

**DESCRIPTION OF PATIENT FLOW IN AN INDONESIAN
EMERGENCY DEPARTMENT OF A MAJOR TEACHING
HOSPITAL**

I Putu Budiarsana

A thesis submitted for the degree of Masters of Nursing Science,
The University of Adelaide

**School of Nursing
Faculty of Health Science
The University of Adelaide**

October 2015

Table of Contents

Chapter 1 Introduction	1
Introduction.....	1
Context of the Study	1
Sanglah General Hospital Profile	1
Facility	1
Staffing.....	2
Patient flow	3
Purpose of the Study	5
Research Questions	5
Aims and Objectives.....	5
Significance of the Study.....	6
Assumptions.....	6
Definitions of terms	6
Outline of the Study	7
Conclusion.....	8
Chapter 2 - Literature review	9
Introduction.....	9
Search Strategy	9
Emergency department in developed countries.....	9
Emergency department in Indonesia	10
Sanglah Hospital Emergency Department	11
Analysing Patient Flow	11
Factors that contribute to disruption of patient flow in emergency departments.	11
Emergency department length of stay	12
The impact of impeded patient flow.....	15
Initiatives to reduce overcrowding and access block.....	16
Altering the arrival process.....	17
Altering the queueing process	17
Altering the service process.....	19
Modelling Approaches for Emergency Department Patient Flow and Crowding Research	20
Balance score cards	21
Discrete event simulation	21

Queuing theory.....	22
Statistical forecasting.....	22
Workflow diagramming.....	23
Lean thinking.....	23
Process mapping.....	24
Patient flow analysis (PFA).....	24
Conclusion.....	25
Chapter 3 – Methods.....	26
Introduction.....	26
Study plan and design.....	26
Design.....	26
Study Population.....	27
Ethical issues.....	27
Recruitment strategy.....	29
Study setting.....	29
Sampling.....	29
Data collection.....	30
Issues of Validity and Reliability.....	32
Data analysis.....	32
Conclusion.....	33
Chapter 4 Results.....	34
Introduction.....	34
Data Analysis.....	34
Response Rate.....	34
Statistical Analysis.....	34
Descriptive analysis.....	35
T-test and one way ANOVA.....	40
The result of multiple regression statistics.....	42
Conclusion.....	44
Chapter 5 Discussion.....	45
Introduction.....	45
Restatement of the problem.....	45

Summary of description of procedures	46
Major findings and their significance to clinical practice	47
Emergency department length of stay	47
Laboratory Turnaround time (TAT) in the SHED.....	50
Other possible factors that contribute to prolonged ED LOS in the SHED	57
Study Limitations.....	59
Recommendations for further investigation	60
Conclusion.....	61
References	62
Appendices	71

Index of figures

Figure 1 Patient flow in the SHED	3
Figure 2 Map of Sanglah Hospital Emergency Department	4
Figure 3 Approximate age	35
Figure 4 Case type presenting to the ED	36
Figure 5 The waiting time for an inpatient bed	37
Figure 6 The mean and standard deviation for patient's journey interval for admitted patients	38
Figure 7 Mean and standard deviation for patient journey intervals for discharged patients	39
Figure 8 Phases in laboratory testing	54

SIGNED STATEMENT

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution.

To the best of my knowledge and belief, this work contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the School of Nursing Library, being available for loan or photocopying.

.....

I Putu Budiarsana

26th November, 2015

ACKNOWLEDGEMENT

I would like to express my gratitude to my supervisors: Dr David Foley and Mr. Ian Everett for their excellent guidance, encouragement and support.

I would like to thank the Human Research Committee of the University of Adelaide and the Udayana University, Bali and Indonesia for providing ethical approval for my research. I would like to say thank you very much for the director of Sanglah Hospital, Bali Indonesia to give me permission to conduct research in the Sanglah Hospital Emergency Department (SHED).

Also I convey my special thanks ambulance nurse that helped me to collect data. I acknowledge special contribution of the nurse director of emergency department, nurse unit manager and nursing staff at the SHED.

I thank to God that keep me healthy during write my thesis. To my wife (Gst Ayu Sri Margiani) and my daughter (Mitha) and my son (Dipa), this thesis is dedicated to you. Thanks to my parents for your support and prayers.

ABSTRACT

Patients in Sanglah Hospital Emergency Department (SHED) may experience delays for a variety of reasons. However, it is difficult to identify the exact factors that contribute to delays or how much delays contribute to waiting time. The main purpose of this study is to form complete descriptions of patients' journeys through the emergency department (ED) in order to identify delays that contribute to crowding in the SHED.

This is a descriptive study using prospective patient flow analysis (PFA). Data was collected on 12 patients (approximately 10per cent¹) per day for eight days. Patients who presented between 12 midday and 8 pm were enrolled. This study capture period was chosen as it is the peak period in the ED. Steps of the patients journey in the SHED were separately timed. Multiple regression was used to examine the association between independent variables and dependent variables of time at each point and total ED LOS time.

There were 96 patients observed and a complete set of data points were collected from these participants. There were significant differences in the mean (\log_{10}) of length of stay (LOS) time according to triage level, arrival modes, arrival types, case types, cubicle areas, decision to admit, waiting for bed availability, discharge/admitted, turnaround time for consultation to other specialisation, imaging turnaround time, laboratory turnaround time and ED bed to nurse ($p < 0.05$). However, a multiple regression analysis determined that only pathology requests had a statistically significant effect and unique contribution to ED LOS (Beta=-0.227, $p = 0.009$).

In the SHED, laboratory turnaround time is associated with delay that contributes to ED crowding. Improving laboratory turnaround time during the pre-analytic and post analytic phase may reduce ED LOS, which in turn should reduce ED crowding.

¹ 44997 patients presented in 2014, a mean of 122 patients per day.

Chapter 1 Introduction

Introduction

This thesis reports on a research study that investigated patient flow in an Indonesian major teaching hospital emergency department (ED). The purpose was to identify the points of delay that contribute to ED overcrowding. This chapter introduces and briefly outlines the context and the ED profile. It then presents a statement of the study purpose, research question, aims and objectives, significance of the study, assumptions and definitions of terms. Lastly, it outlines the study.

Context of the Study

Patients in the ED may experience delay for a variety of reasons. However, it is difficult to identify the exact factors that contribute to the delay or how much they contribute to waiting time. By describing waiting time and patients' flow using patient flow analysis, the ED can begin to address excessive waiting time and ED crowding.

Sanglah General Hospital Profile

Sanglah General Hospital (SGH) is a public hospital located in Denpasar, Bali province, Indonesia. This teaching hospital is for students from the Faculty of Medicine, Udayana University. It also provides clinical placement for general practitioners, specialist physicians, medical consultants, nurses and other allied health profession students. SGH is the major referral centre for the three provinces of Bali, East Nusa Tenggara and West Nusa Tenggara. This hospital also provides services for foreign patients, mainly from East Timor and Australia.

Sanglah Hospital Emergency Department (SHED) has been operational since March 1991. The SHED provides emergency paediatric, maternity, gynaecologic, medical, surgical and trauma services and is open 24 hours per day.

Facility

The ED building is divided into two floors. The first floor is for treating emergency patients, and the second floor is for intermediate care provided to emergency patients who need admission and further observation. The first floor is divided into a non-clinical area, a clinical area and a support service area. The non-clinical area is for administration, the pharmacy and admission unit. The clinical unit is divided into the

following areas: triage, fast track, medical, surgical, paediatric, obstetrics and gynaecology and the short stay unit. The triage room consists of six beds for triaged patients. The fast track area has four beds to treat patients with category four and five problems, and there is also one isolation room in this area. In the medical area, there are 15 beds to treat patients with category two and three problems, one bed for resuscitation, and one isolation room. In the surgical area, there are 15 beds to treat patients with category two and four surgical problems and also four resuscitation beds. The paediatric area has five beds and one resuscitation area. There is an operating area with three operating theatres. There is one delivery room with eight beds. There are several facilities that support emergency services, including the operating theatre, radiology department and a satellite laboratory. The intermediate unit on the second floor is divided into medical and surgical/trauma areas, with each area containing 22 beds for admitted patients. This area is used to observe patients for 24 hours before they move to another part of the hospital.

Staffing

Nursing

There are 10 nurses rostered on each shift. The nurses are allocated into all areas of the ED: one in fast track, three in surgical, one in paediatric, four in medical and one in short stay. Most nurses have graduated from a nursing academy with a nursing diploma.

Doctors

There are three types of medical officers in the SHED. Firstly, general practitioners (GP) of which there are four GPs in the triage area and fast track for each shift. GPs are doctors that have finished seven semesters of academic study and four semesters of clinical placement. They have two functions: triaging patients and treating patients. The second type of medical officers are registrars who work in the medical and surgical areas. The registrar doctors are from a variety of specialisations. Each shift there are 30 registrars in charge of treatment. The third type of medical officers are consultants. The trauma consultants are the only specialists available 24 hours a day. Other consultants are only available via phone contact.

Patient flow

All patients who present to the SHED are triaged, using the Australasian Triage Scale (ATS), by GPs. Patients assigned category one are sent to the resuscitation room. In the resuscitation area, patients are treated by a team of several registrars from relevant specialties. The leader of the team is a senior anaesthetic registrar. Patients assigned category two or three are sent to the medical or surgical treatment areas. In these areas, the patients are treated by a registrar. Patients assigned category four or five are sent to fast track. Obstetrics and gynaecology patients are not triaged in the triage area, but are sent directly to the obstetrics and gynaecology treatment area. After a definitive decision is made by a treating doctor, patients can exit the ED to the intensive care unit, an inpatient ward, intermediate care, the operating theatre or be discharged, as described in the flow chart below (figure 1). In figure 2 the physical design of SHED is presented with a representation of possible patient flow through the ED. Possible times at each point in the flow are also presented in this figure.

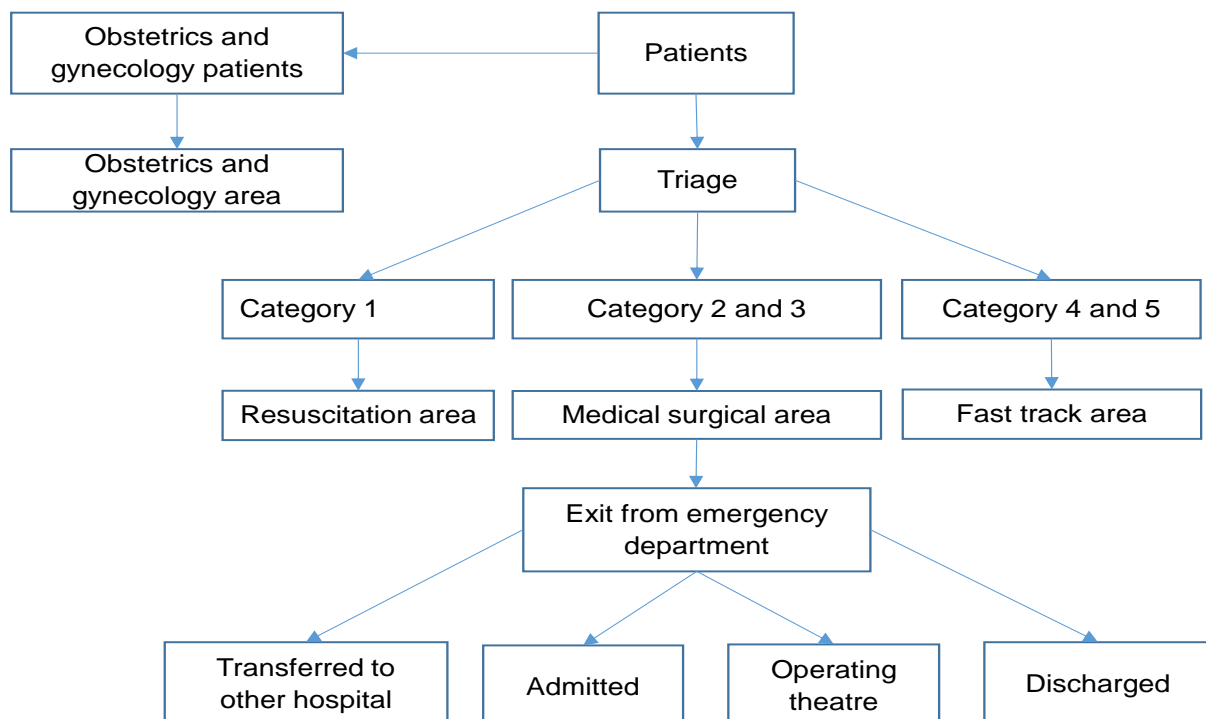


Figure 1 Patient flow in the SHED

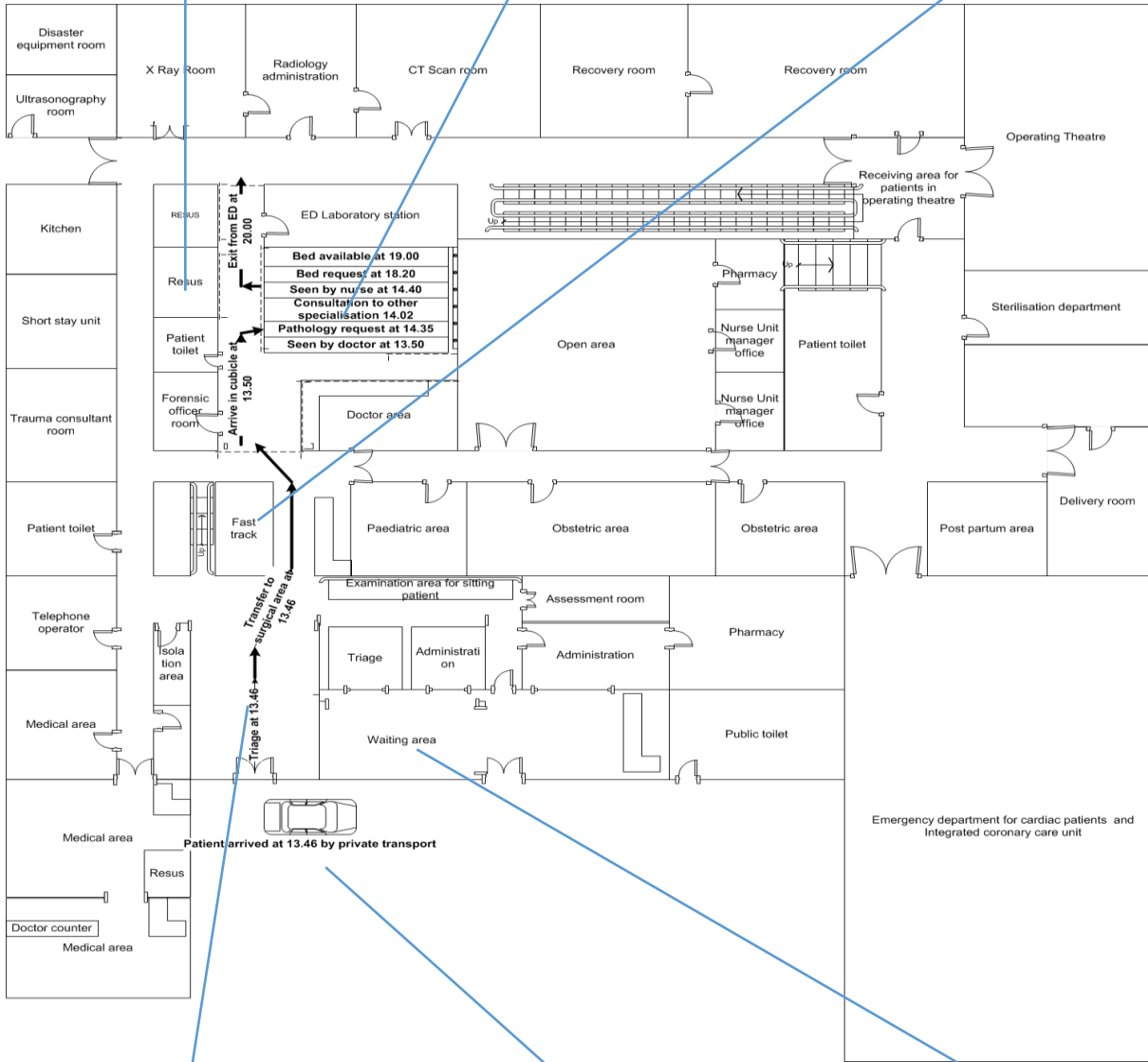


Figure 2 Map of Sanglah Hospital Emergency Department

Purpose of the Study

The main purpose of this study is to improve patient waiting time in the SHED by identifying delays that contribute to ED crowding in the SHED.

Research Questions

The fundamental question of this study is what are the factors that contribute to delays in the Sanglah Hospital Emergency Department (SHED)?

The specific questions are:

1. What are the mean times for each stage of the patient journey through the SHED?
In particular, how long do patients spend at each of the following stages:
 - a. Triage
 - b. Being placed into an ED bed
 - c. ED bed to seeing a doctor
 - d. Decision to admit
 - e. Lab turnaround time
 - f. Radiology turnaround time
 - g. Consultation with other specialisations
 - h. Decision to admit to assigning a bed?
 - i. From being seen by a doctor to exit from the SHED?
 - j. Length of stay (LOS) in the SHED?
2. What factors have the most significant contribution to delays in the SHED?

Aims and Objectives

The aim of this study is to investigate the factors that contribute to delays in the SHED to solve crowding in the ED. To achieve the aim, this study:

1. Conducted time motion studies to measure the average time for each stage of patient journey and LOS in the SHED.
2. Conducted statistical analysis of the data from time motion studies to identify the variables that have the most significant contribution to the ED LOS in the SHED.
3. Used results of this study as a basis to define boarding time to give recommendations for Sanglah Hospital Management to improve patient flow in the SHED which in turn will reduce ED crowding.

Significance of the Study

The benefits of this research are that it will lead to improvements in patient care, reduced waiting times and more expedient delivery of appropriate care. The hospital can use results of this study to improve triage, pathology, radiology, consultation and ED access block. Emergency department leaders can use this data to improve the process of services. Nursing staff can use the results of this study to develop an education plan for practices used in the triage system and in nursing assessment.

Assumptions

Based on the literature review and from personal experience it is assumed that the causes of ED overcrowding are prolonged waiting time, unnecessary increased length of stay and boarding time (or access block). It was assumed that lengthy waiting time was related to time at triage and an increase in the number of non-emergency patients. It was also assumed that prolonged length of stay is associated with laboratory testing, radiology and consultation times. At the end of the patient's time in the ED it is possible that prolonged boarding time may be related to bed availability.

Definitions of terms

These are terms used throughout this thesis report:

Triage is a process to collect information and make decisions in order to sort patients with injury or illness into categories and prioritise their urgency of care based on their clinical or psychological needs (Gilboy & Travers 2007). At the SHED triage uses the Australasian Triage Scale (ATS), which consists of five categories: category one (Immediately Life-threatening), category two (Imminently Life-threatening), category three (Potentially Life-threatening), category four (Potentially Serious), and category five (Less Urgent).

Arrival time is the first recorded time of contact between the patient and ED staff.

Triage time is the time from when the patient arrives in the ED to when the triage doctors complete triage assessment and determine the patient triage category.

Boarding time is time from when the doctor made decision to admit until when the patients exit from ED

Time to ED bed is the time from when the patients arrive in the ED to when the patients are placed in an ED bed.

Time from ED bed to doctor is the time from when the patients are placed in the ED bed to when the treating doctors see the patient.

Time for decision to admit is the time from when the treating doctors see the patient to when the doctors determine whether to discharge or admit the patient.

Admission unit is a department in the ED responsible to book or arrange an inpatient bed for patients.

Lab turnaround time is the time from when the treating doctors make a laboratory request to when the result becomes available in the SHED area of care.

Consultation to other specialisation turnaround time is the time from when the treating doctor asks for a consultation from a doctor from another specialisation to when the doctor from the other specialisation examines the patient.

Radiology turnaround time is the time from when the treating doctor makes a radiology request to when the result is available in the SHED area of care.

Time from being seen by a doctor to exit from ED is the time from when the treating doctor sees a patient to when the patient exits from the SHED.

Waiting for bed availability is the time from when the physician provides the decision to admit to when the patient was assigned to the inpatient hospital bed.

Emergency department length of stay is the time from when the patient arrives in the ED to when the patient exits the ED (whether to be discharged, admitted, or transferred to other hospital or operating theatre)

Outline of the Study

The overall structure of the study takes the form of five chapters.

The first chapter of this report opens with descriptions of the context and ED profile. It then presents the statement of the study purpose, research question, aims and objectives, significance of the study, assumptions and definitions of terms.

The second chapter begins by presenting a general description of EDs in developed countries and developing countries, main problems of EDs, causes of ED crowding, impacts on patient flow, initiatives to reduce overcrowding and access block and modelling approaches for ED patient flow and crowding research.

The third chapter is concerned with the methods used for this study and the reason for use of these methods. It also provides a description on study population, recruitment strategies, study setting, data collection and discusses issues affecting validity and reliability. A discussion of the statistical analysis is also presented.

The fourth chapter presents the data analysis that leads to the findings of the research. The findings will be presented in narrative form supplemented with tables and figures.

The fifth chapter discusses the study findings using current literature. There is a restatement of the problem that the study addresses with a summary of the study procedures. There is also a description of the major findings and their significance to clinical practice. Finally the study limitations are noted and recommendations for further investigation are listed and explained.

Conclusion

This chapter introduced the research topic and the area of interest of the researcher. There appears to be a prolonged LOS in the SHED that leads to ED overcrowding. However, the factors that contribute to the delays are unclear. Therefore, the aim of this study is to investigate the factors that contribute to delays in the SHED to reduce crowding in the ED. The research question of focus in this study is: What are the factors that contribute to delays in the Sanglah Hospital Emergency Department (SHED)? The next chapter examines the literature that informs this question.

Chapter 2 - Literature review

Introduction

This chapter begins by providing a general description of EDs in developed countries and developing countries. It then describes the main problems of EDs, including causes of ED crowding, the impact of impeded patient flow, and initiatives to reduce overcrowding and access block. The last section of this chapter reviews different modelling approaches for ED patient flow and crowding research.

Search Strategy

A search of the literature was conducted using PubMed and SCOPUS. The key words used in the literature search were "Emergency Service, Hospital"[Mesh] AND "patient flow" in PubMed. For searching articles in SCOPUS, the key words were "Emergency Department" AND "patient flow". The initial search found 434 articles in PubMed and 313 articles in SCOPUS. Forty-eight articles were considered as relevant articles. The inclusion criteria for article are that they should be published within the last 10 years, and they should focus on ED patient flow. Articles to be excluded will describe different populations such as paediatric, geriatric, mental health and obstetric gynaecology patients. The articles were selected from peer reviewed journals and were not more than ten years old (from 2005 to 2015). Twenty-three articles were chosen for more detailed review.

