Factors Influencing the Accuracy of Triage by Registered Nurses in Trauma Patients

Thassanee Soontorn, Yajai Sitthimongkol, Orapan Thosingha*, Chukiat Viwatwongkasem

Abstract : An accuracy of triage in patients with trauma at the emergency department can assist them to receive appropriate treatment in time leading to decreased mortality and disability. The objectives of this study were to assess the accuracy of triage performed by registered nurses in the emergency department and examine factors influencing the triage accuracy in patients with trauma. A prospective observational design was performed in five emergency departments of regional hospitals in southern Thailand. The sample comprised 109 registered nurses and 1,090 adult patients with trauma. The accuracy of triage was calculated by using the difference score between the triage coding identified by a triage nurse immediately on patient emergency department arrival and the triage coding identified using the Emergency Severity Index Manual (Version 4). Multiple multinomial logistic regressions were employed to examine the predictors of triage accuracy.

Only 52.4% of patients were categorized into an accurate triage group. Years of work by participants in the emergency department increased the likelihood of over-triage. In terms of patient characteristics, patients with blunt injury, multiple injuries and altered consciousness were more likely to be over triaged. These data provide strong evidence to support the implementation of the Emergency Severity Index version 4 as a standard tool in the emergency department during triage. Such a policy would contribute to improving the accuracy of the triage level designation in patients with trauma receiving service from an emergency department.

Pacific Rim Int J Nurs Res 2018; 22(2) 120-130

Keywords : Accuracy Triage, Emergency Care, Patients with Trauma, Registered Nurses, Thailand.

Introduction

Trauma–related injuries have become an increasingly important cause of premature death and disabilities among young adults in Thailand since 2000.[1] As in other countries, the Thailand national emergency medical service system has been well established. Its policy and action plans aim to reduce preventable death and morbidity by providing effective prehospital care, proper transportation and

Thassanee Soontorn PhD. Candidate. Joint Program between Faculty of Nursing and Ramathibodi School of Nursing, Faculty of Medicine Ramathibodi Hospital, Mahidol University. 2 Wang Lang Road, Bangkok 10700, Thailand. *E–mail:* srirat_5001@yahoo.com
Yajai Sitthimongkol, PhD. (Nursing). Associate Professorand Dean, Faculty of Nursing, Mahidol University 2 Wang Lang Road, Bangkok 10700, Thailand. *E–mail:* yajai.sit@mahidol.ac.th
Correspondence to: Orapan Thosingha PhD. (Nursing). Associate Professor. Chair of Surgical Nursing Department, Faculty of Nursing, Mahidol University. 2 Wang Lang Road, Bangkok 10700, Thailand *E–mail:* orapan.tho@mahidol.ac.th
Chukiat Viwatwongkasem PhD., Biostatistics., Associate Professor Department of Biostatistics, Faculty of Public Health, Mahidol University 420/1 Ratchawithi Road, Ratchathewi District, Bangkok 10400, Thailand *E–mail:* chukiat.viw@mahidol.ac.th

assisting patients to receive the right treatment at the right time.[1] Accordingly, on emergency department (ED) arrival, patients require an effective assessment to classify them according to their genuine acuity and need, the so-called "triage", so that they would obtain the proper treatment on time. Accuracy of triage reduces waiting time for treatment thus it can reduce the burden of disability among trauma patients and decrease mortality rates.[2,3] Triage assessment accuracy is largely dependent on nurses' decision-making competency.[4] It has been suggested that the experiences and qualifications of nurses may influences triage outcomes.[5-7] Furthermore, patients' characteristics such as severity of injury, age, co-morbid disease and organ of injury have been shown to affect triage outcomes.[8,9]

