

# Evaluation of door to operation theatre time following activation of trauma team

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## ABSTRACT

**Introduction:** This study evaluates factors that influence door to operation theatre (OT) time in a tertiary referral centre following activation of trauma team. Specific factors observed in this study were association of the injury severity score (ISS), activation of trauma team and the number of referred specialty to door to operation theatre time.

**Methods:** Retrospective chart review that evaluates all trauma patients which required immediate operative intervention from January 2011 to December 2015. Trauma patients were selected from the resuscitation log book and data were collected by chart review of selected patients.

**Results:** Only 5 out of 279 patients (1.8%) achieved optimal door to OT time. (<60 minutes) Mean door to OT time was 299.27 minutes (95% CI: 280.52, 318.52). Trauma team activation has shown significant improvement in door to OT time ( $p=0.047$ ). Time of multiple team referrals ( $p=0.023$ ) and time of operative decision ( $p<0.001$ ) both had significant impact on door to OT time. Other factors included were demographics, ISS score, Glasgow Coma Scale (GCS), mechanism of injury and systolic blood pressure on arrival all which showed no significance.

**Conclusion:** Trauma team activation in a tertiary centre improved trauma care by reducing door to OT time to less than 60 minutes. Implementation of an effective trauma team activation system in all hospitals throughout Malaysia is recommended.

## KEY WORDS:

*Injury severity score, trauma, Glasgow coma scale, Malaysia*

## INTRODUCTION

Compartmentalisation of surgical and trauma specialties can result in delay of definitive operative intervention in trauma patients. Time and effort taken to make multiple referrals to different surgical units in managing trauma patient often results in missed injuries, inefficiency, repetition of effort and suboptimal care.<sup>1</sup> This is notorious in large tertiary centres where most specialised sub-units are available. Since 2009, a concerted team effort was established in Universiti Kebangsaan Malaysia Medical Centre (UKMMC) towards developing trauma team system activation. In this system, all surgical and anaesthesiology specialties involved in managing trauma can be activated by one call from the

Emergency Department Communication Centre (EDCC). Trauma team takes full advantage of existing resources and constitute a valid approach to the early management of the severely injured patient.<sup>2</sup>

This study retrospectively evaluates efficacy of trauma team activation system in reducing the door to OT time. It will also determine whether international recommended door to OT time of less than one hour is achieved. Other factors studied were mechanism of injury, physiologic variables, initial Glasgow Coma Score (GCS), and injury severity score (ISS). ISS, which was first developed by Baker et al., supplies the anatomic index for Trauma Score and Injury Severity Score (TRISS) which has been a standard tool for three decades.<sup>3</sup> Factors that significantly lengthen door to OT time can be ascertained and would provide a platform for policymakers for future improvements in trauma care.

The general objective is to determine whether there is an improvement in door to OT time following trauma team activation. The specific objectives were to determine the mean of door to OT time and to ascertain whether this is within accepted standard. Association of door to OT time with other factors such as injury severity score (ISS), demographics and multiple referrals were assessed.

## MATERIALS AND METHODS

The figure below depicts the local policy in PPUKM concerning trauma team activation. As depicted the following characteristic of patient will warrant trauma team activation.

This is a retrospective chart review. All trauma victims that require immediate operative intervention from January to December 2011 were included in this study. Trauma cases which died in the emergency department or patients that is dead on arrival and referred cases from other hospitals were excluded.

### *Method of Sample Collection*

Data were collected and analysed retrospectively using ED registry. Polytrauma patients were selected from the resuscitation log book. Patient's demographic data, time of arrival to ED, mechanism of injury, Glasgow Coma Scale (GCS) on arrival, systolic BP on arrival, and time to operation theatre was retrieved from the ED clerking sheet. The Injury Severity Score (ISS) was calculated based on the injury sustained.

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### Sample Size

Henderson KI et al., has shown the median time from emergency call to operation was 127 minutes (140min for blunt and 86min for penetrating injuries).<sup>5</sup> Door to OT time was 54 minutes (56min for blunt and 37min for penetrating injuries). To examine the time of arrival in the ED PPUKM to the operation theatre, the estimated sample size is calculated using the Kish et al., formula which resulted in 185 as the sample size.