Emergency department in developed countries

The ED is an important part of a hospital as this department is the point of hospital entrance for patients, a place where life threatening and serious problems are dealt with. However, different countries have different standards for their EDs. These standards depend on each country's health system and their resources. For example, EDs in the United States (US) are classified based upon the available facilities and the services that they can provide. (American College of Emergency Physician 2011). These US EDs implement the Emergency Severity Index (ESI) (Gilboy et al. (2011) as a triage system. In Australia, the ED has multiple functions. These departments not only treat emergency patients, but also treat non-emergency patients. The Australian College for Emergency Medicine (2012) classifies EDs into four levels based upon the services they provide. Emergency department level 1 is an emergency department in

a remote or rural area that provides a minimum level of service. Emergency department level 2 is part of a secondary hospital. Emergency department level 3 is an emergency department that is part of a major regional and metropolitan hospital that can provide care to most complex cases and provide sub speciality services. Emergency department level 4 is an emergency department that is part of a tertiary referral hospital that can provide services for a wide range of complex cases in a wide range of specialities. All EDs in Australia use the Australasian triage system (ATS) to prioritise patients who present to the ED. This standardised prioritisation system is often different in developing countries, such as Indonesia.

Emergency department in Indonesia

Indonesia is a developing country, however every hospital in Indonesia has an ED. There are 2456 EDs in Indonesia, of these 883 are in public hospitals and 1573 in private hospitals (Kementrian Kesehatan Republik Indonesia 2014). All EDs are open 24 hours. The main functions of Indonesian EDs are to treat life-threatening problems in the patients who present. A doctor leads each ED. Emergency departments in Indonesia are classified into four groups: level I, II, III, and IV. A level I ED has the capability to perform an initial assessment on the emergency patient, resuscitate and evacuate and there is general practitioner available 24 hours. A level II ED can provide an initial assessment to emergency patients, resuscitate and evacuate them. In these EDs there is a general practitioner available at all times for resuscitation, there are also four major specialists such as paediatricians, internists, surgeons and obstetric gynaecologists who are always available on call. A level III ED is able to give an initial assessment to emergency patients, provide resuscitation, transfer to their internal intensive care unit and perform emergency surgery. These level III EDs also have the same four major specialists of paediatrician, internist, surgeon and obstetric gynaecologist always available on site, and there are also general practitioners available at all times. A level IV ED is able to provide all the services of a level III ED, but in addition have sub specialities available onsite (Kementrian Kesehatan Republik Indonesia 2014).

Sanglah Hospital Emergency Department

Sanglah Hospital Emergency Department (SHED) is a teaching hospital for medical and nursing students (Kusuma 2013). It is also a trauma centre. According to the standards released by the department of health, SHED is a level III ED. There are four major specialities available on site, while the sub specialist doctors are not available. However, sub specialists are available 24 hours a day on call. General practitioners are always available in the triage and fast track areas. Resident medical officers for each speciality are available in the treatment area. Supporting facilities such as an operating theatre, pathology department and radiology departments are available 24 hours a day. Commencing in 2012, Sanglah Hospital developed a sister hospital program with Royal Darwin Hospital (Kusuma 2013). Since that time the ED has adopted a model of care from the Royal Darwin Hospital. This has included adopting the same triage process using the Australasian triage scale, a resuscitation team and a fast track waiting room.

Analysing Patient Flow

Emergency departments in many countries are experiencing an increase in the number of patients presenting (Martin et al. 2011). This increase in patient volume contributes to access block and overcrowding in EDs (Eitel et al. 2010). It is therefore important to analyse where patient flow through an ED is delayed in order to reduce overcrowding.

Factors that contribute to disruption of patient flow in emergency departments.

A number of studies have highlighted factors associated with access block and overcrowding in EDs. The factors that disrupt patient flow in ED can be categorised into three phases: input, throughput and outcome (Ding et al. 2010). Input problems are described by Ding et al. (2010), who found that increases in the number of non-emergency patients in EDs contribute to dramatic increases in patients attending EDs. This is supported by Perimal-Lewis et al. (2014) who found that the number of non-emergency patients is increasing during non-working hours. Houston et al. (2015) reported that long waits at triage is another factor that contributes to slow patient flow in the ED.

The second factor that determines ED progression is the throughput phase. Two recent studies (Ryan et al. 2013; Martin et al. 2011) investigating patient flow have shown that blood tests, radiological examinations and the time taken on the decision to admit can result in increases in ED throughput time. Therefore, blood tests and radiological examinations are considered as factors that can significantly impede patient flow during the throughput phase. Ryan et al. (2013) identified that these patients will stay in the ED more than four hours. Martin et al. (2011) set out to identify the determinants of ED delay that contributed to overcrowding in an Australian regional ED, and found that a prolonged time to admit decision results in increased length of ED stay. An increase in ED throughput time therefore results in increased patient length of stay in the ED.

The third determining element of ED length of stay (ED LOS) is the outcome phase (Ding et al. 2010). In an analysis of patient flow, Fogarty, Saunders and Cummins (2014) found that the number of boarders, the patients who stay in the ED waiting for bed availability in wards, influence patient disposition in the ED. Bair et al. (2009) and Powell et al. (2012) also investigated factors that contribute to increased boarding time in the ED. Interestingly, they found that the delay associated with inpatient boarding is one of the most significant factors associated with prolonged ED boarding time for admitted patients.

The phases of input, throughput and outcome divide causes responsible for the disruption of ED patient into three parts, providing a useful mechanism to analyse patient flow. It is clear that delays occur at every step of the patient journey through the ED and delays in any of these phases may lead to overcrowding in the ED.

Emergency department length of stay

While analysis of patient flow has become increasingly sophisticated, it continues to be difficult to determine the specific contributing factors to ED crowding. This is partly because there is no consensus on how to address ED overcrowding (Hwang et al. 2011). Some investigators have developed surrogate markers for ED overcrowding such as ED waiting time, length of stay (Goodacre & Webster 2005), ambulance diversion (McCarthy et al. 2008; Olshaker & Rathlev 2006) and left without being seen

(LWBS) rates (McCarthy et al. 2008). The most common surrogate marker used to determine factors that contribute to ED crowding is prolonged LOS in ED.

The ED LOS has a significant correlation with other factors that contribute to overcrowding in the ED. Delay in any step of patient flow in the emergency department will play an important role in the development of overcrowding, since it will contribute to prolonged stay of patients in the ED. The ED LOS is measured from the first contact in triage until the patient is admitted or discharged from the ED (Australian College for Emergency Medicine 2013). Several studies have identified the role of delay in each step of the patient journey through the ED and correlated this with an increase in mean ED LOS. Houston et al. (2015) reported that long waits at triage is an important factor that contributes to slow patient flow in the ED. Martin et al. (2011), set out to identify the determinants of ED delay that contributed to overcrowding in an Australian regional ED and found that a prolonged time to admit decision in the hospital results in increased ED LOS.

Previous studies also demonstrated that prolonged lab turnaround time is associated with increased ED LOS. Bukhari et al. (2014) in their prospective study in a specialist hospital ED in Saudi Arabia found that laboratory time has a significant association with prolonged waiting time in the ED. Francis, Ray and Marshall (2009) conducted a multisite observational study which reported a direct relationship between lab turnaround times and ED LOS. The study showed that reducing lab turnaround time by redesigning pathology processes can reduce ED LOS. Holland, Smith and Blick (2005) investigated the influence of improving lab turn around time (TAT) on ED LOS and found significant correlation between mean lab turn around time and mean ED LOS. Based on an average waiting time of 5.7 hours, regression analysis showed that each minute of increased lab TAT increased ED LOS by 7 minutes. In a secondary analysis study of 360 million ED visits from nation wide EDs Kocher et al. (2012) showed that obtaining blood testing was associated with longer ED LOS where blood tests added 72 minutes to ED LOS. Li et al. (2015) conducted a multisite retrospective study in EDs of New South Wales, Australia and reported that increasing the number of laboratory tests increases ED LOS with every five additional lab tests increasing ED LOS by 10 minutes. Statistical analysis of this study showed that each additional 30 minutes of lab TAT increases ED LOS by 17 minutes. Storrow et al. (2008) conducted

a simulation model study to determine the effect of reducing lab TAT on ambulance diversion, ED throughput time and ED LOS and found that decreasing lab TAT from 120 minutes to 10 minutes resulted in average ED LOS decreasing significantly. While laboratory turnaround time is a significant contributing factor to ED LOS it is not the only significant factor as other medical specialists may also contribute to an increase in ED LOS.

Turn around time for consultation with other specialisations can also influence ED LOS. In a retrospective cohort study in two urban EDs in Canada, Brick et al. (2014) found that consultation by emergency physicians with another specialisation significantly contributed to prolonged ED LOS. The study found that admitted patients consulted by another specialisation had a longer ED LOS where consultation time accounted for a 33 per cent increase in ED LOS for admitted patients and 54 per cent increase in ED LOS for discharged patients. Mahsanlar et al. (2014) conducted a study of factors that influence ED LOS in Turkey. This study revealed that increasing the number of consultations in the ED can prolong ED LOS. Vegting et al. (2015) conducted a study of two EDs in the Netherlands analysing the factors that contribute to ED LOS and found a significant difference in ED LOS between patients consulted by other specialities and patients who only see an ED doctor (Vegting et al. 2015). Thus, seeing another specialist doctor significantly increased ED LOS. It is therefore apparent that laboratory turnaround time and being consulted by other medical specialists contributes to an increase in ED LOS, however radiology tests and bed availability are also likely to contribute to increase ED LOS.

It has been found that increased ED LOS is associated with prolonged radiology TAT. Kanzaria et al. (2014) found an association between advanced diagnostic imaging (ADI), such as magnetic resonance imaging (MRI) and computed tomography (CT), and increased ED LOS. These authors compared the median length of stay for patients without ADI with patients who received ADI. The study found that the median length of stay for patients who received ADI was longer than patients who did not receive ADI. An observational study by Vegting et al. (2015) analysed the journey of 2262 patients through two teaching hospital EDs to identify the factors that contribute to ED overcrowding and length of stay. Vegting et al. (2015) found that the number of radiology tests conducted on patients during their ED stay is associated with prolonged

ED LOS. However, there are factors other than radiology tests, consultation with other specialists and laboratory tests that contribute to increase ED LOS.

Previous studies have reported that boarding time in the ED can have a significant impact on ED LOS. Ye et al. (2012) found that patients with a boarding time of more than two hours are associated with a prolonged ED LOS. Bair et al. (2009) and Powell et al. (2012) also investigated factors that contribute to increased boarding time in the ED. Interestingly, they found that the delay associated with inpatient boarding is one of the most significant factors associated with prolonged ED LOS for admitted patients. In an analysis of patient flow, Fogarty, Saunders and Cummins (2014) found that the number of boarders, that is, the patients who stay in the ED waiting for bed availability in wards, influence patients' ED LOS. A study conducted by Mahsanlar et al. (2014a) found that prolonged boarding time in a Turkish ED was caused by waiting for inpatient bed availability. In a simulation model study, Khare et al. (2009) investigated the influence of increasing boarding time on daily ED LOS. The study demonstrated that decreasing boarding time without adding more beds in the ED can reduce LOS from 240 to 218 minutes. The largest factor that contributed to prolonged boarding time was bed availability diminished by access block (Fatovich, Nagree & Sprivulis 2005; Forero, McCarthy & Hillman 2011; Henderson & Boyle 2014; Richardson & Mountain 2009; Ye et al. 2012). The studies presented thus far provide evidence that an increase in time for each step of the patient ED process can lead to longer stays in the ED. Therefore, the use of ED LOS to determine factors that contribute to delay in the Sanglah Hospital Emergency Department is appropriate.

The impact of impeded patient flow

Disruption of patient flow can affect all aspects of service in the ED. The impacts of disruption of patient flow in EDs have been explored in several studies. The clinical impacts of overcrowding can be listed as: reducing patient satisfaction, increased numbers of patients leaving the ED without being seen (LWBS), increased patient mortality rates and reduced quality of care. A number of studies have described the disruption of patient flow and how it impacts patient satisfaction. In an investigation into patient satisfaction by Harnett et al. (2010) found that increased waiting time caused by an impediment to patient flow is one of the most obvious factors that

reduces satisfaction with ED care. Conversely, Preyde, Crawford and Mullins (2012) found that short waiting times result in an increased level of patient satisfaction. In a literature review Carter, Pouch and Larson (2014) summarised the effects of ED crowding on the number of patients LWBS and describe a positive correlation between ED crowding and the number of patients who leave EDs prior to treatment completion.

Reduced quality of care in EDs is another significant impact of impeded patient flow in EDs. Recent studies on patient flow have found that ED crowding is associated with a delay in the reassessment process and time to treatment. Depinet et al. (2014) conducted a retrospective cross sectional study over a 2.5 years period to examine the impact of ED crowding on vital sign reassessment in paediatric patients. In this study, the frequency of vital sign reassessment was reduced by 31 per cent for every ten additional admitted patients, by ten per cent for every ED patient in the lobby and by six per cent for every additional ten patients who presented to the ED. The study also found that mean time for vital sign reassessment by nurses was 84 minutes. Reduction in frequency of vital sign reassessment was associated with hourly ED census and the number of patients waiting for admission. While Depinet et al. (2014) focuses on delay in reassessment, Bernstein et al. (2009) is more concerned with the impact of ED crowding on time to treatment. These authors found crowding that occurs in EDs causes delays in the treatment of patients with pneumonia and acute pain. However, this study did not include any randomised controlled trials. In their systematic review on the impact of ED overcrowding on mortality rates, Carter, Pouch and Larson (2014) concluded that the risk of death after ten days hospitalisation is increased when patients come to the ED during periods of ED crowding. It is clear that disruption of patient flow because of ED overcrowding and access block can considerably impact patient care. Therefore, the development of initiatives to reduce overcrowding and impeded patient flow is recommended.

Initiatives to reduce overcrowding and access block

There are three possible changes that might be applied to solve problems of ED delay, these are: alter the service process, alter the arrival process and alter the queueing process.

Altering the arrival process

Recently, investigators examined the effects of the development of patient arrival protocol on patient flow. Khanna, Boyle and Zeitz (2014) studied the effects of a *capacity alert call* on ED occupancy, patient throughput and access block. The capacity alert call was implemented when the hospital bed demand system showed no beds available for patients. The hospital management then diverts non-emergency patients by ambulance to other EDs. All hospital services including EDs are asked to focus on streamlining patient admissions and accelerating discharge planning. If a patient needs treatment in the hospital with a capacity alert call, then the patient is triaged in the ambulance. Patients cannot enter the ED until a bed is available. This study found that implementation of a capacity alert call can successfully reduce occupancy, throughput and access block. However, the capacity alert call may not always work, if there is no hospital that is available to which patients can be diverted or patients come to the ED as walk ins or by private transportation. In developing countries EDs, such as SHED, this strategy may not work as this hospital is a top referral hospital and most of the patients who come to the ED walk in or arrive by private transport. Another study on altering patient arrivals to the ED by Popovich et al. (2012) investigated differential impacts of a volume driven protocol to reduce the number of patients who LWBS by doctors. The protocol was developed in order to identify the need for opening extra services during periods of overcrowding. If the patient volume of the ED met the protocol criteria an extra area for treating non-emergency patients was opened. It was found that implementation of a volume driven protocol could reduce the number of patients who LBWS. These findings clearly show that implementation of protocols to alter the arrival process of patients in the ED can be used to improve patient flow in EDs.

Altering the queueing process

There have been a number of studies involving (Bruijns, Wallis & Burch 2008; Harding, Taylor & Leggat 2011; Oredsson et al. 2011) patient flow that have reported on the role of altering the queueing process to improve patient flow; this can be achieved by improving the triage process. There are several initiatives to improve the triage process in order to improve ED patient flow (Bruijns, Wallis & Burch 2008; Harding, Taylor & Leggat 2011; Oredsson et al. 2011). Triage prioritises patient care based on

the severity of presentation. In a systematic review of 25 studies Harding, Taylor and Leggat (2011) assessed effectiveness of triage systems to improve patient flow in EDs. The effect of triage on patient flow was measured by waiting and length of stay. This study included only three randomised control trials and did not include grey literature such as theses, dissertations or other unpublished reports from experts. The study found that implementation of the triage system could reduce waiting time and decrease length of stay.

Not all triage systems can be used to improve patient flow. The basic triage system which only functions to select and prioritise patients in certain categories is not able to improve patient flow. In order to enable the triage system to improve patient flow, the system should be combined with initial treatment in triage (Bond et al. 2006). Moreover, Oredsson et al. (2011) in their systematic review on triage-related interventions found that the group of interventions, such as streaming, fast tracking, team triage, initiation of laboratory analysis and nurse-requested x-rays are considered to reduce waiting time, length of stay and the number of patients who LWBS. Another possible factor that can influence the effect of triage systems on patient flow are cultural and social factors and the availability of resources in the ED (Harding, Taylor & Leggat 2011). For example, in the developing world the ED experiences limited resources in poor setting, limited medical staff and high burden of diseases. These conditions may influence the ability of an ED to provide additional service in triage (Bruijns, Wallis & Burch 2008).

Several studies (Hayden et al. 2014; Svirsky et al. 2013; Imperato et al. 2012; Burstrom et al. 2012) have investigated the effects of allocating advanced practitioners in triage on patient flow. A recent retrospective study by Hayden et al. (2014) involved nurse practitioners in the triage process. Their study found that the allocation of nurse practitioners to triage can reduce the number of patients who LWBS, door to provider time and patient length of stay. Other studies suggest involving doctors during the triage process. Svirsky et al. (2013) found that resident medical officer initiated triage could reduce ED LOS and reduce the number of patients who LWBS. Similarly, Imperato et al. (2012) found that the allocation of doctors to triage is effective to reduce ED LOS and LWBS. Another study by Burstrom et al. (2012) suggested the use of team triage. The triage team consists of nurses and is led by a physician. The study

found that this model can improve patient length of stay, time to physician, time to discharge and 4 hour turnover rate. There is lack of evidence to support the effectiveness of allocating advanced practitioners in triage for high risk patients, since the study results only have significant impacts on low risk patients.

Altering the service process

Recent evidence suggests two solutions to alter the service process in EDs including changing the admission policy, improving the flow of non-emergency patients (Kang et al. (2014) ; Schull et al. 2012 ; Buckley et al. (2010) ; Tsai et al. (2012). Kang et al. (2014) compared the effectiveness of current admission processes with an alternative admission process. Their current policy suggested that the admission decision is made by a team which consists of attending physicians, residents and physician extenders. The alternative admission policy reduces the number of people involved in the decision process. The results of the study show that the alternative admission policy makes the admission decision faster than current policy. As a result patient ED LOS can be reduced. Several studies have investigated the improvement of service process by improving the flow of non-emergency patients. In order to speed the flow of non-emergency patients some hospitals have developed a special area for non-emergency patients. Current policy recommends that non-emergency patients be treated within four hours. In others words, non-emergency patients should leave the ED before four hours have elapsed. There are two common initiatives in this area which include developing additional room and a policy to reduce the LOS and number of patients who LWBS. These initiatives include development of a clinical decision unit (Schull et al. 2012), an express admit unit (Buckley et al. 2010), rapid medical assessment area (Tsai et al. 2012), a mid-track area (Soremekun et al. 2012) and a fast track area (Theunissen et al. 2014). Although there are various names for these areas, they have a similar function and process. These initiatives improve the success at reaching the 4 hour target, however, this policy has some implications for patient safety. For example, although it may be true that a four hour turnover rate can reduce mortality rate in EDs (Geelhoed & Klerk 2012), this policy will lead to incomplete assessment in EDs leading to worsening the condition when patients arrive in the ward area.

Not all initiatives have a positive impact on patient flow in the ED. For example, Mumma et al. (2014) conducted a major study analysing the impact of increased bed

capacity and ED expansion on patient flow. Although these initiatives can reduce the numbers of patients who LWBS, they introduce new problems to EDs, in particular they result in an increase in boarders in the ED. Another example of a negative impact is the introduction of nurse-initiated laboratory requests and X-rays. In their literature review, Oredsson et al. (2011) concluded that there is a lack of evidence to support the role of these initiatives to improve patient flow in EDs. In addition, there appears to be no single solution to solve the problem of overcrowding in all EDs. Eitel et al. (2010) point out that the first step to improving the service quality of EDs is by understanding ED flow. This view is supported by Martin et al. (2011) who write that before applying a model to solve poor patient flow, ED management should obtain information on all factors that contribute to the problem and then decide on the main factors that contribute to the problem. In other words, it is important for ED decision makers to accurately identify and understand the associated activities by using appropriate models and analysis tools. A number of initiatives to address ED crowding have been developed by the SHED management. These include the initiative for redesigning the ED. In collaboration with the Royal Darwin Hospital, Northern Territory, Australia, the management of SHED redesigned patient flow of the ED. However, these initiatives are only able to provide temporary solution for ED crowding. The length of stay in the ED and number of boarders waiting for bed availability are still increasing. These lead to a chaos situation in the ED and threaten the safety of health care providers and patients. The failure of these initiatives to provide a long-term solution to overcome the crowding in SHED may relate to the lack of research on the factors that contribute to ED crowding. In order to provide the most appropriate solution, this study will identify delays that contribute to overcrowding and access block in SHED.

Modelling Approaches for Emergency Department Patient Flow and Crowding Research

The literature on ED patient flow has described several models and analysis tools that can be used to capture the problem of ED patient flow, these include: balance score cards, discrete event simulations, queuing theory-based models, statistical forecasting, workflow diagramming, and lean thinking.

Balance score cards

Fieldston et al. (2014) conducted a series of investigations to measure and monitor patient flow processes in an ED. They used a balance scorecard with a composite score as a model in their investigation. A balance scorecard is a model from strategic management to help improve the performance of an organisation. It consists of four main parts or processes: learning and growth, financial, customer, and business processes. They found that a balance scorecard model has more advantages than a single measurement system. This is because a scorecard can give a comprehensive assessment of ED performance and at the same time can provide information on the specific area that requires improvement. However, this model has some limitations. The first limitation of the balance scorecard is the inability to identify the degree of complexity of the element involved in the process. The next limitation is that the model cannot provide information on the element which is not the focus of a study. Thirdly, the results of the study cannot be generalised to other settings, if the component under study is specific to that setting.