Currently, the most widely accepted method for triage is the Emergency Severity Index (ESI) system[5,10] which is recommended for ED triage in Thailand. The majority of hospitals in Thailand (75.8%) use the ESI approach to classify patients into 5 levels; 1-resuscitation, 2-emergent, 3-urgent, 4-less urgent, and 5-non-urgent.[1] Effective implementation of the ESI triage system in EDs significantly reduces waiting time to see physicians so that patients can obtain an appropriate treatment on time.[11] Several previous studies of triage processes have shown that appropriate patient assignment of triage acuity scores can shorten ED waiting time and time to treatment leading to decreased patient morbidity.[2] ED triage among patients with life-threatening conditions will identify whether or not a patient can safely wait to be seen by a physician. It also reflects numbers of resources required in emergency care.[10] Based on the severity of the injury and the need for treatment, ESI triage system manages patients within a minimal amount of time, which can lead to appropriate rotation of patients with high reliability and safety.[5] Decreased ED overcrowding was found in many studies after implementation of ESI triage system.[5,10,11] Triage nurses have a role to evaluate the acuity of patients based on patients' assessment, vital signs and estimated resources needed.[12] The ultimate outcome of triage is its accuracy which will lead to proper treatment for each patient base on his or her health need in emergency care.[4,12] Research regarding accuracy of triage performed by ED nurses in patients with trauma is very few, leading to limited body of knowledge to improve quality of service among such patients in the emergency phase. Accordingly, it is vital to assess the accuracy of triage performed by nurses in the ED and examine factors influencing the triage accuracy in patients with trauma.

Conceptual Framework and Review of Literature

Donabedian[16] developed a widely-accepted, health care delivery service quality framework which was used as the conceptual framework of this study. This has three main components, structure, process, and outcome, all related to each other. Good structure of health care services increases the likelihood of good care delivery process, and this in turn increases the likelihood of good health outcomes[13-18] In this present study, the structure of health service in ED refers to RN characteristics, including years of work in ED, years of ED triage experience, and trauma training experience[4,6,7,10] as well as patient characteristics including age, co-morbidities, mechanism of injury, types of organ injuries, Glasgow coma scores, and systolic blood pressure.[4,8,9] The process refers the level designation of triage performed by RN on the ESI levels of patients with trauma.[4] The outcome refers to triage accuracy as measured by an accuracy index (**Figure 1**). The accuracy index is defined into the following 7 categories: 0 = appropriate triage; −1 = over-triage; −2 = excessive over-triage; −3 and −4 = unacceptable over-triage; +1 = to under-triage; +2 = excessive under-triage, and +3 and +4 = unacceptable under-triage.[11] The accuracy index derives from the difference score between the triage coding identified by a triage nurse immediately on patient ED arrival and the triage coding, identified by the researcher using the criteria of the triage tool qualified by the National Institute for Emergency Medicine of Thailand in 2013.[19]
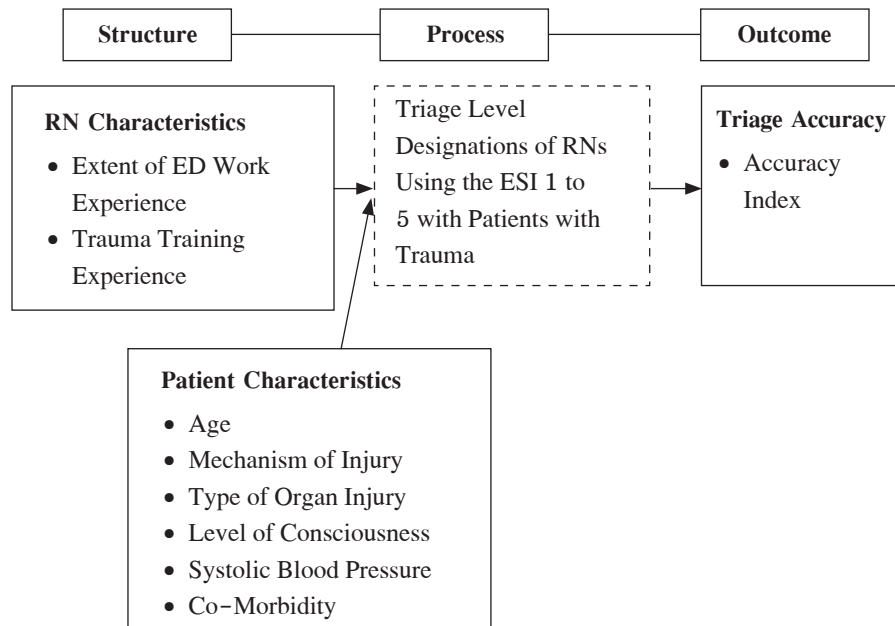
Figure 1 Conceptual framework of the study