### Statistic Methods

Statistical analysis was carried out using the software SPSS 21.0 IBM (SPSS Inc, Chicago, IL, USA). Point estimation from the general population mean with a lower and upper bound of 95% confidence interval was calculated using SPSS. Mann-Whitney U test was used for non-normal distribution or non-parametric data. Student's t test was used for normally distributed continuous variables. Chi-square analysis was used for categorical data. Fisher's Exact test was used for a sample less than five in a grid of crosstab. The results were compared between groups with trauma team activation and group without trauma team activation. Difference is considered significant if the p-value is <0.05 with a confidence interval of 95%.

## RESULTS

During the study period from January 2011 to December 2015, a total of 360 trauma patients that needed immediate operative intervention were identified. Out of 360 patients, 81 were excluded due to missing case notes, scrapped case notes, admission to ward or non-trauma cases, leaving 279 samples for data analysis.

The mean age of the patients in this study was 34.62 ( $\pm 15.7$ SD) years with predominantly male 83.2% (n=232). There were 101 Malay (36.2%), 87 Chinese (31.2%), 55 other ethnicities and 36 Indian (12.9%). Majority trauma patients arrived in ED with the systolic BP>90mmHg and GCS of 13-15. Blunt injury was the main mechanism of injury, which contributed 79.9% (n=223) with the rest being penetrating injury. The details of the patient characteristics were shown in the Table I.

Only 5 out of 279 cases (1.8%) achieved the goal of less than 60 minutes door to OT time (Table II). The mean time for the trauma patients to go to OT was 299.27 (95%CI: 318.52 to 280.03) minutes. The maximum time was 1027 minutes and minimum 43 minutes. This did not take account the pre-arrival time, or time from injury to OT which in previous literature included in the golden hour.

### Trauma Team Activation

A total of 95 out of 279 polytrauma cases (34.1%) had trauma team activated; 82 cases (86.3%) out of the 95 cases were blunt trauma and 90 (94.7%) of the cases had ISS more than 15. Among the 95 cases that had trauma team activated, 53 cases had GCS of 13-15, 15 cases with the GCS of 9-12 and 27 cases with the GCS <8. Twenty-eight cases had systolic BP<90mmHg on arrival.

Table I: Patient Characteristics

	N = 279 Mean Point Estimation
<b>Age, mean (years)</b>	34.62
<b>Gender (%)</b>	
Male	232 (83.2%)
Female	47 (16.8%)
<b>Race (%)</b>	
Malay	101 (36.2%)
Chinese	87 (31.2%)
Indian	36 (12.9%)
Others	55 (19.7%)
<b>Mechanism of injury (%)</b>	
Blunt trauma	223 (79.9%)
Penetrating trauma	56 (20.1%)
<b>GCS (%)</b>	
13-15	178 (63.8%)
9-12	38 (13.6%)
≤8	63 (22.6%)
<b>Systolic BP on arrival (%)</b>	
>90 mmHg	235 (84.2%)
≤90 mmHg	44 (15.8%)
<b>Trauma Activation</b>	
Yes	95 (34.1%)
No	184 (65.9%)
<b>ISS</b>	
<9	16 (5.7%)
9-15	27 (9.7%)
>15	236 (84.6%)

Only five cases achieved ED to OT time of less than 60 minutes. Out of these five cases, four cases had trauma team activated. The characteristics of cases that had trauma team activated was summarised on Table II. Using Fisher exact test based on 95% confidence interval, it was calculated that there was a significant improvement in door to OT time following trauma team activation (p=0.047)

### Mortality

Fifty out of 279 patients died. Twelve patients (4.3%) died within 24 hours, 32 patients (11.5%) died between 24 hours to one month and six patients (2.2%) died after one month.