Discrete event simulation

Other researchers have introduced a discrete event simulation to assess the effectiveness of a patient flow model to reduce ED crowding. A discrete event simulation is a computer-based simulation system that is used to predict performance of a complex system, such as the ED. The advantages of a discrete event simulation model is that various models of patient flow and their interaction can be simulated (Mielczarek & Uziółko-Mydlikowska 2012). For example, Best et al. (2014) conducted a research study using discrete event simulation to identify whether neutral cost resources such as modifying staff and their roles are able to reduce length of stay in an ED in a developing country. The researchers developed a simulation model using de-identified ED presentations. The result of the simulation study showed that these neutral resources could improve patient LOS in comparison with additional resources such as extra staff. In a study which set out to determine the effect of policies to improve LOS, Kang et al. (2014) developed simulation models to examine the effect of 4 types of admission policies on waiting time for the non-admitted patient and the LOS for the admitted patient. The results showed that changing the admission policies with additional policies can reduce waiting time and LOS. These studies clearly show that development of discrete simulation studies in the ED can offer an effective solution

to identify an effective intervention to improve patient flow. However, the implementation of a discrete event simulation is complex and there is significant difficulty applying the discrete event simulation to the software. The software model and coding analysis systems are complex, requiring considerable cost and extensive training (Klein & Reinhardt 2012).

Queuing theory

Wiler et al. (2013) conducted a study which developed a patient flow model using queuing theory to understand the throughput of ED patients. The queuing model was developed from business management and can be used to manage system flow with variable inputs and fixed resources, such as EDs. This retrospective study validated the ED patient flow model based on the queuing system. The authors examined the impact of this model on the number of patients who LBWS by a doctor in the ED. Their findings show that the patient flow model based on queuing principles could predict a reduction of LBWS patients in a varying arrival and boarding scenario. The authors also note that queuing theory can develop a mathematical model of patient flow that describes patient flow in EDs. However, although this model has shown the effectiveness in generating a patient flow model, implementation of this model in healthcare services is very limited to particular sites. Further investigation is needed to demonstrate its usefulness in other health care facilities.

Statistical forecasting

Statistical forecasting is a method used in operation management to forecast certain events using timeline data and mathematical formulae (Eitel et al. 2010). In EDs, these forecasting methods can be used to predict patient attendance. Accurate prediction of patient arrival will help ED management allocate resources efficiently and provide timely treatment to the patient. Kadri et al. (2014) used a time series analysis to forecast patient attendances in an ED. The author demonstrated that time series analysis is useful as a statistical forecasting tool to predict short term demand in EDs. Demand prediction in EDs can be used to provide facilities and support services. However, implementation of this model needs a system that can provide accurate data. The availability of accurate data is a serious problem in health care facilities that do not have computer systems, such as in developing countries. The SHED does not have these computer systems therefore this is not a viable method in Denpasar, Bali.

Workflow diagramming

Some researchers, Ajmi et al. (2015) in particular, used workflow diagramming as a model in their studies. Workflow diagramming is not a model used to map a single process of service unit but is used to describe the entire process of a service unit. Developing workflow diagramming of the entire service is more desirable than considering it as a single process because all of the service systems aspects are interrelated. In order to identify factors that contribute to crowding in a paediatric emergency department (PED), Ajmi et al. (2015) research using a workflow model was used to describe the patient path. The researchers gained a clear picture of PED activity and they were able to identify the sources of slow patient flow. The authors also noted that this model was able to represent the real aspects of the PED that need to be improved.

Lean thinking

Lean is a methodology in business manufacturing that is used to improve services (Dickson et al 2009). This methodology has been adopted to improve health service in several hospital areas, including EDs. The principles of lean business improvement are to develop accurate decisions using appropriate knowledge about customers, the business process, human resources and the available data. Dickson et al. (2009) reported that the lean approach improved patient satisfaction in four overcrowded EDs one year after implementation. The authors noted that the impact of the lean process would be more apparent if the implementation is closer to its original principle of lean process. The original methods of lean should include total quality management (TQM) and Kaizen concepts (Wickramasinghe 2014). Total quality management is a continuous quality improvement approach to improve the whole aspects of an organisation. *Kaizen* means that the improvement should be done continuously and the managers and employers should work together to achieve the goals. Important aspects of successful implementation of these improvement initiatives are active participation of the ED workers and commitment of hospital leaders. Dickson et al (2009) and Holden (2011) showed that using a lean approach improves patient flow in EDs. Application of lean thinking processes to establish streaming of patient flow in the ED appears to be effective, because lean thinking encourages organisation (King, Ben-tovim & Bassham 2006).

Process mapping

Process mapping has been used extensively to improve patient service. Process mapping by flow-charting creates a clearer picture of special processes in the ED. This mapping allows visualisation of the entire process and its' specific components (Martin et al. 2011). Mapping of the entire process of a patient's journey demonstrated the reality of the problem. Understanding patient tracking throughout the patient journey in hospital is considered as the main step in examining patient flow. Identification of the factors that contribute to access block are the first step (Wong et al. 2014). Martin et al. (2011) used patient journey mapping to investigate the bottleneck that leads to overcrowding in an ED. The researchers followed and obtained a complete picture of the patient journey through the ED, and were able to identify the factors that contribute to delay in patient flow. In a redesign process of an ED using lean thinking, process mapping was used to support the lean thinking process in redesigning the ED at Flinders Medical Centre, Australia (Ben-Tovim et al. 2008). In this project, process mapping was used to gain a complete picture of the patient journey through the ED. Process mapping is a fundamental aspect of other modelling processes to improve patient flow throughout the ED (Ajmi et al. 2015). Process mapping is much easier than other modelling techniques and is a powerful model to define ED problems (Phillips & Simmonds 2013).

Patient flow analysis (PFA)

Most of these models and analysis tools are difficult to implement. This is because a high technology system is needed to record all relevant data. These models are usually not possible in developing countries, which do not have this technology. Dixon et al. (2015) report that, in Ghana, the use of PFA may help identify problems associated with ED overcrowding, and can also identify specific areas that need improvement. The authors claim that PFA is much easier to utilise compared to other modelling methods and is also a powerful model to define ED problems (Phillips & Simmonds 2013). A low technology system should be used to analyse patient flow in the SHED, which is why PFA is a more suitable tool. PFA consists of two main aspects: flow mapping and cycle time measurement. These aspects will enable the investigators to form a complete picture of the patient journey and identify the factors that contribute to delay in patient flow in the ED. As a result appropriate strategic plans can be developed to address the problems of overcrowding and excessive delays.

PFA is mostly used in developed countries as a quality improvement tool in a high volume care setting. There is limited evidence to suggest that PFA can be applied in developing countries with limited resources and staffing. However, the use of PFA in a developing country by Dixon et al (2015) suggests that it can be successfully used to “identify patient flow patterns, (and) can be used in resource-limited settings to inform service delivery improvements” (p 126). This study will use PFA to describe patient flow that is specific to the SHED, a major teaching hospital in Indonesia, in order to identify the factors that contribute to crowding.

Conclusion

This chapter has described EDs in developing and developed countries. This chapter has also described the factors that may contribute to ED access block and overcrowding and the relationship of these factors to overcrowding which can be measured by ED LOS. The role of laboratory turnaround time, consultation to other specialisations turnaround time, radiology turnaround time and access block are factors that contribute to prolonged ED LOS. Several modelling approaches that are commonly used to conduct research in patient flow and ED crowding were then described. Finally, patient flow analysis (PFA) was described as the appropriate modelling approach to analyse patient flow and crowding in this study.

The following chapter will describe the methodology of this study that has been informed by the literature and used to answer the question: What are the factors that contribute to delays in the Sanglah Hospital Emergency Department? The factors described are study design, recruitment sample, sample size, research ethical, and data collection procedure and data analysis.

Chapter 3 – Methods

Introduction

This chapter describes and discusses the methods used in this investigation. It begins by describing the study plan and research design, including study population, recruitment strategies, study setting, data collection, and the reason for adoption of the design. Finally, the validity and reliability of the study are discussed, along with statistical analysis methods.

Study plan and design

Design

This is a descriptive study using a prospective patient flow analysis (PFA). A descriptive study is used to describe, observe and document the aspects of a situation occurring in a natural setting (Polit & Beck 2012)., this research design is very useful to gain fundamental information when little is known about the topic.

PFA is one model that can be used to conduct analysis of patient flow constraints in an ED. PFA provides a description of the patient care process and time spent on those processes (Potisek et al. 2007). This model comprises three major activities: preparation, piloting the data collection form and data collection (Dixon et al. 2015). Preparation is the first step of PFA. There are several activities conducted during this step including building a team, defining objectives and process measures, determining the study plan, development of study documents and ensuring available equipment, identifying and training key personnel, and briefing staff.

After preparation, the next step is piloting the PFA. This step is important to identify any potential issues and areas that are problematic. The third phase is performing the PFA using an observation-based data collection form.

Although collection is time consuming, prospective data can give accurate and complete information on the current situation so an accurate strategic plan can be developed to solve clinical problems (Ashmore, Ruthhven & Hazelwood 2011). Prospective data collection can be done by a manual data collection form without the involvement of electronic technology (Potisek et al. 2007). Therefore a descriptive

study using a prospective PFA without reliance on electronic data collection is more appropriate in the context of a developing country ED.

Study Population

The participants in this study were patients who come to Sanglah Hospital Emergency Department (SHED), Denpasar, Bali, Indonesia who met the one of the inclusion and exclusion criteria.

Inclusion criteria

Primary inclusion criteria for the study participants was having an age above 18 years and below 65 years, presenting to the SHED. Patients who are older than 65 years have a different patient flow.

Exclusion criteria

The exclusion criteria for the study participants were:

- patients under 18 years and above 65 years
- patient with obstetrics and gynaecology problems
- patients who are considered as having an apparent mental illness or any patients that may be distressed
- patients who are also prisoners

These above populations were excluded from this study because they have diminished autonomy and in the SHED this population has a different triage process and patient flow.

- Another exclusion criteria was patients declared dead on arrival.

Ethical issues

This research project has been approved by ethical committee's from the relevant university and hospital with the aim of protecting the patient's human rights. Prior to commencing the study, ethical clearance was sought from the Human Research Ethics Committee of the University of Adelaide, Australia (Appendix1) and the Udayana University in Bali, Indonesia (Appendix 2) and letter of permit from Sanglah hospital (appendix 3).

It is most important that research proposals should be reviewed by human ethics committee to protect participant rights (Polit & Beck 2012). In this study, protection of participants' right was ensured in several ways. Firstly, in order to protect the study participant's right to self-determination, the patient was given a patient information sheet (Appendix 4). For patients who could not read the researcher used verbal consent from the participants (Appendix 5). If they agreed to participate, they were asked to sign informed consent (appendix 6). All of the participants were given a slip which consisted of information regarding how to make complaints or ask questions (Appendix 7). Patients were given a chance to stop the observation by informing the nurses in charge if they did not want to be involved in this study.

Secondly, patients' confidentiality was protected during data collection and data analysis. During data collection, any data that could identify patients or relatives were not to be included. Each patient was given a unique identification (ID) number that was associated with time spent in the ED. The researchers were not to photograph or record participants using audio tape, film/video, or any other electronic medium. During data analysis, the obtained data and research report was saved via computer in a password protected file. Data was only accessible by the researcher, supervisors and data analyser. The file could be accessed using a password only by the researcher and the supervisors. The file did not contain any identifying information. If any identifying data was mistakenly collected this was destroyed as quickly as practical. Any potential information that could identify the patients or relatives was removed in order to protect the privacy and confidentiality of participant data and samples.

Thirdly, it was expected that there were to be no risks to patients, with the usual ED care proceeding without interruption. The priority of this study was to ensure that patient safety and the provision of their care was not affected. If the observer notices a threat to patient safety, a threat to patient care or an error in the delivery of care, the observer would suspend data collection. The observer would then follow usual hospital protocol for the reporting of incidents.

Recruitment strategy

There was no recruitment process in this study. The researcher displayed posters in the ED informing patients that their waiting times were being recorded for research purposes. These posters also informed participants on how to opt out of being observed, the process for discovering more information regarding this study and the process to record a complaint (Appendix 8).

Study setting

The study was conducted in Sanglah Hospital Emergency Department. It is located in the capital city of Bali province, Denpasar. The ED presentation was 44997 in 2014, 122 patient per day. This ED is a part of a major teaching hospital and trauma centre in Bali, Indonesia. It is open 24 hours a day. It has 50 beds for emergency presentations and two resuscitation rooms for adult medical patients, two resuscitation areas for trauma patients, one for obstetric gynaecology patients, and one for paediatric patients. This ED receives paediatric, obstetric gynaecology, psychiatric, cardiac, neurologic, trauma and medical emergency patients. Supporting facilities include a radiology department and an operating theatre within the ED building. The pathology department is located in close proximity to the patient ward.

Sampling

Sampling is a process to select study participants that represent the population, in order to make an inference about the population. This study used the convenience sampling technique. Polit and Beck (2012) suggested that if the study cannot perform power analysis and the probability sampling is not viable, then the researchers should use a sampling technique to ensure a large sample size such as quota or consecutive sampling. However, due to time and budget constraints, this study only used a convenience-sampling technique. This technique is useful to provide the sample size using appropriate costs and time. The research participants chosen were the most readily available or convenient group of ED patients for the study sample. The study selected (12) 10 per cent of SHED daily presentations every day. There were 44997 patients presented in 2014, a mean of 122 patients per day.

Data collection

This study used observational methods to collect data. The observational methods were used as the researchers did not conduct any intervention that manipulated the dependent variable (Polit & Beck 2012). The researchers collected the data only by observing the patient journey.

The data was collected prospectively using the data collection form by research assistants (RAs) recruited from ambulance nurses in Sanglah Hospital. The RAs had a role to collect data in medical and surgical areas. The data collection processes were performed during a different shift to the ambulance nurse's normal working hours, so the data collection process would not interfere with their normal work.

Data collection form

The data collection form was developed from the data collection tools of Martin et al (2011). This data collection form has been used to identify the bottleneck of overcrowding in an Australian hospital ED (Martin et al (2011)). Parts of the data collection form were adjusted to fit the context of the SHED. However, these adjustments were not, in the main, components of the original data collection form. There were several small adjustments made. "Chief complaint" was replaced with "type of case", and "the type of medical officers" was adjusted with "the human resources: that were available in SHED. In "admitted patients" the researcher added the "observation with family" agreement. Operating theatre was also added.

The data collection form comprised of three main components: patient arrival and initial assessment, in cubicle assessment/treatment and patient destination (Appendix 9). The first part of data collection form collected information regarding demographics such as arrival mode, gender, age range and triage category. The second part of the data collection form was used to collect information regarding time spent for the taking consultant, imaging request, laboratory tests and consultation to other specialisations. The last part of the data collection form was used to record the time at which the patient exited the ED.

Data collection Process

After receiving ethical approval from the Human Research Ethics Committee (HREC) of the University of Adelaide (Appendix 1) and the Udayana University (Appendix 2), and a letter of permission from the CEO of the Sanglah Hospital (Appendix 3), the three stages of the research process commenced.

Preparation

The researchers met the Medical Director and the nurse unit manager of the SHED to explain the data collection process and to get permission to put posters in some areas of the ED. The researcher then met with the RAs to explain how to collect the data and how to use the data collection form.

Piloting data collection process

In order to identify potential issues during the data collection process and the areas needing improvement, the data collection process was piloted for two days. This process also aimed to train RAs to collect data and identify the issues. All RAs were involved in the process, and each RA had to collect data for two patients. After the pilot session, the researcher discussed with the RAs how to evaluate the data collection process.

Data collection

Data collection occurred from July 10 to July 17 2015. Data was collected prospectively by RAs recruited from ambulance nurses in Sanglah Hospital. Prior to data collection commencing the researcher reported to the manager on duty and team leader who was in charge during that period. The RAs documented the time for each step of the patient journey using study digital watches. The watches were synchronised at the start of every shift. Every day one team was responsible for data collection. Each team consisted of three nurses, one researcher and two RAs, working in 8-hour shifts. Each RA could only track a maximum of six patients simultaneously to optimise data accuracy. The data was collected on the late shift from 12 midday to 8 pm, the peak hours of ED presentation according to the preliminary study. The team members had different roles. The researcher was to stand by the triage area and fast track because they are located in one area. Their role was to select patients suitable

to be research participants, gain informed consent and collect information for the first part of the data collection form. The researchers followed the patient until they were placed in a cubicle, at which point the patient was handed over to the RA allocated to the cubicle area (the second RA). The RAs had a role to observe the patient journey in medical and surgical areas, and record observations in the second and third parts of the data collection form. These cycles continued until 12 patients were observed. If there were patients not discharged from the ED until the end of a shift, one RA was responsible to stay with these patients until they exited the ED. The RAs was paid for overtime.

Issues of Validity and Reliability

Enhancing the validity and reliability of the study are necessary to minimise biases (Polit & Beck 2012). The potential bias from a descriptive study can be reduced by the following: linkages between conceptual definition and operational definitions of the study variables, sample selection and size, the use of a valid and reliable instruments and environmental control of the data collection procedures (Burn & Grove 2005). In order to minimise bias, the researcher implemented several controls. Firstly, this study used a valid and reliable instrument. To assess the validation of the instrument, the researcher sent the data collection form to an expert panel (Polit & Beck 2012), comprised of the following people: the director of the ED, the clinical service coordinator, the nurse unit manager, and several senior nurses. After this, the data collection form was validated for two days by the researchers and RAs in the ED one week prior to data collection. To assess the reliability of the data collection form, the inter-rater reliability was evaluated. The kappa statistic was not measured to determine inter-ratter reliability (Barton & Peat 2014). However, the RAs were asked to record three simulated patients using the form. Secondly, this study used digital watches that were synchronised at the beginning of every shift during data collection to measure time spent for patient journey. Conducting regular instrument calibration reduces the variability of data in relation to time (Hulley, Martin & Cummings 2007).

Data analysis

Data from the mapping process were entered into databases of Microsoft Excel 2007 to measure the time for every step of patient journeys. Data were analysed using

descriptive statistics by SPSS 16. The first step was to conduct descriptive analysis of the demographic data. After that, that the mean for every step of patient's journey was then calculated and presented as mean and standard deviation. The third type of analysis conducted was a t-test and one way ANOVA. Finally, multiple regression statistics were utilised to evaluate the variable causing ED crowding.

Conclusion

This chapter has outlined the methods of this descriptive study. Ethical issues, statistical analysis and the issues of validity and reliability were also presented.

The next chapter will describe the results obtained from the investigation.

Chapter 4 Results

Introduction

This chapter presents the data collected from observing patients for the prospective PFA. This data and its analysis will form a description of patients' journeys during their time in the ED.

Data Analysis

Response Rate

There were 101 patients recruited to participate in the study. Of these, five were excluded from the study because: two patients died before they exited from the ED, one patient was transferred and seen in the obstetrics and gynaecology department, and two patients left without completing treatment. There were no patients that withdrew from the study. A total of 96 patients were observed, and a complete set of data points were collected from these participants.

Statistical Analysis

Prospectively collected data was entered into Microsoft Excel 2007 and the chronological means at each predetermined point were calculated. The data from MS Excel was imported into the SPSS 16.0 software, in which three steps of data analysis were executed. The first step was to conduct descriptive analysis of the demographic data. For each demographic data point the mean time for each stage of the patient journey was calculated. For example, the mean TAT for radiology and radiology testing are used to calculate the turnaround time for those who had laboratory and radiology testing. The second step compared the mean LOS in the ED using t-tests and one way ANOVA. These tests are parametric statistics that can be used to estimate whether the mean values of variables differ significantly from each other (Barton & Peat 2014). The T-test was used to compare the LOS between two independent variables, for example, mean ED LOS for males versus females. An independent sample t-test was used to compare mean scores because the variables were from two different groups of conditions. To compare the mean LOS when there were more than two independent variables, the one way ANOVA test was used. Finally, in the third step a multiple regression analysis was performed. The aim of this statistical analysis

was to determine which factors (independent variables) significantly contribute to a prolonged LOS in the ED.

Descriptive analysis

Demographic data

Descriptive analysis was conducted for each relevant demographic data set. These are summarised in the table in Appendix 10. Analysis revealed that, of the patients included in this study, 60 (62.5 per cent) were male and 36 (37.5 per cent) were female.

Figure 3 shows the proportion of patients based on approximate age. The use of approximate age in this study has occurred because patients who come to the SHED are not able describe their age. It is usual practice that administration officers guess the patient's age, if the patient or a family member cannot provide the exact date of birth. This occurs quite commonly. A total of 20 patients (20.8 per cent) were estimated to age between 19-30 years, 21 patients (21.9 per cent) were estimated to range in age from 31-40 years, 19 patients (19.9 per cent) ranged in estimated age from 41-50 years, 30 patients (31.2 per cent) ranged from 51-60 years, and six patients (6.2 per cent) were aged approximately 61-64 years. These age ranges are not valid demographic data since they were approximated observations by the researcher and his assistants. This means that age cannot be included as a variable when investigating factors that contribute to ED LOS.

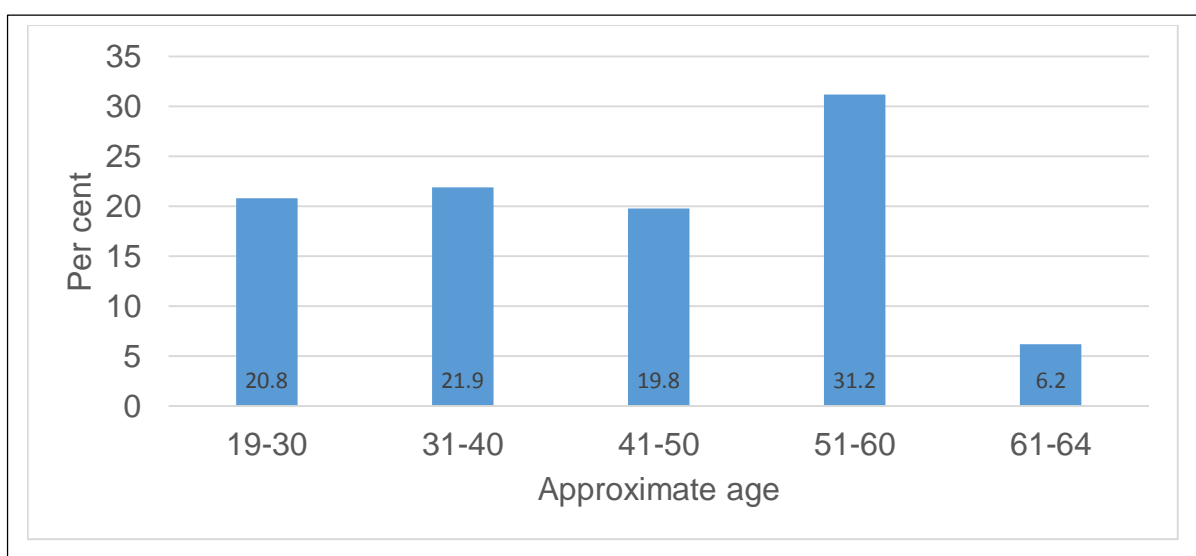


Figure 3 Approximate age

A total of 64 patients (66.7 per cent) were classified into triage level 3, representing the most common triage category assigned to presenting patients, followed by 28 patients (29.2 per cent) classified as triage level 4, while triage level 2 had the smallest number of patients with only four (4.1 per cent).

