess factors associated with LOS in EDs, the median ED-LOS was 4 hours and 3

minutes. Patients in the neurology ED had the shortest LOS. Longer ED-LOS was also associated with number of medications ($R=0.77$), the involvement of more specialists ($R= 0.63$), and transfer to different locations ($R= 0.72$) (20). Conducting specific diagnostic procedures and laboratory tests such as urine testing and radiology imaging was also associated with longer LOS (28).

A recent observational retrospective study about the causes for staying in ED for more than six hours in the Netherlands, with a sample of 568 patients, concluded that 15% of patients stayed in ED for more than six hours. The authors concluded that 76% of the causal factors were organizational and 22% were disease-related. Most of the organizational factors (94%) were beyond ED control. Patients with ED-LOS for more than six hours had a mean of 2.5 consultations and 59% of them were admitted to the hospital. Furthermore, they have a mean age of 57 years. The authors recommended conducting interventions that address the “complete acute care chain” to reduce LOS and crowding in EDs (24).

Limited research was found about factors associated with increased LOS in Africa. A recent cross-sectional study was conducted in Ethiopia on a sample of 399 patients to assess the LOS in EDs and its associated factors. The results have shown that the vast majority (91.5%) stayed more than 24 h in the EDs due to small capacity beds in the hospital wards ($OR= 8.7$), overcrowding ($OR= 3.6$), delay in laboratory tests ($OR= 4.5$), and delay in radiological services ($OR=3.7$) (60). The authors recommended providing a sufficient number of beds to receive admission and reduce laboratory tests and radiological services time in EDs (61).

In a retrospective study conducted in Taiwan with a sample of 149,472 patients, the median LOS in ED was of 2.15 hours. Factors associated with increased LOS for discharged patients were triage level one and level two respectively ($OR=$

2.4, 2.5), Critical conditions (OR= 5.6), and patients transferred from other hospitals (OR=2.7) (3). A recent meta-analysis study conducted in Iran has shown that some patient characteristics could increase the LOS in EDs including older age, triage level, visiting ER on evening shifts, and patients who need many medical tests (19).

Determinants of Increased LOS in Emergency Departments in the Gulf Region and the Middle East

Limited research studies were found about factors associated with increased LOS in the Gulf region and the Middle East countries in general. In a retrospective cohort study aimed to assess differences in LOS in ED between Arab and Jewish in a sample of 82,883 patients, no difference was found in the LOS based on the ethnicity as the waiting time was 38 minutes for both (interquartile range [IQR] 22-63 and [IQR] 21-610, $p = 0.36$) (36). The most important factor associated with longer LOS was morning or evening shift arrival (36). A study was conducted in Saudi Arabia to examine the number of ED visits and LOS at King Abdul-Aziz Hospital from 2003 to 2005. The results show that the number of visits to the ED increased by about 30%, while LOS increased from 72 in 2003 to 78 minutes (59). Another retrospective study was conducted in Saudi Arabia to assess ED-LOS by reviewing 1206 charts. The results have shown that 71% of patients have time less than or equal 10 minutes, while the Median LOS in ED was 144 minutes (62). A recent study conducted in Saudi Arabia highlighted the causes of problems in patient flow in EDs. The study pointed to several areas of “waste” that negatively impact ED patient flow. These wastes included problems in quality management and factors associated with patients, clinicians, facilities, administration, and information. The authors recommended designing interventions to eliminate the root causes of waste and problems in patient flow in EDs (63). In a prospective cohort study with a sample of 390 patients, in an

emergency center in King Abdul-Aziz Medical City, Saudi Arabia, the strongest predictor of low satisfaction with the ED care was related to the increased LOS (12).

A recent study from Qatar showed that the LOS target of four hours or less was met in 53.4% of shifts. However, that study did not present data on proportion of visits breaching the target or any variation in this over three year follow –up period of the study (18). Much less is known about factors associated with LOS target in ED in Qatar. Statistics in Qatar indicate that the country has experienced substantial population growth over the past few decades, most of them (85%) are from outside the country with diverse socio-cultural backgrounds (64–66). In Qatar, one prospective study conducted at the ED of HGH found that many women with non-urgent conditions visit the ED, which increases the demand for ED services (67). Besides, in a retrospective study conducted in Qatar, the unexpected ED return visits (URV) rate within two days of discharge was 5.1%, most patients with URV were “left without being seen” on the previous visit (68).

Factors associated with LOS in ED can be grouped under two broad categories:

- 1- Patient-level factors (also called input factors): these include factors, such as age, gender, presenting complaints, acuity level, and etcetera.

- 2- System level factors: these included two types of factors.

- A- Throughput factors: these include services process in ED and the hospital, ED process: include factors, such as staffing level, time intervals for time from registration to nurse; time from nurse to physician assessment, time from physician assessment to decision to discharge, admit, or transfer to another hospital. Whereas Hospital process included factors, such as consultations needed by

specialty consultants, type and number of laboratory and radiology investigation needed and associated turned around time, time from admission decision to actual admission to inpatient wards in the hospital.

B- Output factors: these include factors, such as hospital occupancy (bed availability for patients with admission order from ED) and hospital discharge rate (69).

Patient Journey in Emergency Department

The number of patients visiting the ED is increasing daily and varies between emergency and non-emergency. Therefore, there must be a system that helps the medical staff to recognize and treat the emergency patients first. A triage system is an initial detection to sort the patients into groups to ensure that the patients receive the accurate level and quality of medical care appropriate to the clinical needs (70).

A triage system is also applied in the emergency department and all common and special circumstances such as wars when there are a scarcity and lack of medical resources and the needs for optimal use of such resources to save a greater number of victims (7,71).

The first application of the triage system was in 1964 (72). Triage is now being used as a well defined priority process across all medical organizations, to categorize patients in terms of urgency (73). The system is applied as a first medical step after the patient's registration, where the nurse takes a brief medical history from the patient him/herself or the patient's relatives and the reason for the patient coming to the ED. Then the nurse takes the vital signs such as blood pressure, heart rate, and temperature to classify the patients as non-urgent, less urgent, urgent, emergency or resuscitation conditions (74). After that, the patient will be examined by the ED

physician and this called the patient initial assessment. Based on the initial assessment, the necessary tests are given to the ED physician (Diagnostic order) and carried out by the nurse (Diagnostic excision). These medical tests will be sent to the laboratory and radiology department and wait for the results to release into the system. At that point the patients will be examined again by the ED physician (patient reassessment) and medical consultation will be requested according to the patient's condition or discharge from the ED (21) (Figure 1).

There are many systems used internationally, but no system has a medical advantage over the other. All these triage systems applying the same criteria to diagnose the patients based on the chief complaint and vital signs, but they differ in classifications, as there are systems that use the three classifications, and others using the four levels and the five levels system (7,71).

Canadian Triage and Acuity Scale (CTAS) has been developed in 1990 in New Brunswick, Canada (53). CTAS is a five-category system from category one (Resuscitation), then category two (Emergency), category three (Urgent), category four (Less urgent), and category five (Non-urgent) (75).

This system has been adopted in Qatar in 2015 to overcome the aforementioned medical obstacles and to meet the 2030 vision which one of its pillars is to promote health for all through the application of an internationally approved medical system.

Four published studies were done in the last five years regarding CTAS in KSA, but none is done in Qatar (76–79). The result showed that CTAS has good reliability among ED triage nurses, the system is adaptable and can be implemented successfully to countries beyond Canada and the ED waiting times becomes shorter compared to the period to before using CTAS.