## DISCUSSION

Results have shown statistically significant difference between the age group and door to operation theatre time. Nevertheless, gender and race have did not show any significance to the main result. Trauma patients with systolic BP<90mmHg on arrival have a significantly shorter time to operating theatre. It was also shown that trauma team activation has shortened the time from ED arrival to operation theatre. Gender and mechanism of injury have shown no statistical significance to time from ED arrival to operating theatre. Number of team referred has no significant relationship to the ED arrival to operating theatre time. However, when using a linear multivariate analysis, time to OT as an independent factor, time to multiple team referrals and time of decision for OT had a significant influence on the door to OT time.

Table II: Comparison of Target-Achieved and Target-Not-Achieved Group Characteristics

Characteristic	Target Achieved (%)	Target-Not-Achieved (%)	p-Value
Total Number	5 (1.8)	274 (98.2)	
Age			
0-9	0 (0)	5 (1.8)	0.013
10-19	0 (0)	31 (11.1)	
20-29	2 (0.7)	93 (33.3)	
30-39	0 (0)	57 (20.4)	
40-49	1 (0.4)	41 (14.7)	
50-59	0 (0)	19 (6.8)	
60-69	0 (0)	18 (6.5)	
70-79	2 (0.7)	9 (3.2)	
80-89	0 (0)	1 (0.4)	
Gender			
Male	4 (1.4)	228 (81.7)	0.849
Female	1 (0.4)	46 (16.5)	
Race			
Malay	2 (0.7)	99 (35.5)	0.848
Chinese	2 (0.7)	85 (30.5)	
Indian	0 (0)	36 (12.9)	
Others	1 (0.4)	54 (19.4)	
ISS			
<9	0 (0)	16 (5.7)	0.629
9-15	0 (0)	27 (9.7)	
>15	5 (1.8)	231 (82.8)	
Systolic BP			
<90 mmHg	3 (1.1)	40 (14.3)	0.005
>90 mmHg	2 (0.7)	233 (83.5)	
Trauma Team Activation			
Yes	4 (1.4)	91 (32.6)	0.047
No	1 (0.4)	183 (65.6)	
Mechanism			
Blunt	3 (1.1)	220 (78.9)	0.262
Penetrating	2 (0.7)	54 (19.4)	

Time to OT for trauma cases may be used as a performance indicator of the trauma system in the hospital. A time limit may be set for both blunt and penetrating trauma patients who need operative intervention. These values can be used as a trauma audit in the hospital. There is evidence shown by the American College of Surgeons that laparotomy delay of more than two hours will have adverse effects on the trauma care.<sup>6</sup> With a good trauma audit system, the delay of trauma care can be identified. However, with this method, there is potential chance of missing those who have laparotomy within the designed time frame, but should have been in the operating theatre much earlier. For example, one hour from emergency department to OT is not acceptable for a haemodynamically unstable penetrating thoracic injury. Clarke et al., demonstrated that time to laparotomy for intra-abdominal bleeding does affect survival, increasing the risk of death by 1% for every three minutes delay.<sup>7</sup>

The mean time for polytrauma patients to go to operation theatre in PPUKM was 299.27 minutes. This is a far delay from the one-hour golden hour time. A study in Oslo University Hospital-Ullevål which is fully equipped for major damage control procedures shows median time to laparotomy of 24.0 to 34.0 minutes from two periods. The

earlier period (24 minutes) was when the OT was in the emergency department and the latter (34 minutes) was when the OT was moved to a dedicated area in the hospital.<sup>8</sup> Our delay is even longer than the median time from emergency call to operation time in Glasgow and Bath which was 127 minutes in 1997.<sup>9</sup> The time to emergency trauma laparotomy is used as an audit of process for the management of a trauma system. It was suggested that the trauma OT to be moved to the emergency department, however several obstacles has prevented this.

Out of 279 poly-trauma cases, only 34.1% of the cases had trauma team activated. This was partly due to the poor adherence of the attending emergency doctors in activating the trauma team. The importance of trauma team activation was not emphasized in the daily practice of trauma care. Many of the junior doctors were not aware of the existence of trauma team or the indications of trauma team activation. This study has shown that activation of trauma team has significant influence to the door to operation theatre time. This means that from trauma team activation, there is more likely for the cases to achieve the "Golden Hour" of damage-controlled surgery.