The most common arrival mode is private transport. A total of 60 patients (62.5 per cent) presented to the ED using private transport. Ambulance was the second most common arrival mode. There were 34 patients (35.4 per cent) arriving by ambulance. Public transportation was the smallest proportion, with only two patients (2.1 per cent).

In total, 60 patients (62.5 per cent) visited the ED because of self-referral and 36 patients (37.5 per cent) visited the ED through transferral by other hospitals.

Figure 4 describes the type of patient case involved in this study. The majority (n=46, 48.9 per cent) of the patients presented with a medical problem, followed by patients with traumatic injuries, (n=37, 38.5 per cent). Nine patients (9.4 per cent) had a neurological problem. A small proportion (n=3, 3.2 per cent) presented with eye, ear nose throat and skin problems.

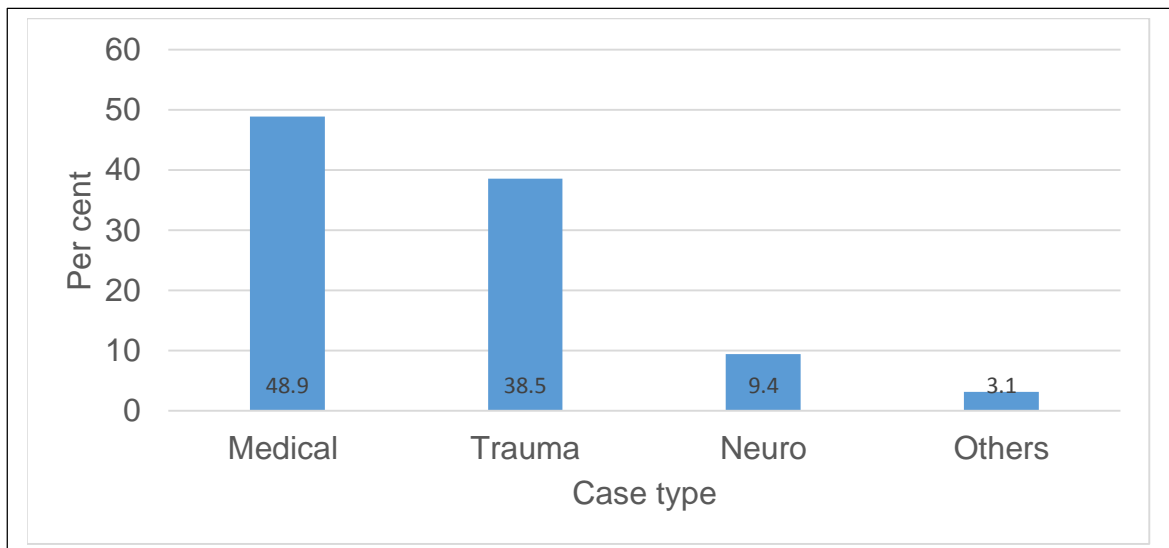


Figure 4 Case type presenting to the ED

Figure 5 describes the waiting time for inpatient bed availability. During the observation period 40 patients (41.7 per cent) waited less than eight hours to get a bed in an

inpatient ward, seven (7.3 per cent) of patients waited between eight and 16 hours, and four patients (4.2 per cent) waited between 17 and 24 hours.

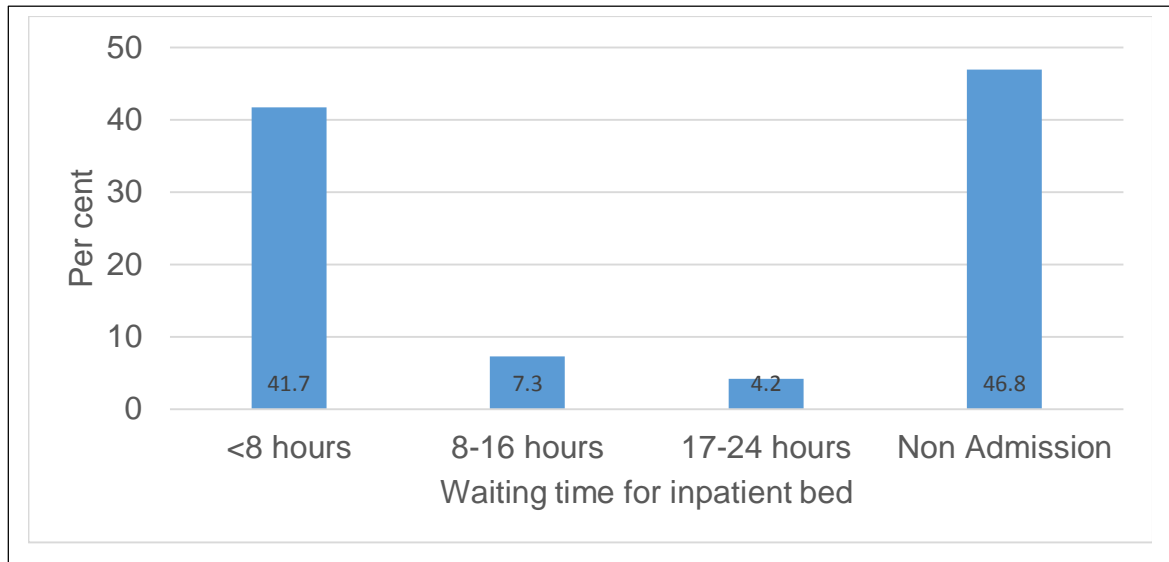


Figure 5 The waiting time for an inpatient bed

It was noted that not all patients were seen by nurses during their presentation in the ED. There were 66 (68.8 per cent) patients seen by nurses, whereas 30 patients (31.2 per cent) were not seen by nurses during their presentation in the ED.

The first doctor to respond to the patient was dependent on the area of care. In the fast track area, the first medical responders were General Practitioners (GPs) and in medical and surgical areas they were registrars. Most of the patients 64 (67 per cent) were initially seen by a speciality registrar whereas 32 (33 per cent) were initially seen by GPs.

After being initially seen, 30 patients (31.2 per cent) needed to be referred to another specialisation, 41 patients (42.7 per cent) required imaging examination, 55 patients (57.3 per cent) required pathology testing, and 49 (51 per cent) patients were admitted to the hospital.

The mean times for each stage of patient journey intervals

Descriptive analysis found that the mean times for each segment of the patient journey varied from 0.05 minutes to 582 minutes. The means of these time periods were calculated to give time measures that were appropriate for comparative analysis. The mean score and standard deviation for each stage of the patient journey are represented in figures 6 and 7. Mean times for each stage of the patient journey are shown.

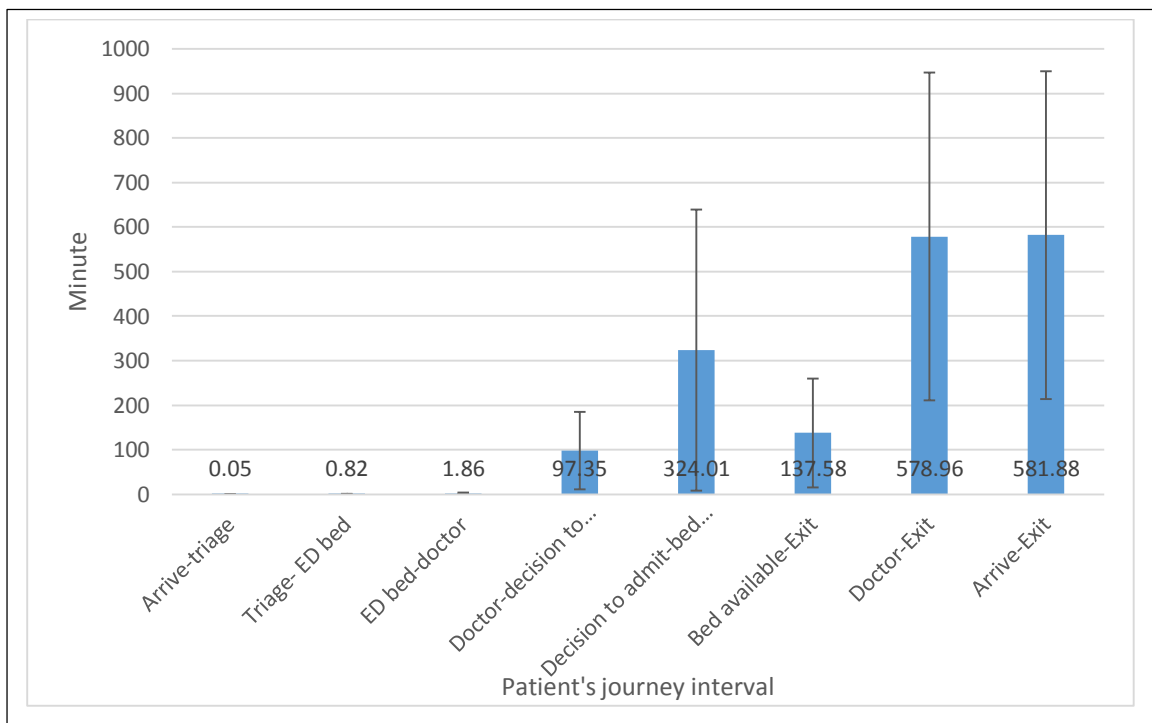


Figure 6 The mean and standard deviation for patient’s journey interval for admitted patients

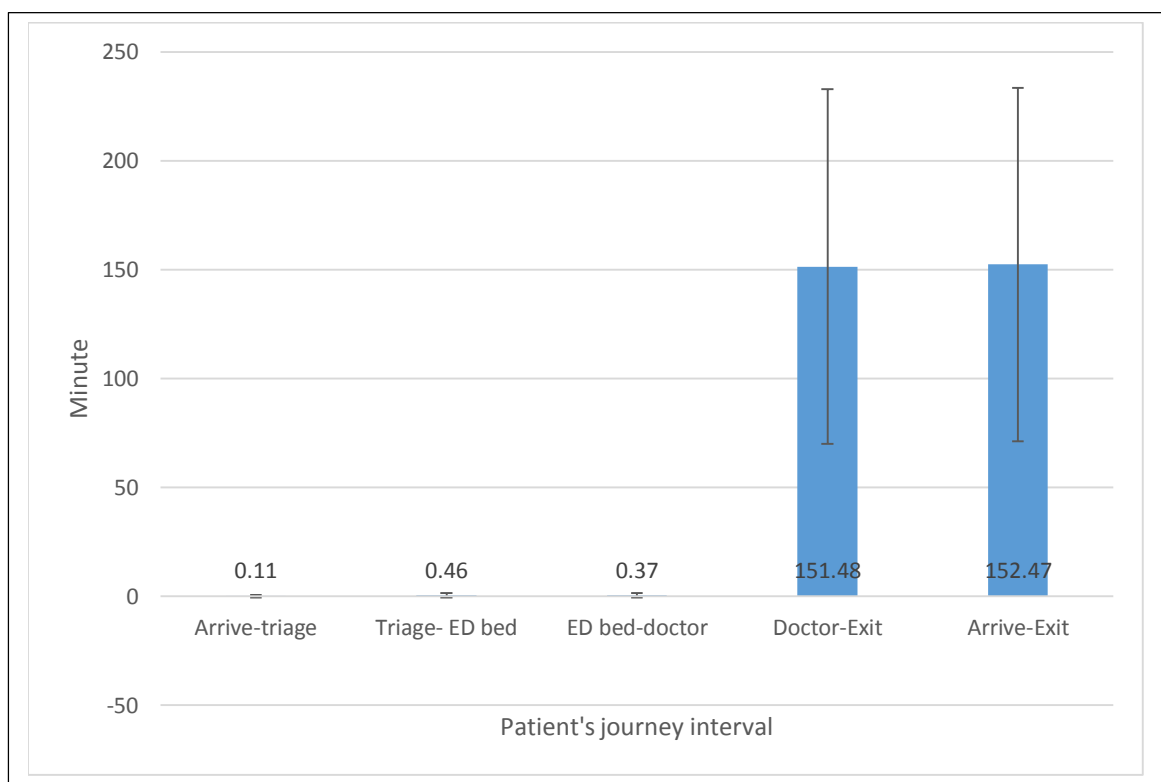


Figure 7 Mean and standard deviation for patient journey intervals for discharged patients

For patients who were admitted from the ED the mean LOS, from arrival time in the ED to exit from the ED, was 581.88 minutes (SD= ± 367.96). For patients who were discharged from the ED the mean LOS was 152.47 minutes (SD= ± 81.22). The mean time for admitted patients is outside the Sanglah Hospital key performance indicator target of six hours (360 minutes). The mean for discharged patients is also outside the hospital target of two hours (120 minutes).

Patient arrival and initial assessment

During the data collection period, triage time was very quick. The patients were triaged by a GP within one minute (0.05 ± 0.24 mins), categorised and sent to the appropriate area. During data collection no patients were sent to the waiting room.

In cubicle assessment and treatment

Mean times observed in the cubicle area, which is the area to assess, manage and treat patients, were measured as: time from bed to physician, time from bed to nurse,

time to admit orders to assign bed, consult to other specialisation TAT, lab TAT, and imaging TAT. The mean time from bed to physician for admitted and discharged patients is very quick. Admitted patients had a quick mean time from lying on a bed to seeing a doctor (1.86 minutes \pm 1.49); for a discharged patient it was even quicker (0.37 minutes \pm 1.02). The mean time from being placed on a bed to seeing a nurse for the first time was 15 minutes. Since not all patients were seen by nurses, this mean time was only calculated for the 66 patients (68.75 per cent) who had been seen by nurses. The mean time from decision to admit to being assigned an inpatient bed, was 324.01 minutes \pm 315.57. The mean TAT from calling for a consultation from another specialisation to being seen by a speciality doctor was 26 minutes. The mean TAT from initial radiology imaging request to imaging results, was 46 minutes. The mean TAT for pathology request, the time interval from the first pathology request to the first pathology result, was 139 minutes.

Patient destination

There were several time phases that were observed in the patient destination phase, Destination phase is phase from decision to admit until exit from ED. The time from decision to admit to bed availability for admitted patients was calculated to be 137.58 minutes (SD \pm 122.31). Time from having a bed assigned to leaving the ED was measured as a mean time of 324.01 minutes (SD= \pm 315.57).

T-test and one way ANOVA

A comparison of the mean LOS in the ED between groups of independent variables that might potentially influence the LOS was conducted using parametric statistics. There are several general assumptions that apply when parametric techniques are used to compare data (Pallant 2013). Firstly, the data to be analysed needs to be interval or ratio data. Secondly, the observation process to get the dependent variable data must be independent of one another. Thirdly, it is assumed that the data of the dependent variable is normally distributed. Fourthly, it is assumed that the data of the dependent variable is taken from a population of equal variance. Evaluation of normal distribution and homogeneity of variance were performed prior to analysis to prevent the violation of assumptions for parametric statistics (Pallant 2013). An evaluation of normal distribution using Kolmogorov Smirnov statistics shows that the mean for ED

LOS was positively skewed so that the frequencies for the mean of ED LOS are clustered at the lower end and the long tail is to the right of the graph. Subsequently, it was suggested by expert Dr Tim Schultz (pers. comm., 25 August) that the mean of LOS data should be transformed using a mathematically modifying formula until the data distribution was normal. The appropriate formula was a logarithmic transformation (Tabachnick & Fidell 2007). Log transformations can squash the right tail of distribution close to normal distribution (Filed 2014). Since the log transformation formula that is available on SPSS 16 to transform positively skewed data is base 10 logs (LG 10), the data was transformed using \log_{10} . Evaluation of the normality process demonstrated that the mean time distributions (log) for LOS were normally distributed. The Levene's test was then used to evaluate the homogeneity of variance. With the homogeneity of variance test it is important to ensure the data comes from the population with the same variance. Violation of this assumption will influence validity and power of significant analysis of the study (Zimmerman 2006). This test process was a part of the t-test and one way ANOVA. Levene's test showed that the variance of the mean (log) for LOS was homogenous ($p > 0.05$).

The t-test and one way ANOVA were performed to compare the LOS according to the dependent variables of sex, triage category, arrival mode, arrival type, approximate age, case type, admit orders to assign bed, waiting bed availability, discharged/admitted, TAT for pathology request, TAT for consult to other specialisation, imaging request TAT, and ED bed to nurse. An independent sample t-test was conducted to compare the mean (log) of LOS between two variables. A one-way analysis of variance was conducted to compare the mean (log) of LOS between more than two variables. T-tests were conducted on the following variables: sex, discharged/admitted, consult to other specialisation, pathology request, imaging request, and nursing time. One way ANOVA tests were conducted on approximate age, triage category, arrival modes, arrival types, case types, cubicle areas, decision to admit, and waiting for bed availability. The results of the t-tests and one way ANOVA's are shown in the tables in appendix 13. There was no significant difference between the mean (log) LOS for males and females (male $M(\log) = 2.45$ $SD \pm .36104$, female $M(\log) = 2.39$ $SD = \pm .38$, $p = 0.40$), or between approximate ages (19-30 $M(\log) = 2.4$ $SD \pm .38$, 31-40 $M(\log) = 2.37$ $SD = \pm .39$, 41-50 $M(\log) = 2.47$ $SD \pm .45$, 51-60 $M(\log) = 2.46$ $SD \pm .32$, 61-64 $M(\log) = 2.39$ $SD \pm .29$, p value = 0.903). There were significant

differences between the mean(log) of LOS in triage level, arrival modes, arrival types, case types, cubicle areas, decision to admit, waiting for bed availability, discharge/admitted, TAT for consult to other specialisation, imaging request TAT, pathology request TAT and ED bed to nurse ($p < 0.05$).

The result of multiple regression statistics

For the t-test and one way ANOVA analyses, the mean (log) LOS for the above independent variables are significantly different, however it is not clear whether the independent variables correlate with the dependent variable, time. In order to identify if the independent variable has a full correlation and a unique contribution to the dependent variable of time in the ED a further evaluation using regression analysis was used to assess these relationships. Since the dependent variable of time was a continuous variable, the suitable regression analysis was standard multiple regression (Pallant 2013). In the standard multiple regression analysis, all independent variables were entered into the regression equation and each independent variable was evaluated for its particular contribution in comparison to other independent variables. Thus standard multiple regressions were used to determine the factor that uniquely contributes to the mean (log) of LOS. The independent variables that were significant at a level of $p < 0.1$ for the t-test and one way ANOVA were included in the multiple regression analysis, these were: arrival type, decision to admit, discharged/admitted, triage category, arrival mode, case type, cubicle area waiting for bed availability, consult to other specialisation, pathology request, imaging request and nursing time. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, homoscedasticity/homogeneity of variance and multicollinearity. Normality and homoscedasticity/homogeneity of variance were not evaluated since these tests were done prior to conducting the t-test and one way ANOVA. Multicollinearity was evaluated as a part of multiple regression analysis. The purpose of this test is to limit the number of covariates that do not have significant associations with the variables, and to identify the variable that has perfect correlation (r value of 0.7 or more) (Pallant 2013). As a result of the multicollinearity evaluation three variables were found to have bivariate correlation scores of more than 0.7. Consequently, these variables were excluded from the regression analysis. These variables were: arrival type, decision to admit and discharge/admitted. According to Tabachnick & Fidell (2007), there are two

important values that should be evaluated in a standard multiple regression; the beta coefficient and p-value. Multiple regression analysis showed that the largest beta coefficient was -0.307, for TAT for pathology request. This means that this variable has the strongest unique contribution to the mean (log) of LOS in the ED. The beta values for other variables were slightly lower, indicating those variables made a smaller contribution to ED LOS. The complete results of the multiple regression analysis are presented in table 1. The only variable to significantly influence ED LOS was pathology request (Beta=-0.227, p = 0.009).

Variable	Unstandardized Coefficients		Standardised Coefficients	P-value
	B	Std. Error	Beta	
(Constant)	3.589	0.264		0.000
Triage category	-0.059	0.068	-0.089	0.386
Arrival Mode	-0.061	0.049	-0.097	0.218
Case Type	-0.026	0.027	-0.074	0.344
Cubicle Area	0.017	0.043	0.036	0.691
Waiting bed availability	-0.041	0.023	-0.212	0.080
Consult to other specialisation time	-0.085	0.067	-0.107	0.207
Imaging Request time	-0.077	0.061	-0.104	0.214
Pathology Request time	-0.227	0.085	-0.307	0.009
Nursing Time	-0.107	0.083	-0.135	0.199

Table 1 Summary of the standard multiple regression analysis

Conclusion

This chapter presented statistical analysis of the data generated from the data collection form used to track patient flow through the SHED. Descriptive analysis was performed using demographic data and time intervals for each step of the patient journey through the ED. The main factor that contributes to prolonged LOS in the SHED is the TAT for pathology requests.

The following chapter will discuss the relationship between these findings and the existing literature. The limitations and implications of this study will also be described.

Chapter 5 Discussion

Introduction

The previous chapter presented the results of this research project. This final chapter will discuss the research results in conjunction with current literature and the limitations of this study. The discussion ends with a conclusion and suggestions for future research.

Restatement of the problem

Patients are usually delayed for up to six hours in the SHED because they may be waiting for an in-hospital bed, blood results, imaging results, and consultants. However, there is no evidence of which factors contribute to the delay or how much they contribute to waiting time. By describing waiting times and patient flow, the management of Sanglah Hospital can begin to address excessive waiting and ED overcrowding.