Conventional process mapping

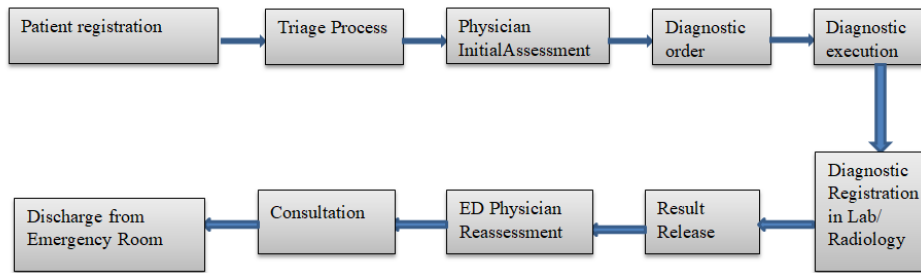


Figure 1 Convectional Process Mapping in ED

Diagnostic Procedures in ED

Blood tests and radiological investigations are usually required in ED to support the clinical decision and plan of care for patients in ED. In term of general hematology, it is an essential ED laboratory test. It is the count of the red blood cells, white blood cells, platelets and the concentration of hemoglobin which is a protein in the red blood cells carries oxygen to the body's organs and transport carbon dioxide out of the body tissues (80). Blood chemistry and metabolic panel are another ED laboratory tests to measure amount of blood substances that includes sodium, potassium, chloride, proteins, glucose, fats, calcium, albumin, bilirubin, blood urea nitrogen, total proteins, alkaline phosphatase, aspartate aminotransferase, alanine transaminase, chloride, creatinine and enzymes. These tests give vital clinical information about the function of the patients' kidneys, liver and other organs condition such as the cardiac and pancreas. These studies help to support the ED clinical decisions and to diagnose patient's conditions. Abnormal levels of these substances indicate a body's chemical imbalance and serious health problem which requires immediate medical interventions (81). Coagulation profile includes measurements of bleeding time, platelets counts and clotting tests like the partial

thromboplastin time (PTT) and prothrombin time (PT). This test is required for patients complain of hemostatic disorders that have long bleeding times (82). Other diagnostic procedure being done in the ED is the X-ray image, which is type of radiation called electromagnetic waves that show the parts of the body in shades like black and white. This occurs when part of the radiation absorbed by the body bones or tissues. When the bones absorb x-rays, they appear black because calcium in the bones absorbs most of the radiation. Whereas the tissues absorb less amount and look gray. Air in the lungs absorbs the least, so lungs look black (83). Computed tomography imaging (CT), also called Computerized Axial Tomography, and provides cross-sectional imaging. This diagnostic procedure used to produce computerized images of the body internal organs and soft tissues (84). Another diagnostic procedure is the US; it is a medical diagnostic procedure to image the body parts like the abdomen. This imaging procedure is free of radiation and inexpensive compared to other imaging procedures such as magnetic resonance imaging or CT. US provides cross-section visual view for many intervention procedures. US is being used over 50 years in the medical field (85).

Summary

In conclusion, ED crowding and increased patient LOS in ED is a worldwide issue for emergency clinicians, policymakers, and hospital administrators. There are many determinants of LOS in EDs worldwide. These determinants are associated with some factors that are under the control of the hospital or outside the hospital control. The literature review has shown that LOS in EDs exceeded the four-hour and six-hour targets in many countries worldwide. After an extensive literature search, it was noted that the determinants of increased ED-LOS are well-studied in many developed countries, such as the USA, UK, and many other Western countries. Less

is known about these determinants in the Gulf Region including Qatar, the Middle East Region, and Africa.

CHAPTER 3: METHODS

This chapter presents the methods used to address the objectives of the study including study design, setting, population, sample size, inclusion and exclusion criteria, data collection, data analysis, and ethical considerations.

Study Design

The study design was a retrospective cohort study which is appropriate study design and also the majority of the looked studies were retrospective designs (86). The data was reviewed retrospectively from January 1st, 2019 until April 30th, 2019, inclusive.

Study Setting

The study was conducted using the medical records of patients who visited the adult ED at AWH between 1st January and April 30th, 2019. AWH is a general hospital which has been designed and staffed to meet acute hospital health care needs of people living in the south of Qatar. The hospital is part of Hamad Medical Corporation (HMC), which is the leading healthcare organization in the state of Qatar. AWH provides high quality health care to patients of all ages in the outpatient departments, emergency care, physiotherapy, obstetrics and gynecology, general medicine, surgery, cardiology and other medical specialties. AWH occupies 130,000 square meters of the area surrounding the main building that spread across 304,000 square meters of land in total. The capacity of AWH is 350 beds, 250 of which are serving the acute and general patients and 80 beds are for critical care patients. There are 3000 employees working in the hospital, including about 250 physicians with different specialties and about 1500 registered nurses. AWH admits around 100 patients and performs around 25 routine surgeries daily. The ED in AWH is located in the ground floor and the first floor offering all the emergency care. The average

monthly number of patients who visited the adult ED in AWH in 2019 was 15,000. The ED has fifteen critical care beds and four noncritical beds. The ED staff includes 161 full-time registered nurses and 36 full-time physicians. The patient-nurse ratio is 2:1 in the critical areas and 3:1 in the noncritical areas, which accords with current international standards (87,88). Other support staff such as departmental clerks and nursing aid helps the medical and nursing teams in providing auxiliary patient care.

Patients visiting AWH ED begin their journey in ED from the registration desk, where the patients register at arrival. After registration, a triage nurse assesses the patient's condition and assigns a triage category for the patient, which is known as triage process (53). If the patient's condition requires immediate medical interventions, the patient will be immediately examined by a physician.

The average daily patient's count in the ED is 550 and, on average, 15 patients are admitted to the inpatient wards and other units via the ED. Surgical patients are admitted to the surgical wards while patients complaining of medical conditions requiring no surgeries are admitted to the medical wards. All critically ill patients are admitted to the intensive care units (ICU), high dependency unit (HDU), cardiac care unit (CCU), or the burn unit. Patients who require specialized treatments and medical interventions are transferred to other facilities within HMC, such as Heart Hospital, Psychiatric Hospital, or HGH.

Population

The adult ED in AWH provides emergency health care to all patients aged 14 years or older. All patients younger than 14 years old are seen in the Pediatric ED in AWH. The current study included all patients who visited the adult ED in AWH between January 1st, 2019 and April 30th, 2019, inclusive. Usually, patients arrive to the adult ED using either their private transportation or emergency medical services

(EMS).

Inclusion and Exclusion Criteria

All patients aged ≥ 14 years who visited AWH between January and April 2019 were included in the study. All patients who registered in ED but left before being seen by the triage nurse or the physician were excluded. In addition, patients who died on arrival, referred to another healthcare facility before starting the ED medical care, or were admitted directly to inpatients wards were excluded because they did not go through the routine healthcare process employed in the ED.

Data Collection

Electronic Medical Record (EMR) of all patients seen in adult ED between 1 January and 30 April 2019 were extracted from CERNER by the Medical Records Department in AWH. To address the objectives of the study, data collection of study variables was guided by the findings of prior studies in other countries on factors associated with LOS in ED (16,28,89–92).

Main outcome variables

The main outcome variables were LOS in ED and the breaching status of the 4-hour LOS target on daily basis as a binary variable (not-breached ≤ 4 hours, breached $\Rightarrow > 4$ hours). The LOS was defined as the time elapsed between patient's registration and discharge from the ED regardless of discharge destination (25,28). All visits with 4 hours or less were classified as "not-breached" and those with a LOS of more than 4 hours were classified as "breached" (16). Other secondary outcome variables were LOS at each stage of patient flow in ED: time from registration to be seen by the nurses; time from seen by the nurse until seen by the physician; time from seen by the physician until discharged, admitted or transferred to another medical facility; time from registration to decision to admit is made; and time from decision to

admit to admission. In addition, the turnaround times for the following laboratory and radiology investigations were extracted: general hematology, blood chemistry, blood coagulation profile, X-ray, US, and computerized tomography.

Predictor variables

The sociodemographic variables were age, gender (female, male), and nationality (Qatari, other) as Qatari patients are seen in a separate area in the ED. The age was measured in years and then was categorized into four groups according to four age quartiles (<28, 28-35, 36-46, and >46 years). The mode of arrival was categorized as self-referral or ambulance referral (arrival by ambulance). Time and date of ED visit was used to derive three 8-hour working shifts (morning (07:00 am-03:00 pm), evening (03:00 pm-11:00 pm), and night (03:00 pm-07:00 am) (3,23). In addition, day of the week and month variables were derived. A medical consultation in ED was defined as medical care provided to patients by specialized medical departments during patient's stay in the ED, such as consultation with a cardiologist, a gynecologist, etcetera (93). The number of medical consultations needed for each patient in ED was categorized as 0, 1, 2, 3, 4 or more medical consultations. The ED discharge destination was classified as discharged home, admitted to AWH, or transferred to another medical facility/hospital. Medical comorbidity was defined as the presence of one or more additional medical conditions (physical or mental) concurrent with the patient's primary condition leading to ED visit (94). Comorbidity status was categorized as a binary variable (no, yes). The other predictor variables were the ordering status (yes, no) for any of the following laboratory and radiology investigations: general hematology, blood chemistry, blood coagulation profile, x-ray, ultrasound, and computerized tomography.