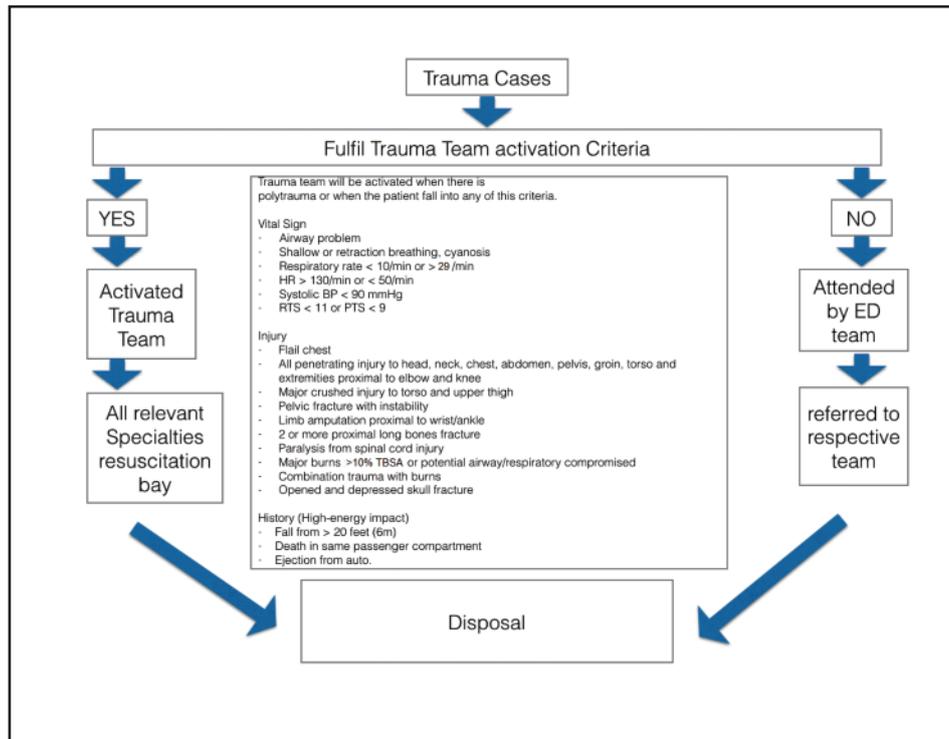


Fig. 1: PPUKM Emergency Department protocol in activating trauma team. (Adapted and altered from Resources for Optimal Care of the Injured Patient; 2014)<sup>4</sup>

However, that, despite trauma team activation, only four out of 95 cases achieved the door to operation theatre time of less than 60 minutes. This low number may be due to the compartmental trauma service in this centre. Although there was trauma team activation, there were minimal three teams involved, namely surgery, orthopaedic and neurosurgery. All three teams are presented by three different doctors. The more complicated the cases that occur, the more teams would be involved. Thus, time often elapsed before a primary team gave the firm decision of entering the operation theatre. This can be improved with the availability of trauma surgery, which will be primary team for all the trauma cases. The existence of trauma surgery can also lead the resuscitation of the trauma cases and coordinate the management of the trauma cases. A general holistic approach can be achieved by having the trauma team that will oversee the care, consequently treating every aspect of the patient, instead of a single system.<sup>1</sup> Nevertheless; trauma care in this centre does not support this concept due to the lack of trauma surgeon in the hospital. The compartmental trauma services will have more difficulties when there is complex patient because there is always absence of inter-department communication. Very often, emergency doctors are the middle man between these departments, and to coordinate the delivery of patient's care. Activation of trauma team should be led by the Emergency physician, or surgeon present, where all the members should follow as in a study in Scandinavia. Closed-loop communication initiated by the leader appears to be beneficial for teamwork. The trauma team consists of an emergency physician, surgeon, anaesthesiologist and registered nurses from ER, OT and anaesthesiology. A

command from the leader to direct the patient to OT results a faster door to OT time. In contrast, a high number of call-outs and closed-loop communication initiated by team members might lead to a communication overload and delay to OT time.<sup>10</sup>

It was also observed that upon trauma team activation, the doctors first attending from respective disciplines would be juniors, namely the house officers or the first year trainees. These juniors would need to consult with the seniors or registrars for the definitive management. It is probable that this has contributed to the delay in the trauma management. Ideally, upon trauma team activation, the senior doctors should be the ones to come and attend to patients.