In the developing country of Ghana, Dixon et al. (2015) suggest the use of patient flow analysis (PFA) to help identify problems associated with ED overcrowding. They also highlight how PFA can identify specific areas that need improvement. The authors (Phillips & Simmonds 2013) claim that PFA is much easier to use than other modelling methods and is a powerful model to define ED problems (Phillips & Simmonds 2013). The methods used to analyse patient flow in the SHED require a low technology system, making PFA a suitable tool to implement. This methodology consists of two aspects: flow mapping and cycle time measurement. These aspects enable investigators to gain a complete picture of the patient journey and identify the factors that contribute to delay in patient flow in the ED. As a result, appropriate strategic plans can be developed to address the problems of overcrowding and excessive delays.. There has been limited evidence to suggest that PFA can be applied in developing countries with limited resources and staffing. However Dixon et al. (2015) used PFA in a developing country suggests that it can be successfully used to “identify patient flow patterns, (and) can be used in resource-limited settings to inform service delivery improvements” (p 126). This study used PFA to describe patient flow specific to the SHED, a major teaching hospital in the developing country of Indonesia, in order to identify the factors that contribute to crowding in the SHED.

Summary of description of procedures

This is a descriptive observational study using a prospective PFA. This model comprised three major activities: preparation, piloting the data collection form and data collection (Dixon et al. 2015). Preparation is the first step of PFA. There are several activities conducted during this step including building a team, defining objectives and process measures, determining the study plan, development of study documents and ensuring available equipment, identifying and training key personnel, and briefing the staff. The next step after preparation is piloting PFA. This step is important to identify any potential issues and areas that are problematic. The third phase is performing the PFA using an observation-based data collection form. Prior to commencing the study, ethics approval was sought from The Human Research Ethics Committee of the University of Adelaide, Australia and the Udayana University in Bali, Indonesia.

There was no specific recruitment process in this study as the researcher displayed posters in the ED informing patients that waiting times were being recorded for research purposes. Patients were also informed of the opportunity to refuse being observed. Data was collected prospectively with data collection forms used by research assistants (RAs) recruited from ambulance nurses in Sanglah Hospital. The data collection form was developed from data collection tools described by Martin et al. (2011) who used the data collection form to identify points of delay that contribute to overcrowding in an Australian ED. The data collection form comprises three main components: patient arrival and initial assessment, in cubicle assessment/treatment and patient destination.

The RAs documented the time for each step of the patient journey using study supplied digital watches. Watches were synchronised at the start of every shift. Every day one team was responsible for data collection. The team consisted of three nurses, one researcher and two RAs. The team worked in 8-hour shifts. Each RA could only track a maximum of six patients simultaneously to optimise data accuracy. Data were collected on the late shift from 12 midday to 8 pm these are peak hours for ED presentation according to a preliminary study. The preliminary study was conducted over three days, in which the total number of patients in the SHED were counted every hour. Thus, the researchers and research assistants recorded the number of

patients treated in the ED each hour for 24 hours in the three areas of care in the SHED. The result of this preliminary study was used to determine the busiest time in the SHED. The busiest time is the best time to detect problems with patient flow in EDs. At this period, the ED is more likely to experience crowding because the number of patients increases.

Major findings and their significance to clinical practice

The purpose of this study was to identify delays that contribute to crowding in the SHED. The contribution each factor had to crowding was determined by measuring the effect on LOS in the SHED. The factor that most significantly contributed to prolonged LOS in SHED was turnaround time (TAT) for laboratory investigations. To discuss this finding, this section is divided into three parts. The first part discusses LOS comparing observations in the SHED with other studies and standards and describes the factors that contribute to a prolonged LOS in the SHED. The second part discusses the laboratory TAT in the SHED and describes possible factors that contribute to prolonged laboratory investigations TAT. The third part discusses waiting for inpatient bed availability as another possible factor contributing to prolonged ED LOS.

Emergency department length of stay

The ED LOS in the SHED

Length of stay in SHED was similar to results of studies conducted in other developing countries. A retrospective study in an academic hospital in Thailand found that ED LOS is more than eight hours (Wibulpolprasert et al. 2014). Another study found that mean LOS in a developing country accident and ED in the Eastern Caribbean was just over eight hours (Banerjea & Carter 2006). Mean LOS in the SHED exceeded the acceptable standard for ED LOS. While there is no national standard for ED LOS in Indonesia, it cannot be determined whether LOS in this study met the national standard. However, LOS in the SHED exceeds the mean length of stay that is recommended by Sanglah Hospital key performance indicators (KPI) (Kusuma 2013). The performance indicator is a local indicator developed by the hospital quality improvement department together with the SHED quality improvement team. The

hospital KPI recommends that LOS for admitted patients in the SHED is up six hours, whereas discharged patients should leave the SHED within two hours.

Mean LOS in the SHED is also longer than previous studies conducted in countries which successfully dealt with ED crowding. Vegting et al. (2015) found that the average LOS in an ED in the Netherlands was 2.1 hours. Wen et al. (2012) found that ED LOS in Singapore was less than six hours. (Bukhari et al. 2014) found that the mean ED LOS in Saudi Arabia was 3.02 hours. A study in Australia shows that the average ED LOS of patients in Australia is four hours 27 minutes (Australian Institute of Health and Welfare 2014). In addition, the mean LOS in the SHED is longer than the international standard benchmark for ED LOS is between 120-240 minutes (Banerjea & Carter 2006). It can be concluded that LOS in the SHED exceeds the acceptable mean LOS needed to reduce crowding in the ED. Patients staying more than six hours in ED leads to crowding (Henneman et al. 2010). However, results of this study only described the LOS of patients who come to the SHED at the busiest time of the day. This study did not provide the mean LOS for all of the patients who came to the SHED over a 24 hour period. Therefore, the LOS of this study may be different to that of previous studies that calculated mean ED LOS over a 24 hour period. It is apparent that ED LOS is associated with a variety of factors that differ from hospital to hospital.

The factors that contribute to prolonged ED LOS in the SHED

Prolonged ED LOS has many influences including advanced diagnostic testing (Kanzaria et al. 2014; Vegting et al. 2015), access block (Fatovich, Nagree & Sprivulis 2005; Forero, McCarthy & Hillman 2011; Henderson & Boyle 2014; Richardson & Mountain 2009; Ye et al. 2012), blood testing (Banerjea & Carter 2006; Kocher et al. 2012), consultation time (Brick et al. 2014; Lee et al. 2008; Mahsanlar et al. 2014 ; Soong et al. 2013; Woods et al. 2008), nurse patient ratio (Chan et al. 2010), treatment by multiple teams (Vegting et al. 2015), time to see the doctor (Banerjea & Carter 2006) and waiting for bed availability (Mahsanlar et al. 2014). Thus, it is apparent that each ED will have different factors that contribute to a prolonged LOS.

The findings of this study show that the most significant bottleneck that contributes to a prolonged LOS in the SHED is TAT for laboratory investigations. The mean TAT for laboratory investigations makes the most significant contribution to mean ED LOS compared to other variables of triage category, arrival mode, case type, cubicle area, waiting for bed availability, other specialisation consultations, imaging request time, pathology request time and nursing time, as these other remaining variables did not show a statistically significant contribution to mean LOS in the SHED. The TAT for laboratory investigations was the only statistically significant contributor to increased LOS. The results of this study are in line with findings of previous studies which found that laboratory investigation is one of the most significant factors contributing to prolonged ED LOS (Bukhari et al. 2014; Francis, Ray & Marshall 2009; Gill et al. 2012; Holland, Smith & Blick 2005; Kocher et al. 2012; Li et al. 2013; Montgomery et al. 2014; Storrow et al. 2008).

Reducing laboratory turnaround time (TAT) can reduce ED LOS

The contribution of laboratory TAT to ED LOS is supported by several previous studies which found that shortening laboratory TAT in EDs can significantly reduce ED LOS. Francis, Ray and Marshall (2009) conducted an observational study to determine whether redesigning pathology processes can reduce ED LOS. These authors found that reducing laboratory investigations TAT by redesigning the pathology process in an ED can reduce ED LOS. In a secondary data analysis from 11 hospitals in the USA, Holland, Smith and Blick (2005) identified that laboratory TAT has a significant relationship with ED LOS and found that by reducing the number of outliers in laboratory TAT ED LOS is significantly reduced.

Data considered as outliers in this study were: the TAT for urinalysis which takes about 30 minutes, the TAT for a complete blood count examination which takes more than 30 minutes, the TAT for chemistry measurement which takes more than 40 minutes and the TAT for Troponin measurement which takes more than 60 minutes. Holland, Smith and Blick (2006) examined the effect of the automation of laboratory processes to reduce laboratory TAT as a factor that contributes to ED LOS and found that reducing laboratory TAT by laboratory automation can eliminate laboratory TAT as a source of increased ED LOS. In a simulated model using annual ED presentation in

an urban ED, Storrow et al. (2008) found that decreasing laboratory TAT can reduce ED LOS. The simulation model showed that by decreasing laboratory TAT from 120 minutes to 10 minutes reduced ED LOS from 2.77 hours to 2.17 hours. In a multisite cohort study, Li, et al. (2015) found that laboratory testing has a significant effect on patient ED LOS. Each 30 minute increase in laboratory TAT could increase ED LOS by 17 minutes. The number of laboratory tests also influences ED LOS (Li et al. 2015). It can therefore be concluded that laboratory TAT has a significant impact on ED LOS and improving laboratory TAT has a positive impact on ED LOS. Therefore, EDs should have clear standards for laboratory TAT to improve ED LOS.

Laboratory Turnaround time (TAT) in the SHED

Laboratory investigation processes in the SHED

In order to meet Joint Commission International accreditation standards the laboratory service in the Sanglah Hospital is centralised for a large variety of laboratory investigations and is available 24 hours a day. In order to support the centralised of laboratory service in the hospital, the hospital has developed several systems. Firstly, the hospital provides continual improvement in technology to make sure that laboratory processes become more automated. Secondly, the hospital implemented a pneumatic tube system to connect the central laboratory department with the patient unit. Thirdly, the hospital established a system to maintain quality assurance of laboratory test results. The quality assurance of laboratory processes in this hospital are standardised by the Joint Commission International, USA. Lastly, the hospital provides computerised data transfer for registration and payment of laboratory investigations.

The flow of the centralised laboratory investigations in the SHED consists of several key steps. To begin the process of laboratory investigations, a physician writes an order for laboratory investigations on a physician order form and then gives the orders to nurses. After that, a nurse collects the sample from the patient and then sends the laboratory sample to the ED laboratory station. In the ED laboratory station, an officer registers the laboratory investigation in the computer and then sends the laboratory samples to the central laboratory department through the pneumatic tube. Once the sample arrives in the central department, the laboratory samples are analysed by a

technician. When results of laboratory investigations are available the technician sends the result to the ED laboratory station through the pneumatic tube. The ED laboratory station officers classify the laboratory test results according to area of care in the ED and inform the ED nurses that results of laboratory tests are available. Finally, the nurses take the laboratory test results from the ED laboratory station and report the results to treating doctors. Although the hospital has implemented recommendations from the Joint Commission International, there are some limitations in the process of a centralised laboratory service due to local limitations. The limitations in the implementation of a centralised laboratory service may influence laboratory TAT in the SHED.

The mean laboratory investigation turnaround time in the SHED

This study calculated that the laboratory TAT in the SHED is 147 minutes. The Sanglah Hospital KPI recommends that in 90 per cent of cases laboratory TAT should be less than 140 minutes. This hospital KPI was determined by the hospital quality improvement department in conjunction with the laboratory department. The laboratory TAT in this study is close to the laboratory TAT KPI metric established by the hospital. However, it is longer than the generally accepted standard for laboratory TAT. Hawkins (2007) recommended that the acceptable standard for laboratory TAT is less than 60 minutes for 90 per cent of laboratory requests. Laboratory TAT is measured from when the laboratory investigation is ordered to when laboratory results are available to doctors. The primary reason for expecting laboratory results to be completed within 60 minutes is to ensure that the laboratory result reflects current patient condition. If results are delayed then the patient's condition is less likely to reflect the results from blood that was collected over an hour earlier (Blick 2013).

Comparing the mean laboratory TAT of this study with the hospital KPI is not appropriate. There are two reasons for this. Firstly, the hospital KPI is more appropriate for less urgent laboratory requests as it is a single standard KPI for the hospital which is not appropriate because laboratory TAT is different between routine and urgent laboratory requests. Laboratory TAT may also be different for metabolic sensitive tests, such as electrolytes, blood gases and glucose levels. The hospital should determine a laboratory TAT KPI based on specific tests, type of patient and

type of test (Pati & Singh 2014). Secondly, as the standards were determined by the hospital's pathology department, the standard may not reflect the definition from the clinician's perspective. There is little agreement regarding the standard for laboratory TAT because the definition of laboratory TAT differs between laboratories and clinicians. Laboratory providers define laboratory TAT as the period from receiving a sample in the laboratory until the laboratory result is reported, whereas the clinician describes the standard for expectations of TAT as period from the requested time to the time when results are available for interpretation. These different perspectives may lead the pathology department to determine the laboratory TAT based on their perspective. Laboratory TAT in the SHED does not meet the standard recommended to improve patient outcomes. However, it is difficult to determine whether laboratory TAT in this study exceeds the most suitable time appropriate for the hospital, since the hospital KPI for laboratory TAT is not specific for the ED.

The contribution of the laboratory TAT in the SHED to ED LOS

There are two possible explanations for how laboratory investigation TAT has significantly contributed to ED LOS in the SHED. Firstly, laboratory TAT in the SHED contributes to a significant proportion of the ED LOS for both admitted and discharged patients. Laboratory TAT contributes up to 25 per cent of the LOS for admitted patients and 96 per cent for non-admitted patients. This is supported by previous studies which found that a significant proportion of ED LOS is due to laboratory TAT that prolongs LOS in ED. Bukhari et al. (2014) found that laboratory TAT contributes to 59.89 per cent of LOS. Li et al. (2013) found that laboratory TAT contributes 42.8 per cent of ED LOS for discharged patients and 25 per cent for admitted patients. Blood analysis in the ED has a stronger influence on LOS for discharged patients compared to other variables that commonly influence ED LOS, such as demographic factors and mode of arrival (Kawano, Nishiyama & Hayashi 2014). Thus, it is evident that laboratory TAT is a significant contributor to ED LOS, internationally and in the SHED.

Secondly, a prolonged laboratory TAT may be associated with delaying patient diagnosis and treatment (Blick 2013). Holland, Smith and Blick (2006) conclude that prolonged laboratory investigation TAT has a significant impact on ED LOS because the doctor has to wait for the laboratory result to make a decision on whether the patient should be discharged or admitted. According to Holland, Smith and Blick

(2006) laboratory results comprised 80 per cent of the information required by the physician to make a decision regarding patient diagnosis and treatment. Reducing laboratory TAT helps the physician to make a faster decision. Shortening laboratory TAT by using point of care testing (POCT) can help the physician make a decision 19 per cent faster than a centralised laboratory service (Hawkins 2007). There can be no doubt that laboratory TAT contributes to prolonged ED LOS since it contributes a significant proportion of time to ED LOS. Although evidence demonstrates that prolonged laboratory TAT can have impact on ED LOS by increase the doctor's decision time, this study did not measure that variable.

Possible factors that contribute to prolonged laboratory investigation turnaround time (TAT) in the SHED

There are several factors that may contribute to prolonged laboratory TAT in the SHED. These factors can be classified into pre-analytical factors, analytical factors and post-analytical factors. Figure 8 describes the phases in laboratory testing. The factors that possibly contribute to prolonged laboratory TAT are pre-analytical factors and post-analytical factors. Analytical factors may not contribute to prolonged laboratory TAT since all of the processes are computerised. This in line with previous studies which found that both pre analytical phases and post analytical phases have significant and differing contributions to ED laboratory investigation TATs (Hawkins 2007; Persoon, Zaleski & Frerichs 2006; Schimke 2009).

Pre-analytical phase

The pre analytic phase begins when laboratory requests are made by physicians and ends when the laboratory samples arrive at the central laboratory department (Schimke 2009). The pre analytic phase consist of two stages: pre laboratory stage and laboratory stage.

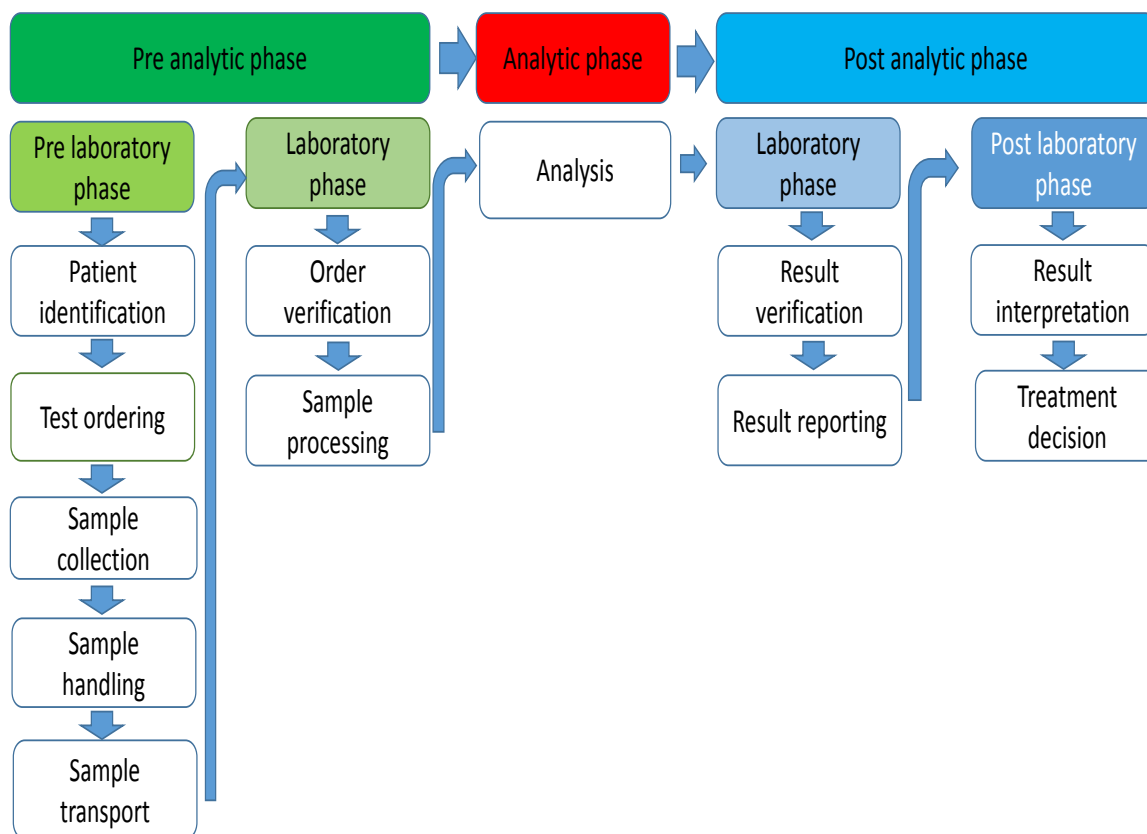


Figure 8 Phases in laboratory testing

Pre laboratory phase

The pre laboratory stage is the responsibility of doctors and nurses in the ED. The key steps of the pre laboratory stage include patient identification, test ordering, sample collection, sample handling and sample transport. There are two possible pre laboratory factors that may contribute to prolonged laboratory TAT in the SHED during the pre-analytical phase, which are prolonged identification of patients who need laboratory investigations and delay of sample transport to the ED laboratory station. The reason for prolonged identification process of a patient who needs a laboratory investigation is that nurses need to manually observe the patient that needs laboratory tests from patient medical records. A manual order system of laboratory request in EDs contributes to difficulty in identifying patients who need laboratory tests (Jalili et al. 2012). Guss, Chan and Killeen (2008) suggest the use of a computerised laboratory order to reduce laboratory TAT in EDs. Difficulty identifying patients for laboratory examination leads to a delay in collecting laboratory samples.

A possible reason for delay of transporting laboratory samples to the ED laboratory station is that nurses send the laboratory sample when they have samples from several patients (Kusuma 2013). Nurses send the laboratory sample collectively as they are multitasking and there are a limited number of nurses in the SHED. Besides providing nursing care, nurses in the SHED are also responsible for non-clinical roles, such as organising inpatient beds. This multitasking role contributes to delays in collecting blood samples. This accords with another study which reported that when sampling is performed by non-laboratory personnel with a multitasking role, such as nurses, laboratory TAT is longer compared to laboratory technicians (Sheppard et al. 2008). In SHED, there are only 10 nurses on duty for each shift so the nurse patient ratio one to 15. This ratio does not reflect patient acuity level. The imbalance between nurses to patients and workload in the ED impacts on additional task completion (Lyneham, Cloughessy & Martin 2008). Prolonged patient identification and delays in sending the laboratory sample from the ED cubicle to the ED laboratory station causes delays in sending laboratory samples to the central laboratory department.

Laboratory phase

The laboratory phase is under the control of laboratory staff. The key steps of the laboratory phase are order verification and sample processing. In the laboratory phase, the possible factors that may contribute to prolonged laboratory TAT in the SHED during the pre-analytical phase are delays in sample processing. Delay of laboratory sample processing is related to several factors. Firstly, a previous study in the SHED by Kusuma (2013) determined that there are not enough staff in the central laboratory department to analyse the specimens as soon as the specimens arrive. This accords with the report from Sanglah Hospital laboratory department which shows that KPI's for laboratory results never reach 100 per cent because of a lack of staff. Similarly, Stotler and Kratz (2012) found that lack of staff in a laboratory department significantly influences the laboratory TAT. This study also found that adding staff in pre analytic and analytic phases of laboratory tests can significantly shorten the laboratory TAT.

The other reason for delays in sample processing in the laboratory department is that there are no specific indicators that a laboratory sample is from the ED, so the laboratory staff are unable to prioritise samples. The SHED quality improvement

project showed the same result (Kusuma 2013). As there is no specific indicator for samples from ED it is difficult for laboratory staff to identify the most urgent laboratory investigations that need to be performed (Francis, Ray & Marshall 2009). This urgency indicator is important since the central laboratory not only provides a service to ED, but the department also provides a service for other parts of the hospital. A study by Francis, Ray and Marshall (2009) suggested the use of specific indicators, including using a coloured sample bag and a priority indicator for laboratory samples from the ED to reduce laboratory TAT. Staffing shortages in the laboratory department and the absence of an identification system that specifies ED samples may contribute to a delay processing laboratory samples. Additionally, these factors could influence the validity of laboratory results because the delay in processing may lead to a contamination or cellular change in laboratory specimens.