The objectives of the study were to:

1. Evaluate the accuracy of RN triage in patients with trauma by compared with the criteria of the triage tool, developed by the National Institute for Emergency Medicine of Thailand in 2013;[19]

2. Examine the association among: (a) RN characteristics (years of work in ED and trauma training experience), (b) patient characteristics (age, co-morbidity, mechanism of injury, type of organ injury, level of consciousness, and systolic blood pressure), and (c) accuracy of RN triage; and

3. Examine the predictive power of RN characteristics and patient characteristics on the accuracy of triage.

Methods

Design: A prospective observational study.

Ethical Considerations: Research ethics approval was obtained from the Institutional Review Board Faculty of Nursing, Mahidol University (No. IRB-NS 2015/27.0704) as well as from each hospital ethics committee. Before data collection, the Principal Investigator (PI) provided the study objectives and data collection procedures to hospital directors and participants. After they agreed to join the study, participants were invited to sign the consent forms and were assured that they could withdraw from the study at any time during the study. The data were kept strictly confidential, identification coding used to protect anonymity, and access limited to the researcher alone. During data collection, the PI assured that all patients received appropriate care and treatment from the trauma team.

Sample and Setting: The study was conducted at five EDs of regional hospital in the southern of Thailand. All settings were similar in terms of ED services. Each hospital offered full facilities with medical staff who were specialists in surgical care for trauma patients, with emergency physicians (EPs) and a full range of advanced medical equipment available 24 hours. Numbers of nurses who worked in each shift (morning, afternoon and night) varied from 7 to 10, of which

one nurse was assigned as a triage nurse. The process of triage comprised two steps. The first was rapid triage or a quick look at patients with trauma without classifying them into any ESI level. The second step involved detailed assessment including taking vital signs, checking patients' level of conscious, and history of injury to completely classify the triage level. This triage process followed the ESI-Version 4 algorithm.[4,11]

The sample was selected from the RNs' staff list in the five EDs at the time of the study. The list showed 160 of RNs, however, only 112 RNs were assigned for a triage role during the study period. Of these 112, 3 RNs had chronic illnesses and refused to participate because they did not perform triage regularly. The sample size of patients was calculated based on the study of Chen et al,[4] who recommended that 10 patients per one ED nurse demonstrated a sufficient number of representatives for the triage. Ultimately, the sample was 109 RNs and 1,090 patients.

Data Collection

Instruments: Three instruments were used to collect the data:

The *Registered Nurse Demographic Characteristics Form* (RNDCF). This form was developed by the PI and used to collect age, gender, years of work in ED, years of triage experience, educational level, and training experience related to trauma nursing and triage.

The *Patient Demographic Characteristics Form* (PDCF): was developed by the PI and used to collect information about a patient's age, gender, co-morbidity, mechanism and time of injury, types of organ injuries, time arrival at ED, type of transportation, physiological response to trauma including Glasgow Coma Scores and systolic blood pressure, management at ED including time of triage and physician assessment, triage classification level, and detailed medical interventions. Data were obtained from the medical records of each patient.

