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Abstract

We performed a hospital-based survey of time to theatre, between arrival at the emergency room for acute surgery cases and surgery intervention, in nine subdepartments of surgery in Sanglah Hospital. The objective of this study was to obtain the determinant factors that affect the time to theatre of acute surgery cases in Sanglah Hospital. There were 321 acute surgery cases during July–October 2016. The majority of them were of ≤65 years old (90.7%) and male cases (69.8%). There were 67% patients from outside of Denpasar city. The predominant cases were in traumatology subdepartment (47.7%), neurosurgery (24.9%), and orthopedic (11.8%). The average time to theatre was 649.83 min, and the surgery duration was 156.38 min. An analysis of the independent *t*-test of time to theatre showed a significant difference in age category ($p = 0.042$); the analysis showed that the time to theatre that differed in categories of gender was significant ($p = 0.006$). The time to theatre was significantly different if managed by traumatology subdepartment than others ($p = 0.006$) and in the type of surgery ($p = 0.001$) performed. This research concluded that the time to theatre of acute surgery was affected by the age of the patient, gender of patient, subdepartment category, and type of surgery. One factor that plays a key role in the efficiency of the acute surgical time is to identify the patients who require emergency or urgent surgery.

Keywords: Time to theatre; Acute surgery; Determinant factors

1. INTRODUCTION

The main principle of acute surgery service is the efficient operating room ability that is particularly designed for acute surgery [1,2]. The combined factors of declining resources are availability and increase of service needs, which resulted in emergency room (ER) under pressure [3]. The mismatch of the resources requirement is estimated to cause delays in the ER setting, unavailability or insufficient bedding for patients, and decreased access to emergency operating room. If the problems continue in the emergency services, the estimated impact would be additional duration of hospitalization as well as increase in complications owing to delays in surgery [2,4,5]. The level of efficiency of the emergency services is reflected by the appropriate clinical assessment and prioritization of cases in surgical patients who had experienced an acute illness [3,6,7].

The management of acute surgery underwent major changes over the last few years. There are many healthcare centers utilizing the acute surgical guidelines in daily practice as an effort to improve the efficiency of treatment and outcomes of patients who require acute surgery. General surgery's patient deaths by up to 90% are estimated to occur in emergency setting [3]. There were studies that showed an increase in the death rate by 2–4 fold in patients with the same type of surgery in the emergency setting than elective [1,2,4,6,8]. Lately, the needs for large hospital facilities are increasing.

Studies on guidelines of emergency services are now trying to determine time to theatre (TTT) eligibility for the acute surgical services. The TTT is a major factor for assessing the efficiency of the emergency operating theatre in a hospital [1-3,8]. The reports of O'Leary *et al.*, about the impact of the delay on the TTT cost analysis on one tertiary referral hospital from 7041 acute surgery patients, which is 34% of this amount had to wait more than 24 h of surgery. This condition had resulted in an estimated loss of 3.5 million Euros per year [3]. Investments for improvement of acute surgery services are deemed essential to prevent TTT delays. There is a tendency of TTT mean difference in patients in each subdepartment surgery in the subgroup analysis [3,9].

In our institution, before the national healthcare system began in Indonesia (2015), the patient should purchase or pay for the necessary medicines and instruments for emergency and urgent surgery. The patient services were believed to be put on

hold. Moreover, the time the patient came to the ER until the surgery was performed, was believed to be very late or delayed. According to the current operational standards of our hospital procedures, it is expected that within less than 6 h patients should be treated properly. Hence, the TTT slowdown affected the mortality and morbidity of patients in the past. Unfortunately, no such TTT evaluation has ever been conducted. Consequently, there is no data as a benchmark for the progress of health services, particularly acute surgery at our institution. Based on the description above, we were compelled to perform this research on the factors that correlate to time to theatre in acute surgery in Sanglah Hospital.

2. MATERIALS AND METHODS

This study was an observational study with cross-sectional analysis. Data documentation, observations, and measurements were performed. Meanwhile, independent and dependent variables were examined. This research was conducted in the ER of Sanglah Hospital. The population target was all of the patients who had undergone acute surgery. The actual population was all of the patients who underwent acute surgery in ER of Sanglah Hospital, from July 2016 to October 2016. Inclusions criteria were patients who underwent acute surgery in Sanglah Hospital during the period shown and never been moved from ER before surgery. This study was approved by ethics committees of Sanglah Hospital.