Post analytical phase

The post analytical phase from the result of laboratory testing is complete to the time that the result is provided to the treating doctors (Schimke 2009). The post analytical phase in the SHED consists of two phases, the laboratory phase and the post laboratory phase. The laboratory phase is under the control of laboratory staff and the key steps include result verification and result reporting. The post laboratory phase is under the control of nurses and doctors and the key steps include result interpretation and treatment decision. In the previous SHED study by Kusuma (2013) the factors associated with prolonged laboratory TAT are the transition from the laboratory phase to the post laboratory phase as there is no information system to inform nurses or doctors that the laboratory results are available at the ED laboratory station. The computer system is only used for patient registration and payment, so doctors cannot access the laboratory results using the computers. Although a simple alarm system has been developed by a quality group improvement to inform staff of waiting laboratory results, the system does not work properly. The nurses have to come to the ED laboratory station to confirm whether the laboratory results are ready. The nurses usually come to the ED laboratory station when they are sending laboratory samples or when the doctors ask about laboratory results. This manual system for confirming laboratory results can prolong laboratory TAT in the ED. For this reason computerisation is one of the most important factors to economically and efficiently complete laboratory testing (Schimke 2009). It is evident that there is no proper system

to inform staff of laboratory results which is another possible factor associated with prolonged TAT in the SHED.

Other possible factors that contribute to prolonged ED LOS in the SHED

There are other factors that potentially contribute to LOS in the SHED. In this study, another possible factor that contributes to prolonged ED LOS is waiting time for bed availability. The waiting time for bed availability is measured from when the doctor requests an inpatient bed to when the patient is assigned an inpatient bed. The contribution of waiting for bed availability is in line with other studies which report that delayed inpatient bed availability is one factor that contributes to ED LOS (Khare et al. 2009; Li et al. 2013; McCarthy et al. 2009; Rathlev et al. 2007; Vermeulen et al. 2009). Waiting for bed availability could make a significant contribution to prolonged ED LOS because it can increase patient boarding time, which is the time from when the patient receives admission orders to when they leave the ED. Singer et al. (2011) found that prolonged boarding time for patients who wait for inpatient bed availability was associated with prolonged LOS patient in an ED. A computer simulation study found that improving patient waiting time for bed availability in ED can shorten ED LOS patients (Khare et al. 2009). Another study on patients with hip fractures found that the boarding time of patients in the ED is delayed by inpatient bed availability (Rashid et al. 2013). Waiting for a bed in the intensive care unit is another factor that contributes to a prolonged ED stay (Mahsanlar et al. 2014b). This waiting time is also known as access block and is strongly correlated with prolonged waiting time in EDs (Fatovich, Nagree & Sprivulis 2005). It is clear that waiting for inpatient bed availability makes patients stay longer in the ED. However, this study did not measure boarding time since the information required to measure this was dependent on the time doctor provided admitting orders which was not observed in this study.

Waiting for bed availability, as a contributing factor to ED LOS in the SHED, is supported by the annual report of the SHED (2014) which states that there are a significant number of admitted patients who do not get an inpatient bed every day. The admission rate of patients who present to the SHED is 30 per cent of all presentations. Patients who present to the ED may be admitted to one of several departments, including ICU, intermediate care and the inpatient unit. Half of the patients stay longer in the SHED while waiting for bed availability. The difficulty accessing inpatient beds

in ICU and intermediate care occurs for several reasons. One reason is that there are limited beds in the ICU and in intermediate care. The patient who needs ICU admission from the ED compete with other patients from outpatients who need elective surgery. The number of post elective surgery patients who need ICU care contributes to delays in ED patients getting an inpatient bed in ICU (Rathlev et al. 2007). The other reason for difficulty getting an ICU bed is that there is, at times, no ventilator available. As a result patients are observed in the ED until the ventilator is available.

Difficulty getting inpatient beds in a ward is caused by high occupancy rate. High occupancy rates in this hospital are caused by a disequilibrium between the numbers of admitted and discharged patients. In one day an inpatient ward receives acute patients from various hospital departments and receives chronic patients who need chemotherapy or a blood transfusion. Conversely, there are few patients discharged from the inpatient unit. A cross sectional study by Vermeulen et al. (2009) found that a disequilibrium between the number of admitted and discharged inpatients significantly affects next-day ED length of stay. The study found that an increase in the ratio of admitted to be discharged patients above 1, increases the next day's mean ED LOS. Information from the SHED annual report clearly describes the contribution of waiting for inpatient bed availability on SHED LOS.

The contribution of waiting time for bed availability to ED LOS in this study analysed how much of ED LOS is comprised of waiting for a bed to become available. For the admitted patient this proportion had a mean of 55.76 per cent of total ED Los for admitted patients. Furthermore, the mean time for bed availability in the SHED exceeds the acceptable time for waiting for an inpatient bed. The mean time waiting for a bed to become available in the SHED is five time longer than the internationally recommended time of 24 minutes (Banerjea & Carter 2006) and in comparison to the US is three times longer. However, waiting time for bed availability results from this SHED study cannot be compared to international and US reports because this study only collected data over an eight hour period of each data collection day when the SHED is usually at its busiest. In this study, there were a small number of patients who waited more than eight hours, whereas there were a large number of patients who wait less than eight hours. Other studies that found an association between waiting for bed availability and a prolonged ED LOS used retrospective sampling with a very large

sample size over a prolonged long study period. Although the mean time for waiting bed availability contributes a significant proportion of time to ED LOS, this study is unable to prove how much of this contributes to mean ED LOS as measured by other studies. This is a limitation of this study.

Study Limitations

There are several limitations to this study. The first limitation is sampling technique. Due to the limited study period and limited financial support, this study used a convenience sampling technique in which patients who came to the SHED during a predetermined eight hour period were observed. As a result, the sample gathered is unlikely to be representative of the whole population that presents to the SHED. This means study results may not be generalizable.

The second limitation is the study population. The study did not include all of the population who visited the ED. Due to time limitations related to obtaining approval from the university ethics committee, this study did not include paediatric, psychiatric and geriatric patients.

The third limitation is the study period. This study did not observe patient flow over 24 hours because there were a limited number of research assistants available to collect data. The study only observed patients for eight hours each day and the study only reported on patient flow during these periods. As a result, study results cannot be used to determine the patient flow for all periods of service in the SHED.

The fourth limitation was the data collection method. Data collection in this study used an observational method as it was not possible to get information by interviewing patients, family members or healthcare providers or to get information from patient medical records. As a result, the researchers could not obtain some data. For example, the study was unable to observe when the doctor gave permission for patients to exit the ED. This information is recorded in the patient medical record and is important to identify patient boarding time.

Fifthly, this study did not observe the complete TAT for consultation with other specialisations. This study only observed the time from first request for another doctor

to attend. As a result, consultation TAT in this study does not reflect the whole process of the consultation to other specialisations TAT in the SHED. The TAT for consultation to other specialisations in the SHED should be measured from when the doctor is consulted to when the results of the consultation are available. Previous studies by Kusuma (2013) in the SHED found that the registrar will consult another specialisation after waiting for the laboratory result and may consult by phone.

The sixth limitation is the study result. The results of this study cannot be generalised to other EDs, since each ED have different stages of patient flow.

The seventh limitation is the Indonesian setting of the SHED which resulted in types of data of that were not valid for analysis. For example, not all patients who come to the SHED could provide their age or date of birth, so this was estimated by the data collectors. The other example is the implementation of the Australasian Triage scale which is not consistent with the Australasian College of Emergency Medicine standard. This study did not find any patient with triage categories one and five during data collection.

The last limitation of this study is attributed to the use of an observational prospective study which may have caused a Hawthorne effect where the healthcare provider gives better service than usual because they are being observed. Although the researcher informed the staff to behave normally, there is a possibility that this effect could have impacted on the results of this study.

Recommendations for further investigation

Further research is required to address the limitations of this study. Future studies should:

- Use a probability sampling method to prevent bias and the obtained sample must represent the patient population in the ED.
- Include paediatric, obstetric, psychiatric and geriatric patients who come to the ED. These populations comprise a significant proportion of the patients who present to the SHED.

- Cover all patients over 24 hours to ensure that all variations in patient flow are described.
- Combine quantitative method and qualitative methods to help obtain data that cannot get be collected by a single method. For example, conducting interviews or group discussions about the factors that contribute to prolonged ED LOS could be used to clarify the findings.
- Measure consultation time to other specialisations from the first request to the result available to understand the whole consultation process.
- Conduct an audit on the consistency of triage implementation in the SHED to make sure that the triage process and triage decisions are valid and reliable.

Conclusion

This final chapter has discussed the results of this study in the context of current literature. This chapter has also briefly summarised the restatement of the problem and description of this study procedure. The main factors that contribute to prolonged LOS in the SHED have been described and findings compared with current literature. Explanation regarding why the factors contributing to prolong ED LOS in this study have been provided in this chapter. Finally, this chapter also outlined the limitations of this study and recommendations for a future studies to obtain improved results.

This study described the main factors that contributed to ED LOS in the SHED, which in turn prolonged ED LOS and contributed to ED crowding. The results of this study have a major implication for reducing overcrowding in the SHED because it identified the most important factor that contributed to ED crowding. Thus, this study provides SHED management with data and results that can be used to reduce ED crowding. The major finding from this study indicated the need to implement a centralised laboratory service to improve laboratory investigations turnaround time. This study also provides nurses with information on how care should be improved to reduce ED crowding. As a result, nurses can be part of the solution by reducing delays in the SHED.

References

- Ajmi, I, Zgaya, H, Gammoudi, L, Hammadi, S, Martinot, A, Beuscart, R & Renard, J 2015, 'Mapping patient path in the pediatric emergency department: a workflow model driven approach', *Journal of Biomedical Informatics*, vol. 54, pp. 315-328.
- American College of Emergency Physician 2011, *ED Facility Level Coding Guidelines*, viewed 19 October 2015, <<http://www.acep.org/Content.aspx?id=30428>>.
- Ashmore, S, Ruthhven, T & Hazelwood, L 2011, 'Preparation, planning, organisation of clinical audit', in R Burgess (ed.), *New Principles of Best Practice in Clinical Audit*, 2nd edn, Radcliffe Publishing, Oxford, New York, pp. 23-58.
- Australian College for Emergency Medicine 2012, *Statement on the delineation of emergency departments*, viewed 19 October 2015, <<https://www.acem.org.au/getattachment/541e19cd-6e5e-48b2-93f6-7416c43ac13a/Statement-on-the-Delineation-of-Emergency-Departme.aspx>>.
- Australian College for Emergency Medicine 2013, *Guidelines on the implementation of the australasian triage scale in emergency department*, viewed 19 October 2015, <<https://www.acem.org.au/getattachment/d19d5ad3-e1f4-4e4f-bf83-7e09cae27d76/G24-Implementation-of-the-Australasian-Triage-Scal.aspx>>.
- Australian Institute of Health and Welfare 2014, *Australian hospital statistics 2013–14*, viewed 24 September 2015, <http://www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=60129549036>>.
- Bair, AE, Song, WT, Chen, YC & Morris, BA 2009, 'The impact of inpatient boarding on Emergency Department crowding: A discrete-event simulation study', in *42nd Annual Simulation Symposium 2009, ANSS 2009, Part of the 2009 Spring Simulation Multiconference*, pp. 49-55.
- Banerjea, K & Carter, A 2006, 'Waiting and interaction times for patients in a developing country accident and emergency department', *Emergency Medicine Journal*, vol. 23, no. 4, pp. 286-290.
- Barton, B & Peat, J 2014, 'Comparing two independent sample', in *Medical statistics: A guide to SPSS, data analysis and critical appraisal*, 2nd edn, John Wiley & Sons, Ltd. Published West Sussex, UK, pp. 52-89.
- Ben-Tovim, D, Dougherty, M, O'Connell, T & McGrath, K 2008, 'Patient journeys: the process of clinical redesign', *Medical Journal Australia*, vol. 188, no. 6, pp. 14-17.
- Bernstein, S, Aronsky, D, Duseja, R, Epstein, S, Hande, D & Hwang, U 2009, 'The effect of emergency department crowding on clinically oriented outcomes', *Academic Emergency Medicine*, vol. 16, no. 1, pp. 1-10.
- Best, A, Dixon, C, Kelton, W, Lindsell, C & Ward, M 2014, 'Using discrete event computer simulation to improve patient flow in a Ghanaian acute care hospital', *American Journal of Emergency Medicine*, vol. 32, no. 8, pp. 917-922.

Blick, K 2013, 'Providing critical laboratory results on time, every time to help reduce emergency department length of stay', *American Journal Clinical Pathology*, vol. 140, no. 2, pp. 193-202.

Bond, K, Ospina, M, Blitz, S, Friesen, C, Innes, G & Yoon, P 2006, *Interventions to reduce overcrowding in Emergency Departments.*, Canadian Agency for Drugs and Technologies in Health, Ottawa.

Brick, C, Lowes, J, Lovstrom, L, Kokotilo, A, Villa-Roel, C, Lee, P, Lang, E & Rowe, B 2014, 'The impact of consultation on length of stay in tertiary care emergency departments', *Emergency Medicine Journal*, vol. 31, no. 2, pp. 134-138.

Bruijns, S, Wallis, L & Burch, V 2008, 'Effect of introduction of nurse triage on waiting times in a South African emergency department', *Emergency Medical Journal*, vol. 25, pp. 395-397.

Buckley, B, Castillo, E, Killeen, J, Guss, D & Chan, T 2010, 'Impact of an express admit unit on emergency department length of stay', *Journal of Emergency Medicine*, vol. 39, no. 5, pp. 669-673.

Bukhari, H, Albazli, K, Almaslmani, S, Attiah, A, Bukhary, E, Najjar, F, Qari, A, Sulaimani, N, Al-Lihyani, A, Alhazmi, A, Al-Maghrabi, H, Alyasi, O, Albarqi, S & Eldin, A 2014, 'Analysis of waiting time in emergency department of Al-Noor Specialist Hospital, Makkah, Saudi Arabia', *Open Journal of Emergency Medicine*, vol. 2, pp. 67-73.

Burstrom, L, Nordberg, M, Ornung, G, Castren, M, Wiklund, T, Engstrom, M & Enlund, M 2012, 'Physician-led team triage based on lean principles may be superior for efficiency and quality? A comparison of three emergency departments with different triage models', *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, vol. 20, pp. 57-67.

Carter, E, Pouch, S & Larson, E 2014, 'The Relationship Between Emergency Department Crowding and Patient Outcomes: A Systematic Review', *Journal of Nursing Scholarship*, vol. 46, pp. 106-115.

Chan, T, Killeen, J, Vilke, G, Marshall, J & Castillo, E 2010, 'Effect of mandated nurse-patient ratios on patient wait time and care time in the emergency department', *Academic Emergency Medicine*, vol. 17, no. 5, pp. 545-552.

Depinet, H, Iyer, S, Hornung, R, Timm, N & Byczkowski, T 2014, 'The effect of emergency department crowding on reassessment of children with critically abnormal vital signs', *Academic Emergency Medicine*, vol. 21, no. 10, pp. 1116-1120.

Dickson, E, Anguelov, Z, Vetterick, D, Eller, A & Singh, S 2009, 'Use of Lean in the emergency department: a case series of 4 hospitals', *Annals of Emergency Medicine*, vol. 54, no. 4, pp. 504-510.

Ding, R, McCarthy, M, Desmond, J, Lee, J, Dominik Aronsky, D & Zeger, S 2010, 'Characterizing Waiting Room Time, Treatment Time, and Boarding Time in the Emergency Department Using Quantile Regression', *The society of Academic Emergency Medicine*, pp. 813-823.

Dixon, C, Punguyire, D, Mahabee-Gittens, M, Ho, M & Lindsell, C 2015, 'Patient flow analysis in resource-limited settings: a practical tutorial and case study', *Global Health: Science and Practice*, vol. 3, no. 1, pp. 126-134.

Eitel, D, Rudkin, S, Malvey, M, Killeen, J & Jesse, M 2010, 'Improving service quality by understanding emergency department flow: a white paper and position statement prepared for the american academy of emergency medicine', *Journal of Emergency Medicine*, vol. 38, no. 1, pp. 70-79.

Fatovich, D, Nagree, Y & Sprivulis, P 2005, 'Access block causes emergency department overcrowding and ambulance diversion in Perth, Western Australia.', *Emergency Medicine Journal*, vol. 22, no. 5, pp. 351-354.

Fieldston, E, Zaoutis, L, Agosto, P, Guo, A, Jonas, J & Tsarouhas, N 2014, 'Measuring patient flow in a children's hospital using a scorecard with composite measurement', *Journal of hospital medicine : an official publication of the Society of Hospital Medicine*, vol. 9, no. 7, pp. 463-468.

Filed, a 2014, 'The beast of bias', in *Discovering statistics using IBM SPSS statistics* 4th edn, Sage, London, pp. 163-212.

Fogarty, E, Saunders, J & Cummins, F 2014, 'The effect of boarders on emergency department process flow', *The Journal of Emergency Medicine*, vol. 46, no. 5, pp. 706-710.

Forero, R, McCarthy, S & Hillman, K 2011, 'Access block and emergency department overcrowding', *Critical Care*, vol. 15, no. 216, pp. 1-6.

Francis, A, Ray, M & Marshall, M 2009, 'Pathology processes and emergency department length of stay: the impact of change', *The Medical journal of Australia*, vol. 190, no. 12, pp. 665-669.

Geelhoed, G & Klerk, N 2012, 'Emergency department overcrowding, mortality and the 4-hour rule in Western Australia', *Medical Journal Of Australia*, vol. 196, no. 2, pp. 122-126.

Gilboy, N, Tanabe, T, Travers, D & Rosenau, A 2011, 'Introduction to the emergency severity index: A research-based triage tool', in *Emergency Severity Index (ESI): A triage tool for emergency department care, version 4*, 3rd edn, vol. 2015, AHRQ Publication, Rockville, pp. 1-6.

Gilboy, N & Travers, D 2007, 'Triage', in K Hoyt & J Thomas (eds), *Emergency nursing core curriculum*, 6th edn, Saunders, Missouri, USA, pp. 28-50.

Gill, D, Galvin, S, Ponsford, M, Bruce, D, Reicher, J, Preston, L, Bernard, S, Lafferty, J, Robertson, A, Rose-morris, A, Stoneham, S, Rieu, R, Pooley, S, Weetch, A & Mccann, L 2012, 'Laboratory sample turnaround times: do they cause delays in the ED?', *Journal of Evaluation in Clinical Practice*, vol. 18, no. 1, pp. 121-127.

Goodacre, S & Webster, A 2005, 'Who waits longest in the emergency department and who leaves without being seen?', *Emergency Medicine Journal*, vol. 22, no. 2, pp. 93-96.

- Guss, D, Chan, T & Killeen, J 2008, 'The impact of a pneumatic tube and computerized physician order management on laboratory turnaround time', *Annals of Emergency Medicine*, vol. 51, no. 2, pp. 181-185.
- Harding, K, Taylor, N & Leggat, S 2011, 'Do triage systems in healthcare improve patient flow? A systematic review of the literature', *Australian Health Review*, vol. 35, no. 3, pp. 371-383.
- Harnett, M, Correll, D, Hurwitz, S, Angela M. Bader, A & Hepner, D 2010, 'Improving efficiency and patient satisfaction in a tertiary teaching hospital preoperative clinic', *Anesthesiology*, vol. 112, pp. 66 -72.
- Hawkins, R 2007, 'Laboratory turnaround time', *Clinical Biochemistry Review*, vol. 28, pp. 179-194.
- Hayden, C, Burlingame, P, Thompson, H & Sabol, V 2014, 'Improving patient flow in the emergency department by placing a family nurse practitioner in triage: a quality-improvement project', *Journal of Emergency Nursing*, vol. 40, no. 4, pp. 346-351.
- Henderson, K & Boyle, A 2014, 'Exit block in the emergency department: recognition and consequences', *British Journal of Hospital Medicine*, vol. 75, no. 11, pp. 623-626.
- Henneman, P, Nathanson, B, Li, H, Smithline, H, Blank, F, Santoro, J, Maynard, A, Provost, D & Henneman, E 2010, 'Emergency department patients who stay more than 6 hours contribute to crowding', *The Journal of Emergency Medicine*, vol. 39, no. 1, pp. 105-112.
- Holland, L, Smith, L & Blick, K 2005, 'Reducing laboratory turnaround time outliers can reduce emergency department patient length of stay an 11-hospital study', *American Journal of Clinical Pathology*, vol. 124, no. 5, pp. 672-674.
- Holland, L, Smith, L & Blick, K 2006, 'Total laboratory automation can help eliminate the laboratory as a factor in emergency department length of stay', *American Journal Clinical Pathology*, vol. 125, pp. 765-770
- Houston, C, Leon D. Sanchez, L, Christopher Fischer, C, Kathryn Volz, K & Richard Wolfe, R 2015, 'Waiting for Triage: Unmeasured Time in Patient Flow', *Western Journal of Emergency Medicine*, vol. 16, no. 1.
- Hwang, U, McCarthy, M, Aronsky, D, Asplin, B, Crane, P, Craven, C, Epstein, S, Fee, C, Handel, D, Pines, J, Rathlev, N, Schafermeyer, R, Zwemer, F & Bernstein, S 2011, 'Measures of crowding in the emergency department: A systematic review', *Academic Emergency Medicine*, vol. 18, pp. 527-538.
- Imperato, J, Morris, D, Binder, D, Fischer, C, Patrick, J, Sanchez, L & Setnik, G 2012, 'Physician in triage improves emergency department patient throughput', *Internal and Emergency Medicine*, vol. 7, no. 5, pp. 457-462.
- Jalili, M, Mojtahed, A, Mojtahed, M & Moradi-Lakeh, M 2012, 'Identifying causes of laboratory turnaround time delay in the emergency department', *Archives of Iranian Medicine*, vol. 15, no. 12.
- Kadri, F, Harrou, F, Chaabane, S & Tahon, C 2014, 'Time series modelling and forecasting of emergency department overcrowding', *Journal Of Medical Systems*, vol. 38, no. 9, pp. 1-20.