Data Analysis

Descriptive statistics were used to summarize the data. The mean, standard deviation (SD), median and interquartile range (IQR) were used to summarize continuous variables and frequencies with percentages were used to summarize categorical variables. A process template was used to present the 80th percentiles of LOS time for patients in each stage of their flow within the ED for discharged and admitted patients separately. The ED LOS data is highly skewed to the right. Therefore, the 80% percentile of LOS is more useful for process mapping than median or mean (95,96). Process templates with 80th percentile are very useful for identification of constraints within a process, which then could be targeted with quality improvement interventions (95,96). Logistic regression was used to identify factors associated with breaching the 4-hour LOS target as a binary outcome variable which is more than 4-hours (yes) or 4- hours or less (no). The following independent variables were considered for assessment in simple logistic regression models. These variables were age group, gender, nationality, arrival mode, triage priority, month, day of the week, working shift, discharge destination, attending physician, number of medical consultations with a consultant, comorbidity status, and whether the patient had any of the following investigations (yes, no): general hematology, blood chemistry, coagulation, metabolic, X-ray, US, and CT. Odds ratio with 95% confidence interval (CI) were used to summarize the magnitude of associations between the predictor variables and the odds of breaching the 4-hour LOS target. Any association with a probability value (p-value) of ≤ 0.05 was considered statistically significant. A manual stepwise entry of variables in univariable analysis was performed. In the next step all statistically significant variables from the univariable analysis were then added to the final multivariable model according to the magnitude of their regression coefficients (predictors with largest regression

coefficients were entered in the multivariable model first) (97). Then all variables that were not statistically associated with breaching the 4- hour target status (yes, no) were entered in the final multivariable model last because the magnitude, direction, and significance of such variable may change in presence of other variable in the final multivariable model and these variables were found to be associated with breaching the target in previous studies (97). Statistical analyses were performed using Stata version 15 (98).

Ethical Considerations

No identifiable information such as name, date of birth, contact details, address, HMC number, or Qatari ID number was extracted. In the dataset, each patient was given a unique study ID number to facilitate exploring data for completeness and accuracy. The de-identified dataset was stored in a password-protected computer. Ethical approval of the study was obtained from the Institutional Review Board (IRB) of Qatar University (IRB approval # QU-IRB 1208-/E/20) and HMC Medical Research Council (IRB approval # MRC-01-19-413) (Appendices 1 and 2).

CHAPTER 4: RESULTS

Characteristics of Patients

A total of 57,865 emergency visits were recorded between 1st January and 30th April 2019. A total of 8392 visits (14.5%) were excluded because the patients registered in ED but left before being seen by the nurse or the physician, arrived dead, were referred to another healthcare facility before starting the ED medical care, or were admitted directly to inpatients wards. The remaining visits (49,486 (85.5%)) were included in the study. Table 1 presents the characteristics of the included patients. The median LOS for all included visits was 172.2 minutes (IQR 89.5-341.8 minutes).

About 51.9% and 72.6% of patients were males and non-Qataris, respectively. The mean age of patients was 37.5 years (SD= 15.1 years) ranging from 14 to 110 years. About 76.5% of patients aged less than 47 years. Around 14% of patients arrived by ambulance. More than two thirds (69.5%) of patients had non-urgent or less urgent triage categories. About 26.0%, 23.8%, 25.9%, and 24.3% of patients were seen in ED in January, February, March, and April, respectively. Slightly lower proportions of patients visited the ER on Fridays (12.3%) and Saturdays (13.9%) as compared to Sundays which had the highest proportion of visits (15.6%). More than one third of patients (37.8%) visited the ER during the evening shifts, when similar proportions of patients visited the ER in the morning (30.4%) and night shifts (31.8%). Around 6.4% and 0.5% of patients were admitted or transferred to another hospital, respectively. Most of the patients (89.5%) were seen by an emergency attending physician, and around 11.3% of patients needed at least one or more medical consultations with medical consultants. Only a small proportion of patients (2.7%) had one or more medical conditions (comorbidities) concurrent with their

primary conditions. About 24.8%, 6.9%, and 5.2% of patients had x-ray, US, and CT scans, respectively. The main blood tests performed for patients were general hematology (29.4%), metabolic panel (29.2%), blood chemistry (18.2%), and coagulation tests (11.6%) (Table1).

Table 1. Characteristics of Patients

Variable	Frequency (%)
Gender	
Female	23,811 (48.1)
Male	25,675 (51.9)
Age	
Mean (standard deviation)	37.5 (15.1)
Median (Interquartile range)	35 (19.0)
Age group (years)	
< 28	13,266 (26.8)
28-35	12,698 (25.7)
36-46	11,882 (24.0)
>46	11,640 (23.5)
Nationality	
Non-Qatari	35,937 (72.6)
Qatari	13,549 (27.4)
Arrival Mode	
Other	42,389 (85.7)
Ambulance	7,097 (14.3)
Triage priority	
Non-urgent	8,230 (16.6)
Less urgent	26,152 (52.9)
Urgent	14,188 (28.7)
Emergency	904 (1.8)
Resuscitation	12 (0.0)
Month	
January	12,847 (26.0)
February	11,783 (23.8)
March	12,826 (25.9)
April	12,030 (24.3)
Day of the week	
Sunday	7,722 (15.6)
Monday	7,355 (14.9)
Tuesday	7,448 (15.1)
Wednesday	7,105 (14.4)
Thursday	6,947 (14.0)
Friday	6,039 (12.2)
Saturday	6,870 (13.9)
Working shift	
Morning	15,049 (30.4)
Evening	18,707 (37.8)
Night	15,730 (31.8)
Discharge destination	
Home	46,083 (93.1)
Admitted	3,151 (6.4)
Transfer to another hospital	252 (0.5)

Variable	Frequency (%)
Attending physician	
Specialist	44,280 (89.5)
Consultant	5,206 (10.5)
Consultation	
Non	43,887 (88.7)
One consultation	3,058 (6.2)
Two consultation	1,626 (3.3)
Three consultation	395 (0.8)
Four or more	520 (1.1)
Comorbidity	
No	48,171 (97.3)
Yes	1,315 (2.7)
General Hematology	
No	34,938 (70.6)
Yes	14,548 (29.4)
Blood Chemistry	
No	40,479 (81.8)
Yes	9,007 (18.2)
Coagulation	
No	43,763 (88.4)
Yes	5,723 (11.6)
X-ray	
No	37,232 (75.2)
Yes	12,254 (24.8)
Metabolic	
No	35,034 (70.8)
Yes	14,452 (29.2)
Ultrasound	
No	46,058 (93.1)
Yes	3,428 (6.9)
Computed Tomography	
No	46,924 (94.8)
Yes	2,562 (5.2)

Proportion of Emergency Visits Breached the 4-Hour LOS Target

A total of 18,349 visits (37.1%. 95% CI 36.7 to 37.5) breached the 4-hour LOS target. About 22% of patients had a LOS between >4 and 8 hours (Table 2).

Table 2. Frequency and Proportion of Visits According to LOS Time in Hours

LOS (hours)	Frequency	Percentage
≤ 4	31,139	62.9
> 4-8	10,809	21.8
> 8-12	4,000	8.1
> 12-24	2,547	5.1
> 24	991	2.0

Month-wise Variation in Proportions of Visits that Breached the 4-Hour LOS Target Between January and April 2019

There were some variations in proportion of visits that breached the 4-hour LOS target between January and April 2019. About 34% and 36% of visits breached the 4-hour LOS target in January and February, respectively. About 39% of the ED visits breached the target in March and April. Figure 2. Shows the median and 80th percentile of ED-LOS time between January and April 2019. March 2019 had the highest median (181 minutes) and 80th percentile (429 minutes) of LOS time as compared to January 2019 (median = 156; 80th percentile = 377).