The dependent variables were the length of stay, TTT, induction anesthesia–start incision time, induction anesthesia–surgery termination time, surgery termination–anesthesia termination time, and duration of acute surgery. The independent variables were the age group, gender, Surgery's subdepartment, and type of surgery. The data documentation was performed using the data collection sheet by the medical records. The data were analyzed descriptively and statistically using SPSS 20.0 for Macintosh. The limit of significance was $p \leq 0.05$ with 95% confidence interval. The chi-square test was used to assess the association of two categorical variables with 2×2 table. The *t*-test was used to evaluate the average difference of nominal data.

3. RESULTS

From July 1, 2016 to October 31, 2016, there were 321 patients admitted to the ER in Sanglah Hospital. The demographics and characteristics of the variables are shown in Table 1. Of these, 321 patients 90.7% were aged ≤65 years. The gender of the patients was men by 224 (69.89%). Moreover, they were mostly patients from traumatology subdepartment (47.7%) followed by neurosurgery (24.9%) and orthopedics (11.8%), while no patients from oncology.

The urgent surgery type dominated with 171 cases (53.3%) and emergency with 150 cases. The average TTT was 649.8 min, and most of the operations (220 cases = 68.5%) were faster than the average. The mean of operating time was 156.38 min and 201 cases (62.9%) in fact longer than the average. General anesthesia was recorded in 219 cases (68.2%), and the highest type of wound was clean, which amounted to 40.5%. The mean (including anesthesia) duration of surgery was for 156.38 ± 90.85 min (Table 2). The origin of patients (106 cases (33%)) was from Denpasar City, followed by Gianyar, Bangli, Negara, and Badung with 36, 35, 32, and 29%, respectively. The lowest percentage was from Buleleng (6 patients) and outside Bali island amounting to 22 patients (6.9%). The length of stay (LOS) was mostly more than 2 weeks, that is, 179 patients (55.8%).

3.1. Time to theatre based on age

The analysis of independent *t*-test showed significantly different age categories ($p = 0.042$), which is shown in Table 3. The type of surgery compared between age (≤65 years old and >65 years old) was different significantly ($p = 0.007$; OR = 0.341). The duration (long and short) of surgery, which was compared between age (≤65 years old and >65 years old), was different significantly ($p = 0.038$; OR = 0.420). Most types of surgery were emergency (86%) or urgent (94.7%) that have been performed on patients aged 65 years old and below. Both of these categories differ significantly ($p = 0.006$).

Most acute surgery with a total duration of short (87.6%) and long (94.4%) operations have been performed on the research subjects aged 65 years and under. The age category and the total duration of the operation has a significant relationship ($p = 0.028$) with OR = 0.420. Most of the short duration of acute surgery (87.5%) and long form (94.1%) were performed on the research subjects aged 65 years and below. The mean duration of surgery in subjects aged ≤65 years old was longer than that in subjects aged over 65 years (OR = 0.438, $p = 0.032$).

3.2. Time to theatre based on gender

The independent *t*-test analysis showed that the average time difference categories of gender was significant ($p = 0.006$). Most subjects who used general anesthesia ($n = 219$), 69.8% were male. The average time surgery termination–anesthesia termination for 157 men was 10.66 ± 8.08 min; whereas, for 62 women was 15.81 ± 19.55 min. The types of surgery (emergency and urgent) compared between male and female (gender) were different significantly (OR = 1.553, $p = 0.048$).

Table 1: Demographic data and characteristics of the study subjects.

Variable	Numbers	Percentage (%)
Age		
≤65	291	90.7
>65	30	9.3
Sex		
Male	224	69.8
Female	97	30.2
Subdepartments		
Neurosurgery	80	24.9
Thoracic-CV	28	8.7
Digestive	6	1.9
Traumatology	153	47.7
Plastic	4	1.2
Urology	5	1.6
Orthopedic	38	11.8
Pediatric	7	2.2
Oncology	0	0
Type of surgery		
Emergency	150	46.7
Urgent	171	53.3
Time to theatre (x = 649.83 min)		
Faster TTT	220	68.5
Longer TTT	101	31.5
Surgery duration (x = 156.38 min)		
Short	119	37.1
Long	201	62.9
Anesthesia		
General	213	66.4
Local	108	33.6
Wound type		
Clean	104	32.4
Clean contaminated	130	40.5
Contaminated	65	20.2
Dirty	22	6.9
City origin		
Denpasar	106	33
Badung	29	9
Tabanan	21	6.5
Gianyar	36	11.2
Klungkung	14	4.4
Karangasem	20	6.2
Buleleng	6	1.9
Negara	32	10
Bangli	35	10.9
Other islands	22	6.9

3.3. Time to theatre based on subdepartment

Most cases (115 cases (76.7%)) of subdepartment of traumatology were urgent surgery; whereas, most of the other were subdepartment (non-traumatology) cases (118 cases (69%)). The chi-square analysis showed a significant difference (p = 0.000; OR = 0.137). The mean length of stay of research subjects of the subdepartment of traumatology (16.58 ± 17.25 days) was shorter than non-traumatology (23.21 ± 24.76 days). An analysis of independent t-test showed that the surgical subdepartment differed significantly (p = 0.006) in terms of length of stay. Most of the study subjects were derived from the subdepartment of traumatology (61.4%) and non-traumatology (75%) had the same TTT shorter than average. An analysis of data categories with TTT subdepartment surgery using chi-square showed a significant difference (p = 0.006; OR = 0.531).