- Kang, H, Nembhard, H, Rafferty, C & DeFlitch, C 2014, 'Patient flow in the emergency department: a classification and analysis of admission process policies', *Annals of Emergency Medicine*, vol. 64, no. 4, pp. 335-342.
- Kanzaria, H, Probst, M, Ponce, N & Hsia, R 2014, 'The association between advanced diagnostic imaging and ED length of stay', *American Journal of Emergency Medicine*, vol. 32, pp. 1253-1258.
- Kawano, T, Nishiyama, K & Hayashi, H 2014, 'Execution of diagnostic testing has a stronger effect on emergency department crowding than other common factors: A cross-sectional study', *PLoS ONE*, vol. 9, no. 10, pp. 1-9.
- Kementrian Kesehatan Republik Indonesia 2014, *Rumah sakit on line*, viewed 15 September 2015, <<http://sirs.buk.depkes.go.id/rsonline/report/>>.
- Khanna, S, Boyle, J & Zeitz, K 2014, 'Using capacity alert calls to reduce overcrowding in a major public hospital', *Australian Health Review*, vol. 38, no. 3, pp. 318-324.
- Khare, R, Powell, E, Reinhardt, G & Lucenti, M 2009, 'Adding more beds to the emergency department or reducing admitted patient boarding times which has a more significant influence on emergency department congestion', *Annals of Emergency Medicine*, vol. 53, no. 5, pp. 575-585.
- King, D, Ben-tovim, D & Bassham, J 2006, 'Redesigning emergency department patient flows: application of lean thinking to health care', *Emergency Medicine Australasia*, vol. 18, no. 4, pp. 391-397.
- Klein, M & Reinhardt, G 2012, 'Emergency department patient flow simulations using spreadsheets', *Simulation in Healthcare* vol. 7, pp. 40-47.
- Kocher, K, Meurer, W, Desmond, J & Nallamotheu, B 2012, 'Effect of testing and treatment on emergency department length of stay using a national database', *Academic Emergency Medicine*, vol. 19, no. 5, pp. 525-534.
- Kusuma, J 2013, 'Analisis waktu pelayanan instalasi gawat darurat dengan pendekatan constraint lean six sigma di RSUP Sanglah Denpasar', Master of Hospital Administration thesis, University of Indonesia.
- Lee, R, Woods, R, Bullard, M, Holroyd, B & Rowe, B 2008, 'Consultations in the emergency department: a systematic review of the literature', *Emergency Medicine Journal*, vol. 25, pp. 4-9.
- Li, S, Chiu, N, Kung, W & Chen, J 2013, 'Factors affecting length of stay in the pediatric emergency department', *Pediatrics & Neonatology Volume*, vol. 54, no. 3, pp. 179-187.
- Lyneham, J, Cloughessy, L & Martin, V 2008, 'Workloads in Australian emergency departments a descriptive study', *International Emergency Nursing*, vol. 16, pp. 200-206.
- Mahsanlar, Y, Parlak, I, Yolcu, S, Akay, S, Demirtas, Y & Eryigit, V 2014a, 'Factors affecting the length of stay of patients in emergency department observation units at teaching and research hospitals in Turkey', *Turkish Journal of Emergency Medicine*, vol. 14, no. 1, pp. 3-6.

Mahsanlar, Y, Parlak, I, Yolcu, S, Akay, S, Demirtas, Y & Eryigit, V 2014b, 'Factors affecting the length of stay of patients in emergency department observation units at teaching and research hospitals in Turkey', *Turkey Journal of Emergency Medicine*, vol. 14, no. 1, pp. 3-8.

Mahsanlar, Y, Parlak, I, Yolcu, S, Akay, S, Demirtas, Y & Eryigit, V 2014 'Factors affecting the length of stay of patients in emergency department observation units at teaching and research hospitals in Turkey', *Turkey Journal of Emergency Medicine*, vol. 14, no. 1, pp. 3-8.

Martin, M, Champion, R, Kinsman, L & Masman, K 2011, 'Mapping patient flow in a regional Australian emergency department: A model driven approach', *International Emergency Nursing (2011) 19*, 75–85, vol. 19, pp. 75-85.

McCarthy, M, Aronsky, D, Jones, I, James R. Miner, J, Band, R, Baren, J, Desmond, J, Baumlin, K, Ding, R & Shesser, R 2008, 'The emergency department occupancy rate: A simple measure of emergency department crowding? ', *Annals of Emergency Medicine*, vol. 51, no. 1, pp. 15-24.

McCarthy, M, Zeger, S, Ding, R, Levin, S, Desmond, J, Lee, J & Aronsky, D 2009, 'Crowding delays treatment and lengthens emergency department length of stay, even among high-acuity patients', *Annals of Emergency Medicine*, vol. 54, no. 4, pp. 492-503.

Mielczarek, B & Uziako-Mydlikowska, J 2012, 'Application of computer simulation modeling in the health care sector: a survey', *Simulation in Healthcare*, vol. 88, no. 2, pp. 197-216.

Montgomery, P, Godfrey, M, Mossey, S, Conlon, M & Bailey, P 2014, 'Emergency department boarding times for patients admitted to intensive care unit: Patient and organizational influences', *International Emergency Nursing*, vol. 22, no. 2, pp. 105-111.

Mumma, BE, McCue, JY, Li, CS & Holmes, JF 2014, 'Effects of emergency department expansion on emergency department patient flow', *Academic Emergency Medicine*, vol. 21, no. 5, pp. 504-509.

Olshaker, J & Rathlev, N 2006, 'Emergency department overcrowding and ambulance diversion: The impact and potential solutions of extended boarding of admitted patients in the emergency department', *The Journal of Emergency Medicine*, vol. 30, no. 3, pp. 351-356.

Oredsson, S, Jonsson, H, Rognes, J, Lind, L, Göransson, K, Ehrenberg, A, Asplund, K, Castrén, M & Farrohknia, N 2011, 'A systematic review of triage-related interventions to improve patient flow in emergency departments', *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, vol. 19, no. 43, pp. 1-9.

Pallant, J 2013, 'Statistical techniques to compare groups', in *SPSS survival manual*, 5th edn, Allen & Unwin, New South Wales, Australia, pp. 211-307.

Pati, H & Singh, G 2014, 'Turnaround time (TAT): difference in concept for laboratory and clinician', *Indian Journal Of Hematology & Blood Transfusion*, vol. 30, no. 2, pp. 81-84.

Perimal-Lewis, L, Ben-Tovim, D, Li, J, Hakendorf, P & Thompson, C 2014, 'Emergency department lengths of stay: characteristics favouring a delay to the admission decision as distinct from a delay while awaiting an inpatient bed', *Internal Medicine Journal*, vol. 44, no. 4, pp. 384-389.

Persoon, T, Zaleski, S & Frerichs, J 2006, 'Improving preanalytic processes using the principles of lean production (toyota production system)', *American Journal Clinical Pathology*, vol. 125, pp. 16-25.

Phillips, J & Simmonds, L 2013, 'Use of process mapping in service improvement', *Nursing Times* vol. 109, no. 17, pp. 24-26. Polit, D & Beck, C 2012, 'Quantitative research design

', in D Polit & C Beck (eds), *Nursing Research: Generating and assessing Evidence for Nursing Practice*, 9th edn, Lippincot Williams & Wilkins, Philadelphia, pp. 201-235.

Popovich, M, Boyd, C, Dachenhaus, T & Kusler, D 2012, 'Improving stable patient flow through the emergency department by utilizing evidence-based practice: one hospital's journey', *Journal of Emergency Nursing*, vol. 38, no. 5, pp. 474-478.

Potisek, N, Malone, R, Shilliday, B, Ives, T, Chelminski, P, Dewalt, D & Pignone, M 2007, 'Use of patient flow analysis to improve patient visit efficiency by decreasing wait time in a primary care-based disease management programs for anticoagulation and chronic pain: a quality improvement study', *BMC Health Science Research*, vol. 7, no. 8, pp. 1-7.

Powell, ES, Khare, RK, Venkatesh, AK, Van Roo, BD, Adams, JG & Reinhardt, G 2012, 'The relationship between inpatient discharge timing and emergency department boarding', *Journal of Emergency Medicine*, vol. 42, no. 2, pp. 186-196.

Preyde, M, Crawford, K & Mullins, L 2012, 'Patients' satisfaction and wait times at Guelph General Hospital Emergency Department before and after implementation of a process improvement project', *Canadian Association of Emergency Physicians*, vol. 14, no. 3, pp. 157-168.

Rashid, A, Brooks, T, Bessman, E & Mears, S 2013, 'Factors associated with emergency department length of stay for patients with hip fracture', *Geriatric Orthopaedic Surgery & Rehabilitation*, vol. 4, no. 3, pp. 78-83.

Rathlev, N, Chessare, J, Olshaker, J, Obendorfer, D, Mehta, S, Rothenhaus, T, Crespo, S, Magauran, B, Davidson, K, Shemin, R, Lewis, K, Becker, J, Fisher, L, Guy, L, Cooper, A & Litvak, E 2007, 'Time series analysis of variables associated with daily mean emergency department length of stay', *Annals of Emergency Medicine*, vol. 49, no. 3, pp. 265-271.

Richardson, D & Mountain, D 2009, 'Myths versus facts in emergency department overcrowding and hospital access block', *Medical Journal Of Australia*, vol. 190, no. 7, pp. 369-374.

Ryan, A, Kate Hunter, K, Cunningham, K, Williams, J, O'Shea, H, Rooney, P & Hickey, F 2013, 'STEPS: Lean thinking, theory of constraints and identifying bottlenecks in an emergency department', *Ireland Medical Journal*, vol. 106, no. 4, pp. 105-107.

- Schimke, I 2009, 'Quality and timeliness in medical laboratory testing', *Analytical and Bioanalytical Chemistry*, vol. 393, no. 5, pp. 1499-1504.
- Schull, M, Vermeulen, M, Stukel, T, Guttman, A, Leaver, C, Rowe, B & Sales, A 2012, 'Evaluating the effect of clinical decision units on patient flow in seven canadian emergency departments', *Academic Emergency Medicine*, vol. 19, no. 7, pp. 828-836.
- Singer, A, Thode, J, Henry, C, Viccellio, P & Pines, J 2011, 'The association between length of emergency department boarding and mortality', *Academic Emergency Medicine*, vol. 18, no. 12, pp. 1324-1329.
- Soong, C, High, S, Morgan, M & Ovens, H 2013, 'A novel approach to improving emergency department consultant response times', *British Medical Journal*, vol. 22, pp. 299-305.
- Soremekun, O, Capp, R, Biddinger, P, White, B, Chang, Y, Carignan, S & Brown, D 2012, 'Impact of physician screening in the emergency department on patient flow', *Journal of Emergency Medicine*, vol. 43, no. 3, pp. 509-515.
- Storrow, A, Zhou, C, Gaddis, G, Han, J, Miller, K, Klubert, D, Laidig, A & Aronsky, D 2008, 'Decreasing lab turnaround time improves emergency department throughput and decreases emergency medical services diversion: A simulation model', *Academic Emergency Medicine*, vol. 15, no. 11, pp. 1130-1135
- Stotler, B & Kratz, A 2012, "'Accessioning-to-result" time does not always accurately reflect laboratory performance', *American Journal Clinical Pathology*, vol. 138, pp. 724-729.
- Svirsky, I, Stoneking, L, Grall, K, Berkman, M, Stolz, U & Shirazi, F 2013, 'Resident-initiated advanced triage effect on emergency department patient flow', *Journal of Emergency Medicine*, vol. 45, no. 5, pp. 746-751.
- Tabachnick, B & Fidell, L 2007, 'Cleaning up your act', in *Using multivariate statistics* 5th edn, Pearson Education, Boston, USA, pp. 60-105.
- Theunissen, BHJJ, Lardenoye, S, Hannemann, PH, Gerritsen, K, Brink, PRG & Poeze, M 2014, 'Fast Track by physician assistants shortens waiting and turnaround times of trauma patients in an emergency department', *European Journal of Trauma and Emergency Surgery*, vol. 40, no. 1, pp. 87-91.
- Tsai, V, Sharieff, G, Kanegaye, J, Carlson, L & Harley, J 2012, 'Rapid medical assessment: improving pediatric emergency department time to provider, length of stay, and left without being seen rates', *Pediatric emergency care*, vol. 28, no. 4, pp. 354-356.
- Vegting, I, Alam, N, Ghanes, K, Jouini, O, Mulder, F, Vreeburg, M, Biesheuvel, T, Bokhorst, J, Go, P, Kramer, M, Koole, G & Nanayakkara, P 2015, 'What are we waiting for? Factors influencing completion times in an academic and peripheral emergency department', *The Netherlands Journal of Medicine*, vol. 73, no. 7, pp. 331-340.
- Vermeulen, M, Ray, J, Bell, C, Cayen, B, Stukel, T & Schull, M 2009, 'Disequilibrium between admitted and discharged hospitalized patients affects emergency department length of stay', *Annals of Emergency Medicine*, vol. 54, no. 6, pp. 794-804.

Wen, L, Venkataraman, A, Sullivan, A & Camargo, C 2012, 'National inventory of emergency departments in Singapore', *International Journal of Emergency Medicine*, vol. 5, no. 38, pp. 1-9.

Wibulpolprasert, A, Sittichanbuncha, Y, Sricharoen, P, Borwornsrisk, S & Sawanyawisuth, K 2014, 'Factors associated with overcrowded emergency rooms in Thailand: A medical school setting', *Emergency Medicine International*, pp. 1-4.

Wickramasinghe, N 2014, 'Lean principles for healthcare', in N Wickramasinghe, L Al-Hakim, C Gonzalez & J Tan (eds), *Lean thinking for healthcare*, 1st edn, Springer, New York, pp. 3-11.

Wiler, J, Bolandifar, E, Griffey, R, Poirier, R & Olsen, T 2013, 'An Emergency Department Patient Flow Model Based on Queueing Theory Principles', *Academic Emergency Medicine*, vol. 20, no. 9, pp. 939-946.

Wong, A, Kozan, E, Sinnott, M, Spencer, L & Eley, R 2014, 'Tracking the patient journey by combining multiple hospital database systems', *Australian Health Review*, 2014, Vol.38(3), p.332-336 [Peer Reviewed Journal], vol. 38, no. 3, pp. 332-336.

Woods, R, Lee, R, Ospina, M, Blitz, S, Lari, H, Bullard, M & Rowe, B 2008, 'Consultation outcomes in the emergency department: exploring rates and complexity', *Canadian Journal of Emergency Medicine*, vol. 10, no. 1, pp. 26-31.

Ye, L, Zhou, G, He, X, Shen, W, Gan, J & Zhang, aM 2012, 'Prolonged length of stay in the emergency department in high-acuity patients at a Chinese tertiary hospital', *Emergency Medicine Australasia*, vol. 24, pp. 634-640.

Zimmerman, D 2006, 'Two separate effects of variance heterogeneity on the validity and power of significance tests of location', *Statistical Methodology*, vol. 3, pp. 351-374.

Appendices

Appendix 1 Ethical approval from Human Research Ethic Committee from the University of Adelaide



RESEARCH BRANCH
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND
INTEGRITY

SABINE SCHREIBER
SECRETARY
HUMAN RESEARCH ETHICS COMMITTEE
THE UNIVERSITY OF ADELAIDE
SA 5005
AUSTRALIA

TELEPHONE +61 8 8313 6028
FACSIMILE +61 8 8313 7325
email: sabine.schreiber@adelaide.edu.au
CRICOS Provider Number 00123M

9 July 2015

Dr D Foley
School of Nursing

Dear Dr Foley

PROJECT NO: H-2015-116
*Description of patient flow in an Indonesian emergency department
of a major teaching hospital*

I write to advise you that the Human Research Ethics Committee has approved the above project. Please refer to the enclosed endorsement sheet for further details and conditions that may be applicable to this approval. Ethics approval is granted for a period of three years subject to satisfactory annual progress reporting. Ethics approval may be extended subject to submission of a satisfactory ethics renewal report prior to expiry.

The ethics expiry date for this project is: 31 July 2018

Where possible, participants taking part in the study should be given a copy of the Information Sheet and the signed Consent Form to retain.

Please note that any changes to the project which might affect its continued ethical acceptability will invalidate the project's approval. In such cases an amended protocol must be submitted to the Committee for further approval. It is a condition of approval that you immediately report anything which might warrant review of ethical approval including (a) serious or unexpected adverse effects on participants (b) proposed changes in the protocol; and (c) unforeseen events that might affect continued ethical acceptability of the project. It is also a condition of approval that you inform the Committee, giving reasons, if the project is discontinued before the expected date of completion.

A reporting form for the annual progress report, project completion and ethics renewal report is available from the website at <http://www.adelaide.edu.au/ethics/human/guidelines/reporting/>

Yours sincerely

 Professor P Delfabbro
Acting Convenor
Human Research Ethics Committee

Appendix 1 Ethical approval from Human Research Ethic Committee from the University of Adelaide



RESEARCH BRANCH
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND
INTEGRITY

SABINE SCHREIBER
SECRETARY
HUMAN RESEARCH ETHICS COMMITTEE
THE UNIVERSITY OF ADELAIDE
SA 5005
AUSTRALIA
TELEPHONE +61 8 8313 6028
FACSIMILE +61 8 8313 7325
email: sabine.schreiber@adelaide.edu.au
CRICOS Provider Number 00123M

Applicant: Dr D Foley

School: Nursing

Project Title: *Description of patient flow in an Indonesian emergency department of a major teaching hospital*

THE UNIVERSITY OF ADELAIDE HUMAN RESEARCH ETHICS COMMITTEE

Project No: H-2015-116

RM No: 0000020652

APPROVED for the period until: 31 July 2018

Thank you for the detailed response dated 8.7.15 to the matters raised by the Committee. It is noted that this study will be conducted by I Putu Budiarsana, Masters student.

Refer also to the accompanying letter setting out requirements applying to approval.

per Professor P Delfabbro
Acting Convenor
Human Research Ethics Committee

Date: 9 July 2015

Appendix 2 Ethical clearance from the University of Udayana, Bali, Indonesia



UNIT PENELITIAN DAN PENGEMBANGAN (LITBANG)
FAKULTAS KEDOKTERAN UNIVERSITAS UDAYANA/RUMAH
SAKIT UMUM PUSAT SANGLAH DENPASAR



Jalan P. Serangan Denpasar Bali (80114) Email : Litbang.unud.rsup@gmail.com Telp. (0361) 244534, (0361)227911-15(p.227)

KETERANGAN KELAIKAN ETIK

(ETHICAL CLEARANCE)

No : 1282/UN.14.2/Litbang/2015

Komisi Etika Penelitian Fakultas Kedokteran Universitas Udayana/Rumah Sakit Umum Pusat Sanglah Denpasar, setelah mempelajari dengan seksama rancangan penelitian yang diusulkan dengan ini menyatakan bahwa penelitian dengan Judul :

“DESCRIPTION OF PATIENT FLOW IN AN INDONESIAN EMERGENCY DEPARTMENT OF A MAJOR TEACHING HOSPITAL”

Peneliti Utama : Putu Budiarsana

Unit/Lembaga/Tempat Penelitian : Instalasi Rawat Darurat RSUP Sanglah Denpasar.

Nomor protocol : 601.02.2.2015

Dinyatakan Laik Etik. Surat keterangan ini berlaku selama satu tahun sejak ditetapkan. Adapun jenis laporan yang harus disampaikan kepada komisi etik:

1. Progress report setiap.....bulan
2. Final report

Denpasar, 23 Juni 2015

Unit Penelitian dan Pengembangan

Komisi Etik Penelitian

Fakultas Kedokteran Universitas Udayana/

Fakultas Kedokteran Universitas Udayana/

Rumah Sakit Umum Pusat Sanglah Denpasar

Rumah Sakit Umum Pusat Sanglah Denpasar

Ketua,



NIP. 195810101987021001

NIP. 195301311980031004

Appendix 3 Letter of permit from Sanglah Hospital (Indonesian version)



KEMENTERIAN KESEHATAN RI DIREKTORAT JENDERAL BINA UPAYA KESEHATAN RUMAH SAKIT UMUM PUSAT SANGLAH DENPASAR

Jalan Diponegoro Denpasar Bali (80114)
Telepon. (0361) 227911-15, 225482, 223869, Faximile. (0361) 224206
Email : info@sanglahhospitalbali.com, Website : www.sanglahhospitalbali.com



SURAT IJIN

No: LB. 02.01./II.C5.D11h¹⁷⁴³¹/2015

Kami yang bertanda tangan dibawah ini :

N a m a : Drg. Triputro Nugroho, M.Kes
N I P : 195801191984101002
Pangkat/Gol : Pembina Utama Muda, IV/c
Jabatan : Direktur SDM & Pendidikan RSUP Sanglah Denpasar

Dengan ini menerangkan bahwa yang tersebut di bawah ini:

Nama : I Putu Budiarsana
Program Studi : School of Nursing of Adelaide Thu University

Diberikan ijin untuk melaksanakan penelitian tentang *"A Description Of Patient Flow In An Indonesia Emergency Departement Of A Major Teaching Hospital"*

Setelah melakukan penelitian yang bersangkutan diwajibkan mengumpulkan 1 (satu) soft copy hasil penelitian di Bag Diklit RSUP Sanglah Denpasar.

Demikian surat keterangan ini dibuat dengan sebenarnya untuk dipergunakan sebagaimana mestinya



Drg. Triputro Nugroho, M.Kes
NIP. 195801191984101002

Tembusan:

1. Yang bersangkutan.

Appendix 3 Letter of permit from Sanglah Hospital (English version)



No : DM.03.01/II.C5.D.12/ 8955 /2015

Denpasar, May 28th 2015

**TO WHOM IT MAY CONCERN
THE APPLICATION BY I PUTU BUDIARSANA TO CONDUCT RESEARCH AT
SANGLAH HOSPITAL, BALI**

This letter is to provide evidence that Mr Budiarsana, currently a student in the Master of Nursing (Emergency Nursing) at the University of Adelaide has received approval from Sanglah Hospital to conduct his research in the Emergency Department of Sanglah Hospital, Denpasar, Bali.

The research is entitled: *Description of patient flow in an Indonesian emergency department of a major teaching hospital.*

The research will be conducted over four months and will commence subject to receiving ethical approval from the University of Adelaide and subsequently, Udayana University, Bali.

Please contact to Education and Research Department at Sanglah Hospital if any further information is required. Ph. +62-361-244548, Email : rs_sanglahbali@yahoo.com .

Yours sincerely,
Director of Human Resources & Education

Drg.
NIP

PARTICIPANT INFORMATION SHEET

PROJECT TITLE: Description of patient flow in an Indonesian emergency department of a major teaching hospital

HUMAN RESEARCH ETHICS COMMITTEE APPROVAL NUMBER: H-2015-116

PRINCIPAL INVESTIGATOR: I PUTU BUDIARSANA, BSN

Dear Participant,

You are invited to participate in the research project described below.

What is the project about?

This project is about tracking patients' journey during their presentation in the Sanglah Hospital Emergency Department (SHED) and measuring the time required for every step of the journey.

Who is undertaking the project?