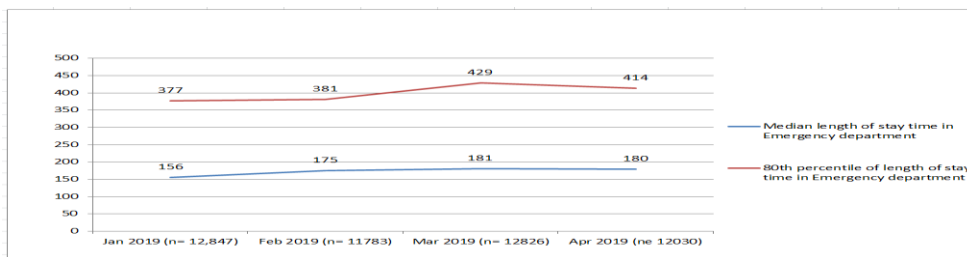


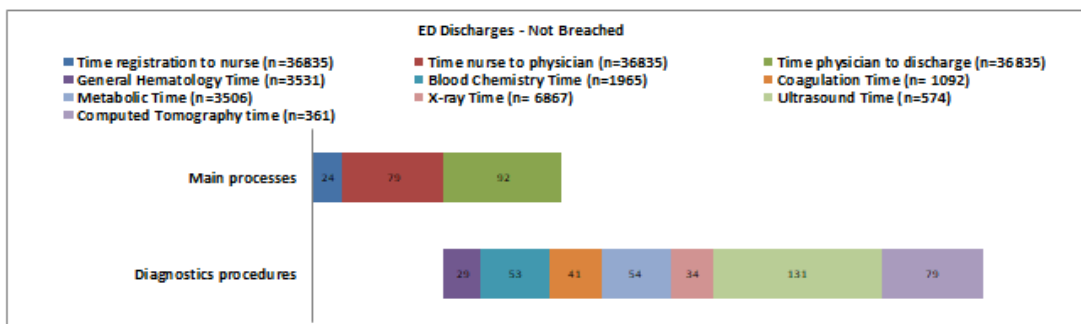
Figure 2. Median and 80th Percentile LOS Time: January to April 2019

Process Flow of Patient Journey in Emergency Department

Process Flow for Discharged Patients

The 80th percentile for LOS time for discharged patients was 346 minutes. This varied significantly between patients according to their breaching status of the 4-hour LOS target.

The 80th percentile for LOS time from registration until being seen by the nurse was the same (24 minutes) for both the non-breached and breached groups. However, the 80th percentile LOS time from seen by the nurse until being seen by the physician was 79 minutes for non-breached patients and 190 minutes for breached patients (Figure 3). Similarly, the 80th percentile LOS time from seen by the physician until discharge time from the ED was 92 minutes and 483 minutes for non-breached and breached groups, respectively. Overall, breached and non-breached patients had similar 80th percentile turnaround time for all laboratory tests and radiology imaging except for x-ray, CT and US (Figure 3). The 80th percentile turnaround time for x-ray was 34 minutes for non-breached patients and 96 minutes for breached patients. Similarly, the 80th percentile turnaround time for US was 131 minutes and 233 minutes for non-breached and breached groups, respectively. In addition, the 80th percentile turned around time for CT was 79 minutes for not-breached patients as compared to 153 minutes for breached patients (Figure 3).



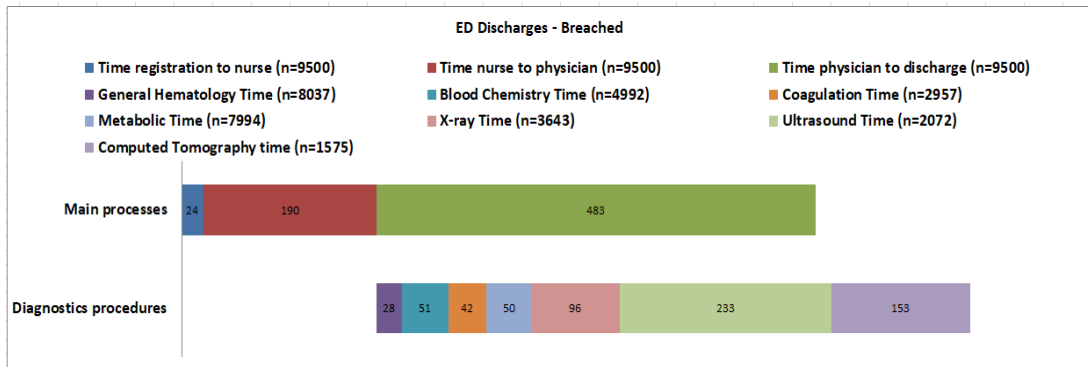


Figure 3. The 80th Percentile Times of Processes Within Patient Journey in ED for Discharged Patients by Breaching Status of the 4-hour LOS Target

Process Flow for Admitted Patients

The 80th percentile for LOS time for admitted patients was 1402 minutes. The 80th percentile for LOS time for non-breached and breached was 217 and 1412 minutes, respectively (Figure 4). The 80th percentile for LOS time from registration until being seen by the nurse among non-breached and breached patients was 13 and 18 minutes, respectively.

However, significant variations were observed in the 80th percentile for LOS times from time being seen by nurse and time being seen by the physician (30 minutes versus 118 minutes for non-breached and breached, respectively). Similarly, the 80th percentile LOS time from seen by the physician until a decision to admit was made was 67 minutes for non-breached patients as compared to 510 minutes for breached patients. Moreover, the 80th percentile LOS time from a decision to admit was made to time of admission was 136 minutes and 801 minutes for non-breached and breached patients, respectively. Similar to discharged patients, admitted patients who breached and non-breached had similar 80th percentile turnaround time for all laboratory tests and radiology imaging except for x-ray, US, and CT (Figure 4). The 80th percentile turnaround time for x-ray was 72 minutes for non-breached patients and 118 minutes for breached patients. Similarly, the 80th percentile turnaround time for US was 130 minutes and 242 minutes for non-breached and breached patients, respectively, and the 80th percentile turned around time for CT was 60 minutes for

non-breached and 152 minutes for breached patients (Figure 4).

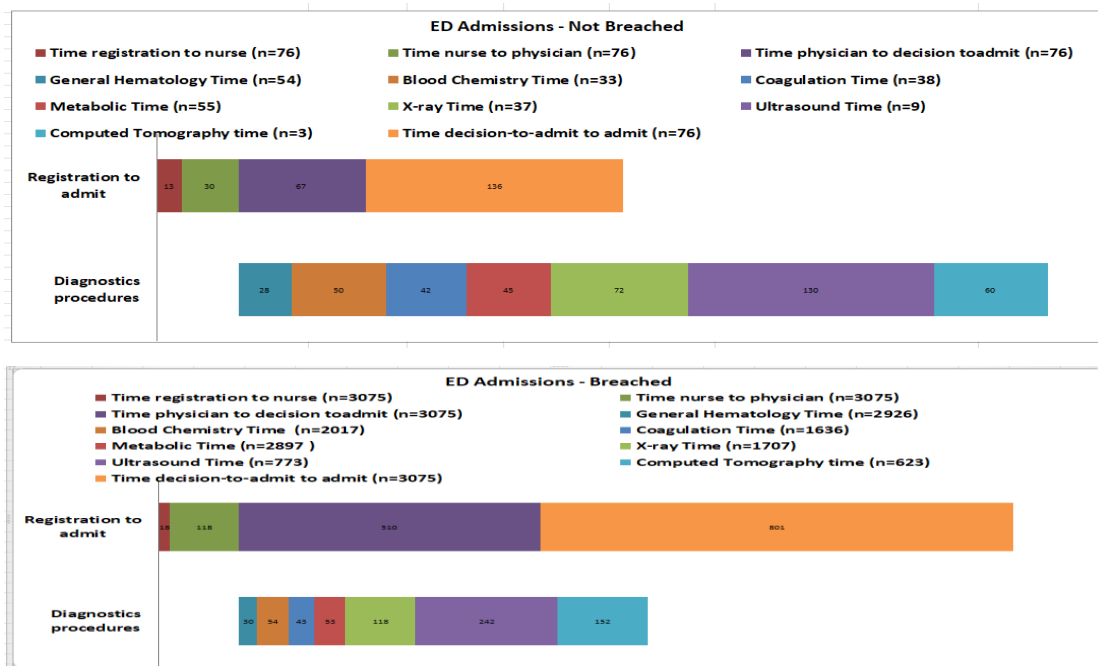


Figure 4. The 80th Percentile Times of Processes Within Patient Journey in ED for Admitted Patients by Breaching Status of the 4-hour LOS Target.