The *Emergency Severity Index Version 4* (ESI-Version 4) was developed by the American Agency for Healthcare Research and Quality.[20] It is a triage algorithm comprising vital sign assessment, guidelines on appropriate treatment, and criteria to determine the expected triage level designations from Levels 1-5.[19] ESI Level 1 is assigned to patients requiring immediate life-saving intervention. ESI Level 2 represents patients who should not wait due to a high-risk situation, a new onset of alteration of consciousness or show severe pain or respiratory distress. ESI Levels 3, 4 and 5 are assigned to patients requiring more than one, one, or no resources, respectively.[19-20]

All the above instruments were tested for their validity by 5 experts in emergency medicine. The content validity index (CVI) for each instrument was calculated. The results showed that CVI of the RNDCF, the PDCF and ESI-version 4 accounted for 1, .97 and .97 respectively.

The PI was an expert nurse in emergency and trauma nursing, with experience as a clinician, clinical instructor and teacher, and a qualification in advanced trauma life support. She attended short course training on using the ESI-version 4 prior to data collection, and practiced using this instrument for triage with 20 patients with trauma. A comparison of her triage results with those of a senior emergency physician on the same duty shift revealed an inter-rater reliability of 0.90.

RN characteristics were collected using the RNDCF while patients' characteristics were collected with the PDCF. The triage levels performed by RNs was recorded from the patients' records, whilst the triage level performed by the PI was conducted by using the criteria of the triage tool qualified by the National Institute for Emergency Medicine of Thailand in 2013.[19] The accuracy of triage was calculated by using the difference score between the triage coding identified by a triage nurse immediately on patient ED arrival and the triage coding identified by the PI using ESI manual. The duty emergency physician was asked to confirm the PI's triage accuracy, and the triage accuracy index for each patient was calculated from the confirmed triage result.

Data Analysis: Multinomial logistic regression analysis examined if the characteristics of RN and patients with trauma related injury could predict triage accuracy. A value of $p < .10$ was used in the univariate analysis in the initial setting regression model.[18] In all further tests, the significance level was set at $p < .05$ and a 95% confidence interval.

Results

The ED nurse sample comprised more females than males. Their average age was 34.39 years (SD ±8.50 years) with a range of 23–58 years. The total number patients with trauma was 1,090 whose average age was 37.52 years (SD ±17.87), ranging from 18–92 years. More than half (51.9) were young adults (ages ranged from 18–34 years) and 18.8% were aged >55 years. There were 627 (57.5%) male and 463 (42.5%) female patients. The percentage of patients who came to hospitals by themselves was 69.2%, while 30.8% were transferred from the injury scene by Emergency Medical Service ambulances. The 4 leading causes of injuries were traffic injury (n= 437, 40.1%), sustained cutting or lacerated wounds by sharp objects in the environment (e.g. knives, saws, hammers during farming (n=198, 18.2%), falls (n= 186, 17.1%) and physical assault (n= 63, 5.8%). The majority of patients (n= 647, 59.4%) had blunt injury and musculoskeletal injuries (57.4%). About 66% had at risk systolic blood pressure while only 3.9% had altered consciousness on ED arrival. Nearly 90% did not have co-morbid diseases. Only 18% of patients had a pain assessment by ED nurses, and among these 4.5% (49), 8.1% (88), and 5.4% (59) had minor, moderate and severe pain respectively.

Nearly half of the patients were categorized into an inaccurate triage group (n = 518, 47.6%). Of this group, approximately 25.5% were over-triaged, 5.4% were too over-triaged, 15.2% were under-triaged, and 1.5% were too under-triaged (**Table 1**). ESI level 2 accounted for the highest under-triage designation. Musculoskeletal injury (n=101), multiple organ injuries (n=24), and traumatic brain injury (n=22) were the top 3 of those patients who had an inaccurate under-triage designation.