This project is being conducted by I Putu Budiarsana, BSN. This research will form the basis for the degree of Master of Nursing Science (Emergency Nursing) at the University of Adelaide under the supervision of Dr David Foley and Mr. Iain Everet (School of Nursing, Faculty of Health Science).

Why am I being invited to participate?

You are chosen as the study participants because you are aged above 18 years and below 65 and you have presented to the Sanglah Hospital Emergency Department.

How much time will the project take?

We will not ask you to do anything that will interfere with your treatment process. We only record the time required for every step of your journey in Sanglah Hospital Emergency Department in order to get a complete picture of your journey in this emergency department. All of the observation processes will be performed in the usual setting. The researchers will not photograph or record participants using audiotape, video / film, or any other electronic medium.

How much time will the project take?

You do not need to allocate any specific time for participation in this project. We will manually observe and record each patient journey from arrival to exit from ED. There is no reimbursement in this study.

Are there any risks associated with participating in this project?

There are no any foreseeable risks, side effects, emotional distress, discomfort, inconveniences or restriction. This study will be taken in your natural setting without any interference from the researchers except to observe your progress through the emergency department.

What are the benefits of the research project?

This information may give a new perspective for the Emergency Department management about the causes of SHED crowding. As a result, SHED can develop some strategies for improving the patient flow in the emergency department. We will not collect any personal information from health care providers, your family members or your medical records.

Can I withdraw from the project?

Participation in this project is completely voluntary. If you do not want your journey in Sanglah Hospital emergency Department to be observed, you can tell the nurse on duty at any time. Your choice withdraw from being observed will not affect the services that you get during your visit in SHED.

What will happen to my information?

Any data that could identify your personal information or relatives will not be included. You will be given a unique identification (ID) number that will keep you anonymous. The obtained data will be saved in a password-protected file and it will not contain your name or any identifying personal details. The file can only be accessed using a password and only by the researcher and his supervisor. If any identifying data is mistakenly collected this will be destroyed as quickly as possible. The obtained data in this research will be kept for 5 years after the data collection. The information from this study will be used and reported to the School of Nursing, University of Adelaide and Sanglah Hospital Emergency Department. Researchers intend to publish the study results in a journal to spread and enrich the nursing knowledge of patient flow in Emergency Departments. At no stage will any of your personal details be stored or reported on.

Who do I contact if I have questions about the project?

If there is any enquiry for this research, you can contact me at: I Putu Budiarsana, e-mail : budiarsana79@gmail.com, HP : +62-81353332252, or

What if I have a complaint or any concerns?

If you wish to make complaint, you can contact Mrs. Komang Ayu Mustriwati, SKep, MPH (Head of Education and Training Department of Sanglah Hospital), office : 0361244548, mobile : +6181338508988, e-mail : k_ayumustri@yahoo.com.

The study has been approved by the Human Research Ethics Committee at the University of Adelaide (H-2015-116). If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, and then you should consult the Principal Investigator. Contact the Human Research Ethics Committee's Secretariat on phone +61 8 8313 6028 or by email to hrec@adelaide.edu.au. If you wish to speak with an independent person regarding concerns or a complaint, the University's policy on research involving human participants, or your rights as a participant. Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

If I want to participate, what do I do?

If you want to participate, you can sign the consent form.

Yours sincerely,

INFORMED CONSENT VERBAL SCRIPT

I am I Putu Budiarsana, a postgraduate student at the University of Adelaide Australia.
OR, if being read by research assistant:

This research is being conducted by I Putu Budiarsana, a postgraduate student at the University of Adelaide Australia and I am his assistant. The research is being conducted with the help of Dr. David Foley and Mr. Ian Everret from School of Nursing , Faculty of Health Science the University of Adelaide, we are conducting research about tracking patients' journey during their time in the Sanglah Hospital Emergency Department (SHED) and we are measuring the time required for every step of the journey. You have been chosen as a possible study participant because you are aged above 18 years and below 65 and you have presented to the Sanglah Hospital Emergency Department.

I will not ask you to do any activities that will interfere with your treatment process. I will only record the time required for every step of your journey in Sanglah Hospital Emergency Department in order to get a complete picture of your journey in this emergency department. All of the observation process will be performed as you make your way through the emergency department in the usual way. I will not photograph or record you using audiotape, video / film, or any other electronic medium.

You do not need to allocate any specific time for participation in this project. I will manually observe and record your journey from arrival to exit from the ED. You will not be paid to be part of this study.

There are no any foreseeable risks, side effects, emotional distress, discomfort, inconveniences or restriction as part of this study. This study will be taken in your natural setting without any interference from the researcher.

This information should give a new perspective for the Emergency Department management about the causes of SHED crowding. As a result the SHED can develop some strategies for improving the patient flow in the emergency department.

Participation in this project is completely voluntary. If you do not want your journey in Sanglah Hospital emergency Department to be observed, you can tell the nurse on duty at any time. Your decision to withdraw from being observed will not affect the services that you get during your visit in SHED.

Any data that could identify you or your relatives will not be included. You will be given a unique identification number. The information associated with this ID number will be saved in a password-protected file. The file can only be accessed using a password

known only by the research supervisors and the researcher. The file will not contain any identifying information. If any identifying data is mistakenly collected this will be destroyed as quickly as possible. The obtained data in this research will be kept for 5 years after data collection. The information from this study will be used and reported to School of Nursing, University of Adelaide and Sanglah Hospital Emergency Department. Researchers intend to publish the study results in a journal to spread and enrich nursing knowledge regarding patient flow particularly in Emergency Department

Do you have any questions about the purpose or the process of this study?

Is there anything else you would like me to clarify?

If you would like to know more about this research, you can contact I Putu Budiarsana. Here is his phone number. (Hand them a slip of paper with the contact information written on it: I Putu Budiarsana, e-mail : budiarsana79@gmail.com, HP : +62-81353332252.

If you wish to make complaint, you can contact Komang Ayu Mustriwati, SKep, MPH (Head of Education and Training Department of Sanglah Hospital) in her office. Here is her phone number (Hand them a slip of paper with the contact information written on it: Komang Ayu Mustriwati, SKep, MPH, office : 0361244548, mobile : +6181338508988, e-mail : k_ayumustri@yahoo.com.

The study has been approved by the Human Research Ethics Committee at the University of Adelaide (H-2015-116). If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the Principal Investigator. You can contact the Human Research Ethics Committee's Secretariat on phone +61 8 8313 6028 or by email at hrec@adelaide.edu.au if you wish to speak with an independent person regarding concerns or a complaint, the University's policy on research involving human participants, or your rights as a participant. Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

If you would like to participate, you can sign the signed consent form.

Appendix 6 Consent form



Human Research Ethics Committee (HREC)

CONSENT FORM

1. I have read the attached information sheet and agree to take part in the following research project:

Title:	Description of patient flow in an Indonesian emergency department of a major teaching hospital
Ethics Approval Number:	H-2015-116

2. I have had the project, so far as it affects me, fully explained to my satisfaction by the research worker. My consent is given freely.
3. I have been given the opportunity to have a member of my family or a friend present while the project was explained to me.
4. Although I understand that the purpose of this research project is to improve the quality of medical care, it has also been explained that my involvement may not be of any benefit to me.
5. I have been informed that, while information gained during the study may be published, I will not be identified and my personal results will not be divulged.
6. I understand that I am free to withdraw from the project at any time and that this will not affect medical advice in the management of my health, now or in the future.
7. I am aware that I should keep a copy of this Consent Form, when completed, and the attached Information Sheet.

Participant to complete:

Name: _____ Signature: _____ Date: _____

I have described the nature of the research to _____

(print name of participant)

and in my opinion she/he understood the explanation.

Signature: _____ Position: _____ Date: _____

Appendix 7 Complaints form



The University of Adelaide

Human Research Ethics Committee (HREC)

This document is for people who are participants in a research project.

CONTACTS FOR INFORMATION ON PROJECT AND INDEPENDENT COMPLAINTS PROCEDURE

The following study has been reviewed and approved by the University of Adelaide Human Research Ethics Committee:

Project Title:	Description of patient flow in an Indonesian emergency department of a major teaching hospital.
Approval Number:	H-2015-116

The Human Research Ethics Committee monitors all the research projects which it has approved. The committee considers it important that people participating in approved projects have an independent and confidential reporting mechanism, which they can use if they have any worries or complaints about that research.

This research project will be conducted according to the NHMRC National Statement on Ethical Conduct in Human Research (see <http://www.nhmrc.gov.au/publications/synopses/e72syn.htm>)

1. If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the project co-ordinator:

Name:	Dr David Foley
Phone:	:+61 883131758
Name:	I Putu Budiarsana
Phone:	:+62-81353332252

2. If you wish to discuss with an independent person matters related to:

- making a complaint, or
- raising concerns on the conduct of the project, or
- the University policy on research involving human participants, or
- your rights as a participant,

contact the Human Research Ethics Committee's Secretariat on phone (08) 8313 6028 or by email to hrec@adelaide.edu.au

You also can contact Mrs. Komang Ayu Mustriwati, SK ep, MPH (Head of Education and Training Department of Sanglah Hospital), office : 0361244548, mobile : +6181338508988, e-mail : k_ayumustri@yahoo.com.

Appendix 8 Research poster

Description of Patients Flow in Sanglah Hospital Emergency Department

TO PATIENTS & CLIENTS OF SANGLAH HOSPITAL EMERGENCY DEPARTMENT

COLLECTION OF PATIENTS FLOW INFORMATION

This project is about tracking patients' journey during their presentation in Sanglah Hospital Emergency Department and measuring time required for every step of the journey. Population in this study are emergency patients in Sanglah Hospital Emergency Department in Denpasar, Indonesia.

This project is being conducted by I Putu Budiarsana., BSN. This research will form the basis for the degree of Master of Nursing Science (Emergency Nursing) at the University of Adelaide under the supervision of DR. David Foley and Mr. Ian Everret (School of Nursing, Faculty health Science).

You are chosen as the study participants because you are aged above 18 years and below 65 who presents to the Sanglah Hospital emergency department .

We will not ask you to do certain activities and interfere your treatment process. We only record time required for every step of your journey in sanglah Hospital Emergency Department in order to get a complete picture of your journey in Emergency Department. This information may give a new perspective for Emergency Department management about the causes of SHED crowding. As a result SHED can develop some strategies for improving the patient flow in SHED. We will not collected any personal information from health care providers, your family members or your medical records.

Participation in this project is completely voluntary. If you don't want your journey in Sanglah Hospital Emergency Department to be observed, you can tell the nurses on duty at any time. Your withdrawn to be observed will not affect the services that you get during your visit in SHED.

We will take all reasonable steps to make sure that the obtained data from this research is treated confidentially, is only used for the purposed described and is stored securely. The obtained data in this research will only accessible by the researcher, supervisors and data analyzer. The obtained data in this research will be kept for 5 years after the data collection. The information from this study will be used and reported to School of Nursing the University of Adelaide and Sanglah Hospital Emergency Department. Researchers also will publish the study results in a journal to spread and enrich nursing knowledge regarding patient flow particularly in Emergency Department.

The study has been approved by the Human Research Ethics Committee at the University of Adelaide (approval number H-2015-xxx). If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the Principal Investigator. Contact the Human Research Ethics Committee's Secretariat on phone +61 8 8313 6028 or by email to hrec@adelaide.edu.au. if you wish to speak with an independent person regarding concerns or a complaint, the University's policy on research involving human participants, or your rights as a participant. Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

IF YOU HAVE ANY QUESTION ABOUT THIS STUDY OR WOULD LIKE MORE INFORMATION
PLEASE CONTACT :

I Putu Budiarsana
E-mail : budiarsana79@gmail.com
Phone :
HP : +62-81353332252

Appendix 9 Data collection form

This form is the adapted version from Martin et al (2013)

Time:	Day :	Patient Number:
-------	-------	-----------------

1. Age Approximate

21-30	31-40	41-50	51-60	61- 70

M	F

2. Arrival type

Transfer	Self Referral	Clinic	Others
		

Exit unseen

Yes	No
Hour.....	M
Minute.....	

3. Arrival Mode

Private transport	Ambulance	Public Transport	Others
		



Arrival	Starthour.....minutes
---------	-----------------------------



Triage	Starthour.....minutes.....
--------	----------------------------------



Waiting room	Starthour.....minutes
--------------	-----------------------------



Collecting from waiting room	Enterhour.....minutes.....	Exithour.....minutes.....
------------------------------	----------------------------------	---------------------------------



4. Triage category

Category 1	Category 2	Category 3	Category 4	Category 5

5. Case :

Medical	Trauma	Cardiac	Neuro	Others

Data collector	
----------------	--

Appendix 9 Data collection form

Collected from waiting room Starthour.....minutes.....

Waiting in the ED cubicle Cubicle number Starthour.....minutes

Consultation

Decision to admit

First attending medical staff

Chief Registrar Doctorhour.....minutes.....

Registrar Nursehour.....minutes...

Medical student Bed request ...hour...minutes...

Others

Non ED consultant Request

More than one request Yes No

1st request made ...hour...minutes...

1st contact made...hour...minute...

Attendhour.....minutes

Imaging request

More than one request Yes No

1st request made ...hour...minutes...

Taken to Radiology...hour...minute...

Result.....hour.....minutes.....

Pathology request

More than one request Yes No

1st request made ...hour...minutes...

Blood taken...hour...minute...

Result.....hour.....minutes.....

Hospital transfer

Family agreement.....hours.....minutes

Bed Availability...hour...minutes...

OT

Family agreement.....hours.....minutes

Bed Availability...hour...minutes...

Admitted Ward :

Family agreement.....hours.....minutes

Bed Availability...hour...minutes...

Discharge

Administration.....hours.....minutes

Data collector

Boarding from ED...hour...minutes

Day of Week:

Appendix 10 Demographic Data

	Number	Percentage
Sex		
Male	60	62.5
Female	36	37.5
Triage level		
Category 2	4	4.1
Category 3	64	66.7
Category 4	28	29.2
Approximate age		
19-30	20	20.8
31-40	21	21.9
41-50	19	19.8
51-60	30	31.2
61-64	6	6.2
Arrival mode		
Ambulance	34	35.4
Private Transport	60	62.5
Public Transport	2	2.1
Arrival type		
Self-referral	59	61.5
Transfer	36	37.5
Others	1	1
Case Type		
Medical	47	48.9
Trauma	37	38.5
Neuro	9	9.4
Others	3	3.1
Cubicle area		
Fast Track	28	29.2
Medical area	38	39.6
Surgical Area	30	31.2
Decision to admit		
<10 minute	2	2.1
10-30 minute	11	11.5
31-60 minute	15	15.6
61-120 minute	11	11.5
>120 minute	12	12.5
No admission	45	46.9
Waiting bed availability		
<8 hours	40	41.7
8-16 hours	7	7.3
17-24 hours	4	4.2
Non Admission	45	46.9

	Number	Percentage
Discharge/admitted		
Admitted	49	51
Discharge	47	49
Consul to other specialisation		
Yes	30	31.2
No	66	68.8
Imaging request		
Yes	41	42.7
No	55	57.3
Pathology request		
Yes	55	57.3
No	41	42.7
Nursing		
Yes	66	68.8
No	30	31.2

Appendix 11 The mean time for every stage of patient's journey in the SHED

Variables	Number	Mean	Standard Deviation
Admitted			
Arrive-triage	49	0.05	±0.04
Triage- ED bed	49	0.82	±0.75
ED bed-doctor	49	1.86	±1.49
Doctor-decision to admit	49	97.35	±87
Decision to admit-bed available	49	324.01	±315.57
Bed available-Exit	49	137.58	±122.31
Doctor-Exit	49	578.96	±368.17
Arrive-Exit	49	581.88	±367.96
Discharge			
Arrive-triage	47	0.11	±0.611
Triage- ED bed	47	0.46	±1.13
ED bed-doctor	47	0.37	±1.02
Doctor-Exit	47	151.48	±81.49
Arrive-Exit	47	152.47	±81.22
Pathology request	55	147.25	±51.89
Imaging	42	49.52	±34.61
Consultation	32	25.56	±30.23

Appendix 12 Comparison of the mean length of stay

	Arrive-triage (minute)	Triage-waiting room (minute)	Waiting room-cubicle (minute)	Cubicle-doctor (minute)	Doctor-decision to admit (minute)	Decision to admit-bed available (minute)	Bed available-Exit (minute)	Doctor-Exit (minute)	Arrive-Exit (minute)
Sex									
Male	0.08	0.00	0.71	0.73	61.73	172.35	66.45	393.33	394.98
Female	0.08	0.00	0.58	1.88	35.02	171.77	84.16	354.00	356.61
Approximate age									
19-30	0.30	0.00	0.30	0.90	57.95	142.75	88.90	370.20	371.80
31-40	0.00	0.00	1.04	0.61	31.28	55.47	55.47	352.33	354.33
41-50	0.05	0.00	0.68	0.94	73.05	73.31	73.31	468.31	470.00
51-60	0.03	0.00	0.56	1.50	55.90	83.33	83.33	361.70	363.80
61-64	0.00	0.00	1.00	3.00	14.00	30.16	30.16	298.66	302.67
Arrival type									
Self-referral	0.11	0.00	0.62	1.11	39.27	79.76	65.76	268.67	270.66
Transfer	0.02	0.00	0.75	1.25	73.55	87.13	87.13	563.44	565.53
Others	0.00	0.00	0.66	1.00	0.00	0.00	0.00	208.00	380.59
Arrival Mode									
Ambulance	0.00	0.00	0.73	1.35	74.76	317.20	96.82	565.44	567.53
Private Transport	0.13	0.00	0.45	1.03	39.96	78.31	55.83	261.30	263.07
Public transport	0.00	0.00	6.00	2.00	12.50	520.50	187.50	720.50	728.50
Triage category									
Category 1	0.00	0.00	1.00	0.00	168.00	255.00	30.00	453.00	454.00
Category 2	0.00	0.00	3.00	2.00	30.33	478.33	140.00	648.66	653.67
Category 3	0.03	0.03	0.76	1.51	63.89	222.51	92.76	451.78	454.14
Category 4	0.21	0.21	0.17	0.32	22.03	21.21	22.50	179.67	180.61

	Arrive-triage (minute)	Triage-waiting room (minute)	Waiting room-cubicle (minute)	Cubicle-doctor (minute)	Doctor-decision to admit (minute)	Decision to admit-bed available (minute)	Bed available-Exit (minute)	Doctor-Exit (minute)	Arrive-Exit (minute)
Case Type									
Medical	0.17	0.00	0.76	1.73	40.19	188.60	101.00	406.56	409.41
Trauma	0.00	0.00	0.64	0.64	61.78	159.18	38.81	347.83	349.16
Cardiac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	77.00	77.00
Neuro	0.00	0.00	0.44	0.88	92.22	217.66	103.88	460.33	461.67
Others	0.00	0.00	0.33	0.00	0.00	0.00	0.00	184.00	184.33
Decision admit									
<10 minute	0.00	0.00	0.00	1.50	8.50	548.50	197.50	754.50	760.00
10-30 minute	0.00	0.00	0.00	1.63	17.09	347.00	118.00	587.45	590.55
31-60 minute	0.06	0.00	0.00	2.53	42.00	303.00	158.26	516.13	519.53
61-120 minute	0.18	0.00	0.00	2.27	87.27	153.18	123.18	364.54	367.73
>120 minute	0.00	0.00	0.00	0.91	264.16	448.41	132.91	817.00	818.50
No admission	0.11	0.00	0.00	0.37	0.00	0.00	0.00	151.48	152.47
Bed availability									
<8 hours	0.07	0.00	0.65	1.87	81.75	177.32	160.92	444.72	447.52
8-16 hours	0.00	0.00	2.28	1.85	119.85	680.85	42.28	847.42	851.57
17-24 hours	0.00	0.00	0.00	1.75	214.00	1166.50	71.00	1451.50	1453.50
Non Admission	0.11	0.00	0.48	0.37	0.00	0.00	0.00	151.48	152.47
Admission									
Yes	0.05	0.00	0.82	1.86	97.35	324.01	137.58	578.96	581.88
No	0.11	0.00	0.46	0.37	0.00	0.00	0.00	151.48	152.47
Consul to other specialisation									
Yes	0.03	0.00	0.60	1.63	90.13	262.26	118.36	510.96	513.23
No	0.10	0.00	0.69	0.95	34.25	131.16	52.51	318.40	320.30

	Arrive-triage (minute)	Triage-waiting room (minute)	Waiting room-cubicle (minute)	Cubicle-doctor (minute)	Doctor-decision to admit (minute)	Decision to admit-bed available (minute)	Bed available-Exit (minute)	Doctor-Exit (minute)	Arrive-Exit (minute)
Imaging request									
Yes	0.02	0.00	0.87	1.34	74.70	268.21	104.21	502.73	505.00
No	0.12	0.00	0.50	1.03	34.58	100.50	49.89	286.03	287.85
Pathology request									
Yes	0.054	0.00	0.81	1.78	62.54	261.50	119.49	504.87	507.56
No	0.12	0.00	0.46	0.34	37.19	52.24	10.85	209.17	210.27
Nursing									
Yes									
No									

Appendix 13 The result of one way ANOVA and t-test

	Mean(log)of LOS	P value
Sex		
Male	2.4533±.36104	0.405
Female	2.3882±.38314	
Triage level		
Category 2	2.7630±.14124	0.00
Category 3	2.5166±.36464	
Category 4	2.1807±.25992	
Approximate age		
19-30	2.4192±.38123	0.903
31-40	2.3685±.38638	
41-50	2.4725±.45012	
51-60	2.4570±.31897	
61-64	2.3932±.29453	
Arrival mode		
Ambulance	2.6472±.32339	0.00
Private Transport	2.2908±.32760	
Public Transport	2.8586±.08184	
Arrival type		
Self-referral	2.2957±.33462	0.00
Transfer	2.6508±.31535	
Case Type		
Medical	2.4962±.32884	0.042
Trauma	2.3135±.42146	
Neuro	2.6102±.23082	
Others	2.2528±.13316	
Cubicle area		
Fast Track	2.2109±.21891	0.00
Medical area	2.6629±.22245	
Surgical Area	2.3359±.45966	
Decision to admit		
<10 minute	2.8792±.05266	0.00
10-30 minute	2.7450±.15286	
31-60 minute	2.6625±.22091	
61-120 minute	2.5323±.18185	
>120 minute	2.8091±.31968	
No admission	2.1270±.22727	
Waiting bed availability		
<8 hours	2.6124±.18515	0.00
8-16 hours	2.9042±.15478	
17-24 hours	3.1573±.07792	
Non Admission	2.1270±.22727	