Factors Associated with Breaching the 4-hour LOS Target

Input variables

Table 3 presents the crude and adjusted associations between included variables and breaching the four-hour LOS target. In the univariable logistic regression analyses, all variables (except day of the week visiting the ED) were associated with breaching the four-hour target. However, in multivariable analysis, all variables were associated with breaching the four-hour target except the type of attending physician, comorbidity status, and receiving a coagulation blood test. Patients aged more than 46 years had higher odds of breaching by 1.26 compared to those aged less than 28 years (95% CI 1.16, 1.36). Patients aged 28 to 36 years also had higher odds of breaching the 4-hour target than those aged less than 28 years (OR 1.25, 95% CI 1.16, 1.34). As shown in table 3, male patients had higher adjusted odds of breaching by 1.50 compared to female patients (95% CI 1.42, 1.59). Non-Qatari patients

also had higher odds of breaching the 4-hour target than Qatari patients (adjusted OR 3.00, 95% CI 2.76, 3.18).

Throughput variables

With regards to timing of visiting the ED, patients who attended during the evening shift had lower odds of breaching by 24% as compared to patients attending in the morning shift (OR 0.76, 95% CI 0.70, 0.83). However, patients who attended the ED during the night shift had increased odds of breaching by 1.17 times (95% CI 1.09, 1.25) than patients who attended during the morning shift. With respect to breaching the 4-hour waiting target according to the day of the week, patients who attended the ED on Thursdays, Fridays, and Saturdays had lower odds of breaching as compared to those who attended on Sundays by 19% (OR 0.81, 95% CI 0.73, 0.90), 38% (OR 0.62, 95% CI 0.56, 0.70), and 22% (OR 0.78, 95% CI 0.71, 0.90), respectively. However, no statistically significant odds of breaching were observed for patients who attended the ED on Mondays, Tuesdays, and Wednesdays in comparison to Sundays (Table 3). In addition, increased odds of breaching were observed according to the month of visiting the ED. As compared to patients who attended during January, those who attended the ED in February, March, and April had increased odds of breaching the target by 1.31 times (95% CI 1.21, 1.42), 1.67 times (95% CI 1.54, 1.79), 1.89 times (95% CI 1.70, 2.09), respectively. Significant associations were observed between mode of arrival and triage category with breaching the 4-hour target. Patients who arrived by ambulance had increased odds of breaching the target in comparison to those who arrived by other modes or means of arrival (OR 1.13, 95% CI 1.05, 1.22). The triage priority showed a positive association with the outcome of the breach at 4 hours LOS except for cases with triage categories of “emergency” and “resuscitation”. As compared to the non-urgent triage category, patients who were triaged as less urgent and urgent had significantly increased odds

of breaching the 4-hour waiting time target by about two times (OR 1.99, 95% CI 1.82, 2.19) and three times (OR 3.06, 95% CI 2.77, 3.39), respectively (Table 3). With regards to number of medical consultations needed by different medical consultants, patients who had one or more medical consultations had significantly increased odds of breaching (Table 3). Patients who had one medical consultation by a consultant had increased odds of breaching by 3.48 times than those who had no medical consultations by a consultant (95% CI 2.98, 4.08). Similarly, as compared to patients who needed no medical consultations with a consultant, the odds of breaching the target for those who had two, three, and four or more medical consultations with different consultants were 3.16 (95% CI 2.48, 4.03), 3.70 (95% CI 2.02, 6.60), and 2.43 (95% CI 1.44, 4.11), respectively. However, no statistically significant associations were observed between attending physician type (specialist vs consultant) and breaching the target (Table 3).

With respect to the associations between the types of laboratory investigations performed and breaching the target, all types of laboratory investigations were associated with statistically significant increased odds of breaching expect for blood coagulation testing. Patients who had laboratory tests for general hematology, blood chemistry, and blood metabolic panel were at increased odds of breaching by 6.82 times (95% CI 4.86, 9.58), 1.22 times (95% CI 1.09, 1.36), and 2.21 times (95% CI 1.57, 3.10), respectively. Similarly, patients who had any type of radiology (imaging) investigations were at increased odds of breaching than patients who had no imaging investigations (OR 1.96, 95% CI 1.85, 2.10), 4.02 (95% CI 3.50, 4.63) for US, and 4.05 (95% CI 3.37, 4.87) for CT. With regards to ED discharge destination, patients who were admitted had increased odds of breaching the target by 4.61 times (95% CI 3.46, 6.15) in comparison with patients who were discharged home.

However, patients who were transferred to another hospital had significantly lower odds of breaching than those who were discharged home (OR 0.23, 95% CI 0.15, 0.35)

(Table 3).

Table 3. Crude and Adjusted Association Between Included Variables and Breaching the 4-Hour LOS Target in Emergency Department