Table 1 Numbers of Patients Presented by Triage Accuracy Index (n = 1,090)

ESI Levels	Number of patients	Mean (SD)	Groups of Accuracy Index (Number/Percentage)				
			0=Appro-priate	−1 = Over-triaged	−2 = Too over triaged	+1 = Under-triaged	+2 = Too under triaged
Total	1,090	−0,18 (0,08)	572 (52,4)	278 (25,5)	59 (5,4)	165 (15,2)	16 (1,5)
1	15	0,27 (0,45)	11			4	
2	193	0,63 (0,64)	80	3		96	14
3	314	0,17 (0,47)	240	11		61	2
4	366	−0,41 (0,52)	210	150	2	4	
5	202	−1,13 (0,65)	31	114	57		

In regard to RNs' characteristics, years of work in ED was a predictor of triage accuracy (p<0.001). RNs who had years of work in ED ≥10 years demonstrated risk for over-triage than those having <10 years (β = 1.54, 95%, Cl =1.17 – 2.02, p = 0.002) (**Table 2**). In terms of trauma, patient characteristics, mechanism of injury, types of organ injury, and level of consciousness were predictors of triage accuracy (p<0.001). The data indicated that injured patients with both blunt and penetrating injuries had an

increased risk of over-triage compared with blunt or penetrating injury alone (β = 0.32, 95% CI 0.21-0.47, p <0.001) (table 2). Patients with multiple organ injuries were more likely to receive over-triage compared with those who had one organ injury (β = 0.52, 95% CI 0.33-0.80, p = 0.003). In addition, patients with altered level of consciousness were more likely to receive over-triage compared with those who had a normal level of consciousness (β =0.17, CI 0.005-0.58, p = 0.004) (Table 2).

Table 2 Multiple Multinomial Logistic Regression Analysis of Characteristics of RNs (n=109) and Patients with Trauma (n=1,090) on Triage Accuracy

RN and Patient Characteristics	Over vs. Accurate Triage			Under vs. Accurate Triage		
	Exp (β)	95% CI	p-value	Exp (β)	95% CI	p-value
Years of work in ED						
< 10 (n=60)	1	ref		1	ref	
≥ 10 (n=49)	1.51	1.09-2.09	0.02	0.74	0.49-1.11	0.15
Years of triage experience						
≤ 2 (n=34)	1	ref		1	ref	
3 – 5 (n=37)	0.81	0.56-1.15	0.24	1.01	0.65-1.56	0.94
> 5 (n=38)	1.05	0.71-1.56	0.95	1.71	1.06-2.76	0.02
Mechanism of injury						
Blunt (n=647)	1	ref		1	ref	
Penetrating (n=210)	0.88	0.62-1.25	0.48	0.75	0.46-1.20	0.23
Both (n=233)	0.34	0.23-0.51	<0.001	0.96	0.64-1.44	0.86
Type of organ injury						
One organ (n=949)	1	ref		1	ref	
Multiple organs (n=141)	0.61	0.38-0.98	0.04	0.79	0.48-1.31	0.37
Level of consciousness **(GCS = 3-15)**						
15 (n=1048)	1	ref		1	ref	
3-14 (n=42)	0.25	0.07-0.87	0.03	1.28	0.60-2.70	0.52

P-value of Logistic Regression <0.001

ref=reference category,

Exp (β)= If the β is negative, Exp (β) will be lower than one, which means odds decrease. If higher the Exp (β)will be higher than 1, meaning odds increase.

Discussion

Findings revealed that only half of trauma patients (52.4%) received accurate triage while 47.6 % received inaccurate triage. Although the rate of accurate triage in this study was congruent with the previous study of Chen et al.[4], the detail of inaccuracy in our study was different. In this study 30.9% of patients were over-triaged and 16.7% were under-triaged, in contrast to the Chen et al. study that found patients were under-triaged more than over-triaged (24.3% and 19.7% respectively). The numbers of inaccurate triage in this study were relatively high, leading to the need for urgent improvement in nurses' triage competencies. Interestingly, increasing years of work in ED resulted in a risk for over-triage.