This study has shown that there was no relationship between ISS score and the door-to-operation theatre time. The ISS score has been chosen to assess the severity of the injuries and the patients were further classified into ISS <9, ISS 9-15 and ISS >15 for comparison. The Injury Severity Score (ISS) provides an overall anatomical score for patients with poly-trauma. The injuries are allocated according to six body regions (external, head, face, thorax, abdomen, extremities/pelvic) and each injury is given an Abbreviated Injury Scale (AIS) score. The highest AIS score in each region is used. Then the three highest AIS score are squared and summed up to get the ISS score. Thus the ISS score will range from 0 to 75. The disadvantages of ISS score are that any error in AIS scoring will lead to the error in ISS scoring. Also, the weightage to different body regions is the same; so many different injury patterns can have the same ISS score. Furthermore, the full

description of the injuries is only known after the operation or full investigation. Thus ISS is not a useful triaging tool in trauma care.<sup>4</sup>

Statistic has shown that the activation of trauma team significantly ( $p=0.047$ ) influenced the door-to-operation theatre time (Table II). With trauma team activation, there was more likely for the poly-trauma cases to reach the operation theatre within 60 minutes. The idea of trauma team activation for poly-trauma cases was to have all teams readily available when there was trauma resuscitation. All these specialties would manage the trauma resuscitation together with the lead of emergency attending physician. With this, the goal of Golden Hour in resuscitation is more likely to be achieved. This would have speed up the management of trauma resuscitation. This also correlates to the time of total all referrals and decision making which was significant in improving door to OT time.

There is no existence of trauma surgeon in this centre. So the trauma team was composed of all relevant specialties such as general surgery, orthopaedics, and neurosurgery. For complex cases, the numbers of team involved may be even more, including anaesthetist, maxillofacial, cardiothoracic, vascular, urology and so on. In this study, the highest number of specialties involved was from seven specialties. There was no relation between number of specialty referred and the time to operation theatre.

In terms of polytrauma outcome for a prolonged door to OT time, only 50 out of 279 died. The results of mortality and discharge rate was comparable to a study done on 770 polytrauma patients, only 66.5% survived to day 3 of injury.<sup>11</sup> The study included ISS >16, as our current study, majority of patients (85%) has ISS >15. Even though there is much delay in injury to OT time, the outcome of mortality following admission does not vary significantly from previous studies.<sup>11,12</sup> However as stated in the limitations, this study examines the door to OT time, and the patients who died in ER and did not reach OT was not included. Hence, in terms of count to mortality, the outcome of polytrauma is far worse than reported among the patients that reached OT.

#### LIMITATION

Patients who died in the department during resuscitation or patients who were transferred from other hospitals were excluded from this study. This population contributed to a certain number of severely injury polytrauma that needed operative intervention. Some of these patients were planned for operation, however, during resuscitation or while waiting for operation theatre to call, they succumbed to death.

The adherence of ED attending physicians to the criteria of trauma team activation guidelines was a confounding factor. Frequently trauma team was not activated in despite of a polytrauma victim. This is mainly due to low awareness of the role of a trauma team.

ISS score was chosen as a tool to assess the injury severity in this study. Nevertheless, ISS score can only be calculated after full investigations and operation. And the scoring largely depended on the documentation and investigations ordered. Incomplete documentation will lead to inaccurate ISS scoring. This features also made ISS score only suitable for retrospective study but not prospective study.

Another limitation was a low number of trauma victims that achieved optimum door to OT time. This can skew the statistical calculation.

Finally, this study was done retrospectively which limitations include incomplete data, poor documentation and lost documentation.

#### CONCLUSIONS

Lack of coordination among different specialties contributed heavily to delay of door to OT time. This delay can be resolved with an efficient and well coordinated trauma team, led by the operating team who has full control on OT decision making and has sound knowledge in trauma. Trauma team should be implemented in all hospitals. Trauma team activation threshold should be lower and done according to protocols recommended.

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