Variable	Not-breached (n= 31,137) Frequency (%)	Breached (n= 18,349) Frequency (%)	Crude OR (95% CL)	SE	P- value	Adjusted OR (95% CL)	SE	P- value
Age group (years)								
<28	9,844 (31.6)	3,422 (18.6)	Ref					
28-35	8,191 (26.3)	4,507 (24.6)	1.60 (1.50, 1.67)	0.043	<0.001	1.25 (1.16, 1.34)	0.047	<0.001
36-46	7,290 (24.4)	4,592 (25.0)	1.81 (1.72, 1.91)	0.050	<0.001	1.20 (1.12, 1.30)	0.047	<0.001
>46	5,812 (18.7)	5,828 (31.8)	2.90 (2.73, 3.04)	0.080	<0.001	1.26 (1.16, 1.36)	0.050	<0.001
Gender								
Female	16,712 (53.7)	7,099 (38.7)	Ref					
Male	14,425 (46.3)	11,250 (61.3)	1.84 (1.80, 1.91)	0.035	<0.001	1.50 (1.42, 1.59)	0.042	<0.001
Nationality								
Qatari	10,538 (33.8)	3,011 (16.4)	Ref					
Non-Qatari	20,599 (66.2)	15,338 (83.6)	2.61 (2.49, 2.73)	0.061	<0.001	3.00 (2.76, 3.18)	0.106	<0.001
Arrival mode								
Other	27,278 (87.6)	15,111 (82.4)	Ref					
Ambulance	3,859 (12.4)	3,238 (17.6)	1.52 (1.44, 1.59)	0.039	<0.001	1.13 (1.05, 1.22)	0.042	0.001
Triage priority								
Nonurgent	7,473 (24.0)	757 (4.1)	Ref					
Less urgent	18,688 (60.0)	7,464 (40.7)	3.94 (3.64, 4.30)	0.160	<0.001	1.99 (1.82, 2.19)	0.093	<0.001
Urgent	4,859 (15.6)	9,329 (50.8)	18.95 (17.45, 20.58)	0.797	<0.001	3.06 (2.77, 3.39)	0.157	<0.001
Emergency	116 (0.4)	788 (4.3)	67.06 (54.43, 82.63)	7.143	<0.001	1.09 (0.84, 1.43)	0.149	0.519
Resuscitation	1 (0.0)	11 (0.1)	108.59 (14.00, 842.24)	113.495	<0.001	0.63 (0.08, 5.28)	0.685	0.674
Month								
January	8,503 (66.0)	4,344 (34.0)	Ref					
February	7,520 (63.7)	4,263 (36.3)	1.11 (1.05, 1.17)	0.030	<0.001	1.31 (1.21, 1.42)	0.052	<0.001
March	7,763 (60.6)	5,063 (39.4)	1.28 (1.21, 1.34)	0.033	<0.001	1.67 (1.54, 1.79)	0.063	<0.001
April	7,351 (61.0)	4,679 (39.0)	1.25 (1.18, 1.31)	0.032	<0.001	1.89 (1.70, 2.09)	0.098	<0.001
Day of the week								
Sunday	4,843 (15.6)	2,879 (15.7)	Ref					
Monday	4,640 (14.9)	2,715 (14.8)	0.98 (0.92, 1.05)	0.033	0.639	0.92 (0.83, 1.01)	0.044	0.076
Tuesday	4,577 (14.7)	2,871 (15.7)	1.06 (0.99, 1.13)	0.035	0.109	0.97 (0.89, 1.07)	0.047	0.597
Wednesday	4,482 (14.4)	2,623 (14.3)	0.984 (0.92, 1.05)	0.034	0.645	0.93 (0.84, 1.02)	0.045	0.112
Thursday	4,410 (14.2)	2,537 (13.8)	0.97 (0.91, 1.04)	0.033	0.339	0.81 (0.73, 0.90)	0.040	<0.001
Friday	3,858 (12.4)	2,181 (11.9)	0.95 (0.89, 1.02)	0.034	0.159	0.62 (0.56, 0.70)	0.032	<0.001
Saturday	4,327 (13.9)	2,543 (13.9)	0.99 (0.92, 1.06)	0.034	0.739	0.78 (0.71, 0.90)	0.038	<0.001
Working shift								
Morning	9,643 (31.0)	5,406 (29.5)	Ref					
Evening	11,552 (37.1)	7,155 (39.0)	1.11 (1.06, 1.16)	0.025	<0.001	0.76 (0.70, 0.83)	0.034	<0.001
Night	9,942 (31.9)	5,788 (31.5)	1.04 (0.99, 1.09)	0.025	0.111	1.17 (1.09, 1.25)	0.040	<0.001
Discharge destination								
Home	31,002 (68.0)	15,081 (32.0)	Ref					
Admitted	76 (2.0)	3,075 (98.0)	83.18 (66.19, 104.52)	9.693	<0.001	4.61 (3.46, 6.15)	0.683	<0.001
Transfer to another hospital	59 (23.0)	193 (77.0)	6.73 (5.02, 9.01)	1.003	<0.001	0.23 (0.15, 0.35)	0.048	<0.001
Attending physician								
Specialist	27,935 (89.7)	16,345 (89.1)	Ref					
Consultant	3,202 (10.3)	2,004 (10.9)	1.07 (1.01, 1.14)	0.032	0.025	1.04 (0.96, 1.13)	0.045	0.368
Consultation								
Non	30,670 (70.0)	13,217 (30.0)	Ref					
One consultation	310 (10.0)	2,748 (90.0)	20.57 (18.26, 23.17)	1.251	<0.001	3.48 (2.98, 4.08)	0.280	<0.001
Two consultation	120 (7.0)	1,506 (93)	29.12 (24.16, 35.11)	2.779	<0.001	3.16 (2.48, 4.03)	0.391	<0.001
Three consultation	17 (4.0)	378 (96)	51.60 (31.72, 83.91)	12.803	<0.001	3.70 (2.02, 6.60)	1.104	<0.001
Four or more	20 (4.0)	500 (96)	58.01 (37.09, 90.74)	13.242	<0.001	2.43 (1.44, 4.11)	0.650	0.001
Comorbidity								
No	30,788 (98.9)	17,383 (94.7)	Ref					
Yes	349 (1.1)	966 (5.3)	4.90 (4.33, 5.55)	0.310	<0.001	0.97 (0.80, 1.17)	0.095	0.760

Variable	Not-breached (n= 31,137) Frequency (%)	Breached (n= 18,349) Frequency (%)	Crude OR (95% CL)	SE	P- value	Adjusted OR (95% CL)	SE	P- value
General								
Hematology	29,242 (93.9)	5,696 (31.0)	Ref					
No	1,895 (6.1)	12,653 (69.0)	34.28 (32.41, 36.25)	0.979	<0.001	6.82 (4.86, 9.58)	1.183	<0.001
Yes								
Blood								
Chemistry	30,036 (96.5)	10,443 (56.9)	Ref					
No	1,101 (3.5)	7,906 (43.1)	20.65 (19.32, 22.08)	0.705	<0.001	1.22 (1.09, 1.36)	0.067	<0.001
Yes								
Coagulation								
No	30,564 (98.2)	13,199 (71.9)	Ref					
Yes	573 (1.8)	5,150 (28.1)	20.81 (19.05, 22.74)	0.942	<0.001	0.92 (0.81, 1.03)	0.055	0.141
Metabolic								
No	29,251 (93.9)	5,783 (31.5)	Ref					
Yes	1,886 (6.7)	12,566 (68.5)	33.70 (31.87, 35.64)	0.963	<0.001	2.21 (1.57, 3.10)	0.383	<0.001
X-ray								
No	26,280 (84.4)	10,952 (59.7)	Ref					
Yes	4,857 (15.6)	7,397 (40.3)	3.65 (3.502, 3.813)	0.079	<0.001	1.96 (1.85, 2.10)	0.060	<0.001
US								
No	30,795 (98.9)	15,263 (83.2)	Ref					
Yes	342 (1.1)	3,086 (16.8)	18.21 (16.25, 20.39)	1.053	<0.001	4.02 (3.50, 4.63)	0.286	<0.001
CT								
No	30,971 (99.5)	15,953 (86.9)	Ref					
Yes	166 (0.5)	2,396 (13.1)	28.02 (23.92, 32.83)	2.265	<0.001	4.05 (3.37, 4.87)	0.380	<0.001

Abbreviations CI, Confidence interval; OR, odds ratio; SE, Standard error; P,

Probability

CHAPTER 5: DISCUSSION

The aim of this retrospective cohort study was to estimate the proportion of patients exceeding the four-hour waiting time target in adult ED in AWH and identify associated factors. The objectives were to (a) identify overall proportion of ED visits that breached the 4-hour LOS target between January and April 2019, inclusive; (b) identify any variations in monthly proportions of ED visits that breached the 4-hour LOS target between January and April 2019, inclusive; (c) identify any differences in LOS time in processes within patient flow in ED by breaching status among discharged and admitted patients; (d) identify factors associated with breaching the 4-hour LOS target.

In the current study, 37.1% of ED visits breached the 4-hour LOS target. This is lower than that observed in a recent study in HGH in Qatar in which 46.6% shifts did not meet the 4-hour LOS target (18). Generally, this is much higher than those reported in most previous studies in other countries. One study was conducted in United Kingdom (UK) over two years (2014 to 2016; n= 232,920) showed that less than ten percent of ED visits breached the four-hour LOS target (2). Another retrospective cohort study from the UK was conducted between April 2008 and April 2013 (n=374,459) revealed that only nine percent of all ED visits breached the four-hour target (16). A recent report by the National Health Services (NHS) in UK in 2020 indicated that the proportion of ED visits that breached the four-hour target has increased from 5.5% in 2014 to 15.3% in 2019 (42). On the other hand, one study showed that 61% of ED visits in Indonesia breached the four-hour LOS target (43).

Such lower proportion in UK than Qatar would be due to the established health care system since long time in UK compared to the growing system in Qatar. Patients in UK used to access primary health care facilities as the first point of access, whereas people in Qatar tend to approach ED for easy access of care rather than primary health care centers, which keep ED in Qatar under constant pressure, which may contribute to such high proportion of

breach of the 4 hours target of ED-LOS (21,42). One potential explanation for this is that ED provides free health care services, unlike the health care centers, in which the patient must pay an amount of money in the absence of a health card, which many labors who work in the industrial companies do not have. These workers represent large percentages of ED patients at present, due to their injuries and health conditions resulting from their work in the country construction projects and this require the provision of service by nurses, physicians and other clinicians, which constitutes burden on them and thus patients wait in the ED longer (21). Also the inadequate community awareness and lack of community education regarding the main role of the emergency departments compared to the primary health care centers is another factors influence the non-urgent visits to the ED in the gulf region which has been explored in some local studies (99). Another important explanation is the unavailability of inpatient beds reduces the ED capacity. The shortage of inpatient wards beds had increased the ED waiting time as ED physicians faced difficulties to assess new ED registered patients due to the high bed occupancy rate in ED by those patients pending to be transferred to the inpatient wards (100).