3.4. Time to theatre based on type of surgery

Most of the study subjects who underwent emergency (78%) and urgent (60.2%) surgery had a TTT shorter than the average. An analysis type of surgery with TTT using chi-square showed a significant difference (p = 0.000; OR = 2.341).

Table 2: Time to theatre characteristics in emergency room in Sanglah Hospital.

Variables	*n*	Mean ± SD	Minimum	Maximum
Age (year old)	321	35.72 ± 21.22	0	93
Length of stay (day)	321	20.05 ± 21.73	1	98
Time to theatre (min)	321	649.83 ± 800.42	7	6061
Induction anesthesia–start incision (min)	321	26.6 ± 28.89	0	450
Induction anesthesia–Surgery termination (min)	321	119.81 ± 77.80	8	510
Surgery termination–Anesthesia termination	219	12.12 ± 12.609	3	130
Surgery duration (min)	321	156.38 ± 90.85	15	585

Table 3: Time to theatre category versus variable of study subjects.

Time to theatre category	Variable	Mean (min)	Standard deviation (min)	Minimum (min)	Maximum (min)	*p*
Time to theatre	Emergency	503.67	638.79	7.00	5.597.00	0.002
	Urgent	778.03	901.63	50.00	6.061.00	
Induction anesthesia–surgery termination	≤65 years old	122.65	77.55	8.00	510.00	0.042
	>65 years old	92.33	76.04	15.00	335.00	
Surgery termination–anesthesia termination	Male	10.66	8.08	3.00	55.00	0.006
	Female	15.81	19.55	5.00	130.00	
	Emergency	14.01	15.32	3.00	130.00	0.020
	Urgent	10.07	8.37	5.00	55.00	

4. DISCUSSION

This study is the first hospital-based study in terms of time to theatre of acute surgery in Sanglah Hospital. The strength of this study was using all patients that distributed among Surgery's subdepartment in Sanglah Hospital in the study period shown. The TTT is a key indicator of the efficiency of operating room time in acute surgical cases. The mean of TTT patients who required acute surgery was approximately 10 h (649.83 min). In 2014, O'Leary reported in Ireland that the average of TTT was 26 h and 2 min at 7041 acute surgery [3]. The TTT of acute surgery in tertiary hospital in Nepal also showed a longer record time of 717 min [10]. Overcrowding in ER that occurs in situations of acute surgical needs exceeded the resources of doctors, nurses to provide resuscitation, diagnosis, and treatment quickly, and quality control as well [6,9]. Previous studies showed that delays cause prolonged waiting time of operation, resulting in increased morbidity and mortality. Delays were often caused by a mismatch between supply of facilities and surgery service needs [2]. As the population is becoming older, increasing demands and complexity of the case requires time on the efficiency of health services, particularly acute surgery [3]. These findings indicate that the average TTT at our institution is faster than previous reports, owing to the ability of traumatology surgeon at our institution to diagnose rapidly after resuscitation and other investigations, and categorize cases as emergency cases. In our institution, a trauma surgeon is on duty for 24 h in turn. Consequently, there is always a trauma surgeon consultant who is able to make quick decisions. In addition, there are three special emergency cases in operating rooms in our institution that facilitate emergency cases' surgery services.

The mean of surgery preparation in Sanglah Hospital was 26.6 ± 28.89 min, which is faster than that in Nepal that reached 75 min [10]. The mean of surgery duration of acute surgery in Sanglah Hospital was 2 h; the fastest was 15 min, meanwhile the longest was 585 min. The delay of acute surgery in Nepal owing to surgery waiting queue, the special precaution before the surgery, waiting for the available blood transfusion, consultation to other departments, delays owing to the informed consent of the patient and/or patient's family, delay of tools and/or implant preparation, and delays owing to changing the shift or duty time of the nurses [10]. The preparation for operations at our institution is considerably faster owing to the availability of integrated ER diagnostic laboratory and radiology, including line of consultation to other departments that are available for 24 h in the ER, and including internal medicine and anesthesia specialists who are on call 24 h a day.