In the present study, there were some variations with increasing trend in proportions of ED visits that breached the 4-hour LOS target between January (34%) and April (39%) 2019. This observation accords with similar observations from other countries reporting variations in ED visits breaching the LOS target (16,90,91), For example, the NHS in the UK reported that 16% of ED visits breached the target in January and February in 2019 as compared to 13% in March and 15% in April in 2019 (18). The exact explanation for our finding regarding the variations in proportions of breaches between January and April 2019 is not very clear. However, one potential explanation is that our study was conducted in the winter/spring seasons in which the number of patients who visited the ED was higher compared to the other months of the year (101). In our study, 13847, 11793, 12826, 12030

of ED visit occurred between January and April 2019, respectively (plus 8392 excluded visits for various reasons as explained in the results section). However, the number of visits in AWH adult ED (without any exclusions) between May and December 2019 were as follows: 13221, 12102, 12050, 10466, 13021, 13413, 13551 and 14446, respectively (101).

The current study showed consistent similarities and differences in the 80th percentile LOS time in main processes within patient flow in ED between visits that breached and did not breach the four-hour LOS target among discharged and admitted patients. Among discharged patients, as compared to “not-breached” visits, visits that breached the target had higher 80th percentile LOS time from time seen by nurse to being seen by the physician, time from seen by the physician until discharge, x-ray time, US time, and CT time. Among the admitted patients, the same differences were observed plus longer 80th percentile times from seen by the physician to a decision to admit is made and from admission decision to actual admission to a ward between visits that breached and “not-breached” the target. In addition, the present study showed that increasing age, male gender, non-Qatari nationality, arrival by ambulance, night shift, month of visiting the ED, triage acuity (less argent and urgent), increasing number of consultations with consultants, performing laboratory tests and radiologic examination, and inpatient admission were independent predictors of breaching the four-hour LOS target. These findings support our finding of main difference in LOS time of main processes in patient flow in ED. These findings very consistent with the results of prior studies from several countries, including USA, UK, France, The Netherlands, and Australia (16,28,89–91,95,102). Although we accounted for important factors of breaching (admission, triage category, comorbidity, number of consultations, blood and radiologic examinations) older age and male gender remained independent predictor of breaching the LOS target. The exact explanation for this is not clear from the current study. However, one potential explanation is that older and male patients may have presented with more severe complaints

in nature (as opposed to number of complaints per se) which often require more complex therapeutic interventions, which we did not account for, and thus are associated with prolonged LOS in ED (28). In addition, such patients may have to wait in ED until inpatient beds are available for them to be admitted. It is well known that reduced hospital inpatient capacity is associated with significant prolonged stay in ED (90,103). This explanation is also likely to explain our finding that arrival by ambulance was associated with higher odds of breaching the LOS target. Our finding that non-Qatari patients had higher odds of breaching the LOS target than Qatari patients could be explained by the fact that Qatari patients are managed in a separate stream, and therefore, their journey in the ED is more streamlined than non-Qataris (21). Increasing odds of breaching the LOS target associated with less urgent and urgent triage categories, increasing number of consultations with medical consultants, performing laboratory tests and radiologic investigations could be explained by increased case complexity, timely access to medical investigation results, prolonged laboratory turnaround time and radiologic and diagnostic testing reports in peak hours or when staffing levels are minimum (e.g. radiologists and technicians), and staffing training levels (especially in teaching hospitals) and availability of senior medical consultants, which have been reported as key predictors of LOS in ED (16,28,89,95,102). These factors are also likely to explain the higher odds of breaching the LOS target at night, weekdays as compared to weekends, and the period between February and April as compared to January. These factors are very likely to explain our findings of higher 80th percentile LOS times from time seen by nurse to being seen by the physician, diagnostic imaging time, and time from seen by the physician until discharged for breached patients as compared to “not-breached patients” among discharged patients. Likewise, these factors are also very likely to explain our findings of higher 80th percentile LOS times from time seen by nurse to being seen by the physician, diagnostic imaging time, time from seen by the physician to a decision

to admit is made, and from admission decision to actual admission to a ward in visits that breached as compared to those “not-breached” among admitted patients. The current study showed that, as compared to non-urgent visits, “emergency” and “resuscitation” triage categories had increase and lower odds of breaching the LOS target, respectively. Prior studies have showed mixed findings regarding this observation, and are likely to be influenced by ED census, staffing capacity, and bed availability (43,104,105). A likely explanation for our finding is that such categories represent a very small proportion of ED visits and always are streamlined and admitted quickly at AWH or transferred to other hospitals.

Implications for Clinical Practice and Future Research

The current study has shown that about more than one out of three patients visiting AWH breaches the four-hour LOS target. In addition, this study has identified main factors and processes associated with higher odds of breaching the LOS target which could be targeted with healthcare quality improvement interventions. These findings have important implications for clinical practice, health services administration, and future research. Prior research initiatives have shown that increased LOS in ED could be improved using various interventions. Introducing an emergency journey coordinator or a clinical assistant to monitor, manage, facilitate the flow of patients, and speed decision making in ED was associated with increase in proportion of ED visits meeting the LOS target (106), and reducing overall LOS in ED, and reducing the proportion of patients leaving without being seen (107). Other studies have showed that increasing senior medical personnel capacity such as adding one more emergency physician or increasing number of consultants per shift were associated with shorter LOS time in ED (18,108). For example, one study from Qatar showed that increasing numbers of on-duty consultants per shift was associated with higher

odds of meeting the LOS target in ED during the shift by 1.27 times (95% CI 1.20, 1.34) (18). Other studies showed that staffing a fast-track clinic in ED to manage non-urgent visits that do not require emergency beds or intravenous treatments was associated with meeting the four-hour LOS target for 92% of these cases. Similarly, one study showed that fast-tracking stable patients in ED by an emergency physician, resident, and a senior nurse was associated with higher odds of meeting the LOS target by 15% (OR 1.15, 95% CI 1.07, 1.24) (106). Other research studies found that introducing of “point-of-care” testing and automation of main laboratory with robotics (109,110), or a “Stat Laboratory” in which urgent lab tests are processed immediately were associated with shorter LOS time in ED (111). In addition, some studies reported that "diagnostic anticipation" and ordering of laboratory tests by senior triage nurses or nurse practitioners at triage before patients are seen by emergency physicians was also associated with shorter LOS in ED (112,113). Therefore, hospitals should provide long-term strategies to reduce patients waiting in the ED and to accommodate cases that require admission without delay, such as increase the number for the hospital beds and expediting the discharge process for those who don't need to be admitted, while providing clear medical protocols to speed up the process of discharging patients without waiting for the decision of the medical consultants who are engaged with other patients elsewhere (114,115). In addition, improving communication and organization of care between ED physicians and consultants out of ED may improve the flow of ED patients. Numerous attempts by emergency physicians to reach subspecialties were described as difficult, especially during peak times with high patient volume in ED (116). Moreover, a national strategy or plan is highly required to enhance the process of emergency services and national targets. For example, easy access to walk-in clinics in primary health care facilities providing emergency services 24/7 for lesser acuity patients, may decrease pressure and load on secondary and tertiary hospitals. The present study also implicates that more prospective

research studies at multiple sites with measure of organizational factors affecting LOS in ED and root causes analyses across the patient journey in ED are needed to better understand unique modifiable factors affecting LOS in ED. In addition, cost-effectiveness studies are needed to examine the various interventions aiming at reducing LOS in ED a cross-multiple site and employ those with the greatest positive impact on LOS target in ED.

Strengths and Limitations

The main strengths of the current study is the use of a large sample size of ED visits from the second largest acute hospital in Qatar (117). In addition, we have accounted for important factors affecting LOS in ED including laboratory and radiologic investigations. Moreover, the data was extracted from the CERNER system which tracks patient's journey in an accurate and timely manner. Also, the ED administrative database provides complete data on the patient's journey in the ED including time intervals, laboratory and radiology investigation performed during the visit to ED. The data extraction complete for all variables used in the study. In addition, the study covered four months that are associated with high peak of ED attendance in the year (101,118). Moreover, the findings are likely to be generalizable to other governmental hospitals in Qatar such as HGH which has higher proportion of ED visits breaching the four-hour LOS target than AWH (18). One more strength was that the use of multivariable regression to account for potential confounding variables (119), which was coupled with process template of patient journey in ED that enhanced interpretation of data.