In 2011, Akinbami showed that acute surgery at the general surgery department were known to have higher morbidity in elderly patients [5]. The mean age of the oldest was found in the subdepartment of digestive surgery. The age category of patients had no significant relationship with duration of surgery with general anesthesia ($p = 0.435$). The mean of TTT on

research subjects aged ≤65 years was 10 h and 24 min, which was lower than aged over 65 years (15 h). This was consistent with the research of O'Leary *et al.* [3]. Most of the study subjects were male gender (69.8%). The average time of weaning of 157 men was 10.66 ± 8.08 min; whereas, in 62 women, the average time of weaning was 15.81 ± 19.55 min. A *t*-test analysis showed the significant correlation between the gender ($p = 0.006$) and surgery termination–anesthesia. Most types of surgery that were emergency (74.7%) and urgent (65.5%) were performed on men. The second category is related significantly to the chi-square analysis ($p = 0.048$) with OR = 1.553. In 2011, Akinbami showed that acute surgery in the general surgery were known to have higher morbidity in male patients [5]. In our study, the chi-square test showed that the gender has no significant relationship with TTT, induction anesthesia–surgery termination time, and surgery duration.

Most cases of subdepartment of traumatology (76.7%) were urgent surgery; whereas, most of others (69%) were emergency. Most of the study subjects were derived from the subdepartment of trauma surgery (61.4%), and others (75%) had a shorter TTT than average but showed no significant difference ($p = 0.006$). The mean TTT of acute abdominal surgery in Zaria, Nigeria was 22.3 h [2]. The duration was considerably longer than the TTT in the subdepartment of digestive surgery in Sanglah Hospital (666.17 min). The constraints in preparing for the surgery of acute abdominal disease in Nigeria was the condition of patients who generally had variety of bad complications, and the purpose of the purchase of certain medical instruments or materials before starting the operation. Most of the causes of abdominal operation delays in Nigeria for more than 6 h are due to financial problem, the results of late admission at night, no available blood cross match, full operating room, surgery, and personal problems on others. A long waiting time increases patient morbidity. There was 81.6% of acute surgery in Nigeria that has TTT over 6 h [2]. Recommendations in our hospital to prepare the patient for surgery, include detailed history, physical examination was good, leading further investigation, and resuscitation that does not exceed 6 h. The mean of acute TTT in the subdepartment of plastic surgery in Sanglah Hospital was 253 min. The TTT was faster than the section of plastic surgery in a hospital in the UK, which reached 15.7 h [5]. Calgary city in Canada has implemented the principles of the American Colleague of Surgeons (ACS) in both trauma and non-trauma patients. The median TTT in non-trauma patients in Calgary was 509 min [3]. In 2013, Geskey showed that the application guidelines, which set the target time for doctor including operating decisions, were able to accelerate the response of any staff involved in emergency departments in almost all subdepartment of Surgery [11]. In our hospital, acceleration was expected owing to reduced conflict, because the new protocol of surgery was clear and has targeted a specific time. One factor that plays a key role in the efficiency of the acute surgical time is to identify patients who require emergent or urgent surgery.

Most of the study subjects who underwent emergency surgery (78%) and nonurgent (60.2%) had a shorter TTT. An analysis of the type of surgery with TTT showed a significant difference (OR = 2.341; $p = 0.000$). Recommendations that were suggested in 2015 by Elizabeth in response to the operating room utilization, overtime, and cancellation of operations that occur in educational hospital were to provide a special operating room for emergency cases [12]. Several other studies showed that other factors were expected to play a role in the delay of acute surgery, such as the number of consultations to other departments and surgery in working hours [4]. Acute surgical access was difficult during working hours owing to the high demand for the current operating days and hours of work beyond working hours [3]. Our institution has provided three special operating rooms for emergency cases. We reduced the number of consultations to other departments that have also been on standby for 24 h, and we provide full-time 24 h surgeons to reduce the queue beyond working hours.

5. CONCLUSION

Time to theatre of acute surgery in Sanglah Hospital; based on the length of stay, TTT, induction anesthesia–start incision time, induction anesthesia–surgery termination time, surgery termination–anesthesia termination time, and duration of acute surgery; was affected by factors such as age, gender, subdepartment category, and type of surgery. In this study, it can be concluded that the more effective handling of patients or TTTs in our institution is due to the availability of definite funding for surgery in the form of national health insurance; integrated laboratory inspection system, radiology, and other investigation in the emergency room; availability of a 24-h consultation service to shorten the waiting duration of consultation in an educational hospital; and the availability of 24-h emergency operation room including its surgeon.

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Author Contributions
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Conflict of Interest
The authors declare that there is no conflict of interest regarding the publication of this paper.

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