The present study also has some limitations that should be considered. One limitation is that, due to the retrospective design of the study, we did not have information on other important factors associated with increased LOS in ED such as crowding, number of patients waiting in ED for admission, number of and training levels of staff at different shifts, and

exact severity of presenting complaints among patients, emergency diagnoses made, the duration and number of Theopoeitic interventions given to them, discharge and inpatient flow in the hospital, and any communication barriers between the clinicians and patients who do not speak Arabic or English. Another limitation is that we had no information on repeated visits and therefore the use of logistic regression rather than mixed models may have violated the assumptions of dependence of observations (visits by same patients).

In addition, this study was conducted in one location covering only four months, and therefore the findings may not be generalized to other hospitals with different healthcare processes and systems or other months during the year. However, our findings are very consistent with the findings of other studies from several countries.

Conclusion

This study shows that one out of three patients attending the ED at AWH breaches the four-hour LOS target. The main factors associated with breaching the LOS target were older age, male gender, non-Qatari nationality, less urgent and urgent triage categories, time of presentation (night shift, week days, and month of presentation), arrival by ambulance, inpatient admission, increasing number of medical consultations, and performing laboratory tests and diagnostic imaging. The main processes in patient journey that accounted for a major part of LOS in ED was waiting time to see the physician, time elapsed from seeing the physician until discharge or admission to a ward. These findings suggest that LOS in ED is mainly affected by organizational and modifiable factors. Enhancing turnaround time for laboratory and diagnostic imaging results, timely consultations with senior medical consultants, decision making, and employing cost-effective interventions to enhance patients flow in ED may significantly reduce proportion of patients breaching the LOS targets.

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APPENDIX

Appendix 1. Hamad Medical Corporation IRB approval

Approval Letter





APPROVAL LETTER
MEDICAL RESEARCH CENTER
HMC, DOHA-QATAR

Mr. Amjad Hamad Mohd Al Khawaldeh 032942 Head Nurse (CP) Accident & Emergency Al Wakra Hospital (AWH) Hamad Medical Corporation	Date: 18th July 2020								
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; padding: 2px;">Protocol No.</td> <td style="padding: 2px;">MRC-01-19-413</td> </tr> <tr> <td style="padding: 2px;">Study Title</td> <td style="padding: 2px;">Proportion of emergency visits with a length of stay greater than four hours in Qatar and associated factors: a cross-sectional study .</td> </tr> </table>	Protocol No.	MRC-01-19-413	Study Title	Proportion of emergency visits with a length of stay greater than four hours in Qatar and associated factors: a cross-sectional study .					
Protocol No.	MRC-01-19-413								
Study Title	Proportion of emergency visits with a length of stay greater than four hours in Qatar and associated factors: a cross-sectional study .								
The above titled research study has been approved to be conducted in HMC summarized as below:									
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; padding: 2px;">Study type:</td> <td style="padding: 2px;">Data Review</td> </tr> <tr> <td style="padding: 2px;">Data Collection Period:</td> <td style="padding: 2px;">01/01/2019 - 30/09/2019</td> </tr> </table>	Study type:	Data Review	Data Collection Period:	01/01/2019 - 30/09/2019					
Study type:	Data Review								
Data Collection Period:	01/01/2019 - 30/09/2019								
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; padding: 2px;">Team Member List:</td> <td style="padding: 2px;">Mr. Amjad Hamad Mohd Al Khawaldeh , Ms. Taiba Abdulla Salman Ahmed</td> </tr> <tr> <td style="padding: 2px;">Review Type :</td> <td style="padding: 2px;">"Exempt" under MOPH guidelines "Category 3: Research involving the collection or study of existing: Data, documents, records and the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects".</td> </tr> <tr> <td style="padding: 2px;">Decision :</td> <td style="padding: 2px;">Approved</td> </tr> <tr> <td style="padding: 2px;">Hospitals/ Facilities Approved:</td> <td style="padding: 2px;">Al Wakra Hospital (AWH)</td> </tr> </table>	Team Member List:	Mr. Amjad Hamad Mohd Al Khawaldeh , Ms. Taiba Abdulla Salman Ahmed	Review Type :	"Exempt" under MOPH guidelines "Category 3: Research involving the collection or study of existing: Data, documents, records and the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects".	Decision :	Approved	Hospitals/ Facilities Approved:	Al Wakra Hospital (AWH)	
Team Member List:	Mr. Amjad Hamad Mohd Al Khawaldeh , Ms. Taiba Abdulla Salman Ahmed								
Review Type :	"Exempt" under MOPH guidelines "Category 3: Research involving the collection or study of existing: Data, documents, records and the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects".								
Decision :	Approved								
Hospitals/ Facilities Approved:	Al Wakra Hospital (AWH)								

This study must be conducted in full compliance with all the relevant sections of the Rules and Regulations for Research at HMC and the Medical Research Center should be notified immediately of any proposed changes to the study protocol that may affect the 'exempt' status of this study. Wherever amendments to the initial protocol are deemed necessary, it is the responsibility of the Principal Investigator to ensure that appropriate reviews and renewed approvals are in place before the study will be allowed to proceed.

Please note that only research documentation uploaded in ABHATH currently are to be utilized at any stage in the conduct of this study. The research team must ensure that changes and progress on the study is appropriately recorded in ABHATH, the online research system of the Medical Research Center. PI must ensure that any link to patient identifiers must be destroyed after data collection and data security must be maintained.

We wish you success in this research and await the outcomes in due course.
Yours sincerely,

Prof. Michael Paul Frenneaux
Chief of Scientific, Academic and Faculty Affairs
Hamad Medical Corporation

		
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Appendix 2. Qatar University IRB Approval



Qatar University Institutional Review Board **QU-IRB** QU-IRB Registration: MOPH-QU-010, QU-IRB, Assurance: IRB-A-QU-2019-0009

January 2nd, 2020

Conditional Ethics Approval

Dr. Mujahed Shraim
College of Health Sciences
Qatar University
Phone: + 974 4403 7503
Email: mshraim@qu.edu.qa

Dear Dr. Mujahed Shraim,

Sub.: Research Ethics Exempted Approval

Ref.: Student, Amjad Hamad AL-Khawaldeh / e-mail: aa1700270@student.qu.edu.qa

Project Title: "Proportion of emergency patients with a length of stay greater than four hours in Qatar and associated factors: a cross-sectional study"

We would like to inform you that your application along with the supporting documents provided for the above student project, has been reviewed by the QU-IRB, and having met all the requirements except HMC Hospital approval, is granted a **Conditional Exemption** based on the following category(ies) listed in the Policies, Regulations and Guidelines provided by MoPH for Research Involving Human Subjects:

Category 3: Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified.

Category 4: Research and demonstration projects which are designed to study, evaluate, or otherwise examine: (i) Public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in levels of payment for benefits or services under those programs.

Please note that this is a provisional approval notifying you that QU-IRB review of your application is complete and the Board has no further ethical concerns. However, it does not permit you to commence any part of the study until the final letter with the final approval number is issued, which is contingent upon the receipt of the HMC MRC approval.


Documents reviewed: QU-IRB Application Human Subject- Ver 2_Bilingual-Amjad2 (1), QU-IRB Application Material Check List-Sample-Amjad (2), Research proposal by Amjad Al-Khawaldeh, MRC-01-19-413_DataCollectionSheet_Eng_21-DEC-19_1Pages_1404004 (2), QU-IRB Review Forms, responses to IRB queries and updated documents.

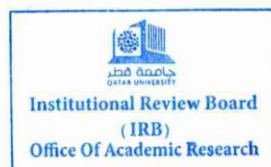
Missing document(s): HMC MRC ethics approval letter.

Please note that exempted projects do not require renewals; however, any changes/modifications to the original submitted protocol should be reported to the committee to seek approval prior to continuation.

Your Research Ethics Exempted Approval Number is: **QU-IRB 1208-E/20**. Kindly state this number in all your future correspondences to us pertaining to this project. In addition, please submit a closure report to QU-IRB upon completion of the project.

Best wishes,

Dr. Ahmed Awaisu

Chairperson, QU-IRB



Qatar University-Institutional Review Board (QU-IRB), P.O. Box 2713 Doha, Qatar
Tel +974 4403-5307 (GMT +3hrs) email: QU-IRB@qu.edu.qa