Particularly, nurses who had worked in ED >10 years showed a risk for over-triage greater than those having 10 or <10 years' experience. One explanation for this is that more experienced nurses tended to over triage because they were afraid that trauma patients might deteriorate more if they were classified in at less severe acuity level and had to wait for the treatment. On the other hand, if the patients were assigned with more severe acuity, they would receive prompt attention from emergency physicians.[18] Over-triage might lead patients to receiving earlier attention from physicians, but would satisfy the patients and their family. Moreover, whilst over-triage decreases the risk of morbidity and mortality, it also leads to increased use of unnecessary resources, resulting in more expensive care services. In addition, staff would then spend more attention to this group of patients while some of them who received under-triage might be neglected. This result was incongruent with the earlier findings of Chen et al[4] in that nurses who worked >5 years had a higher accurate acuity rating. Moreover, the result was incongruent with the other 2 previous studies[6,17] that explored the relationship between working experience of emergency nurses and triage skills. These studies found that working experience had positive relationship with triage skills and lead to triage accuracy.

Training experience of ED nurses did not predict the accuracy of triage. This finding was incongruent with previous studies in that training increased nurses' knowledge and skills.[3,6,20.21.] A possible explanation was that numbers of nurses who received formal training in post-graduate specialized nursing curriculum was very small. Only 15 of 109 nurses (13.8%) had received a special certificate in emergency or trauma nursing. This small number led to non-normal distribution of this variable so that it was not selected in the final analysis by multinomial logistic regression modelling.

Findings indicated that the mechanism of injury, types of organ injury, and level of consciousness were predictors of triage accuracy. Injured patients with both blunt and penetrating injuries were more likely to receive over-triage compared with blunt or penetrating injury alone. In addition, patients with multiple organ injuries were more likely to receive over-triage compared with those who had one organ injury. Patients with an altered level of consciousness were more likely to receive over-triage compared with ones who had a normal level of consciousness. The mechanism of an injury is a main factor related to over-triage. Patients who sustained both blunt and penetrating injuries usually demonstrated severe injuries and arrived at ED with external hemorrhage, some of them showed hypovolemic shock with low systolic blood pressure and hypoxia on ED arrival.[23-27] Accordingly, this group of patients receive much attention, are assigned into high acuity for injuries and usually receive over-triage.[25-27] A similar explanation goes to patients with multiple injuries who arrived in ED with a severe appearance, so that nurses would assign them into higher injury acuity, and they were over-triaged. Those patients who showed alteration of consciousness, often traumatic brain injury, and needed urgent investigation and care. Although, their Glasgow Coma Scores (GCS) were little altered from normal of 15 to 14 on ED arrival, they received much attention and close observation regardless of their score. [28-31] Eftekhar Behzad et al.[30] demonstrated that GCS (mean score=14.5, SD=2), adjusted with age, was a significant predictive risk factor for mortality rate increase. Studies of adult patients (aged $\geq$16 years), indicated that GCS <14 is a criterion for an initial assessment of traumatic brain injury diagnosis in an emergency room[31,32] or GCS <15 within 2 hour after injury on assessment in the emergency room.[31] Refining the trauma triage algorithm at an Australian major trauma center, Dinh et al.[33] reported that the strongest predictor of major trauma after using multivariable adjusted was abnormal GCS. Further, Middleton[34] proposed that GCS is an important variable to indicate the level of injury, allowing triage and immediate intervention, and enabling monitoring of trends in consciousness.

It is important to note that the majority of patients with trauma in this study (82%) did not receive pain assessment although pain level is one symptom in ESI triage algorithm, and pain management in patients with trauma has been widely recognized as an important issue. Moreover, there are evidence-based guidelines available.[35] This finding reflected that pain management for patients with trauma in this study was neglected, and might lead to patients' discomfort and dissatisfaction with care.

Limitations

The numbers of nurses who finished specialty ED training were very small so that the training experience of ED nurses did not show its significance in the final analytic model. Further research should be expanded to cover 13 regional services of Thailand.

Conclusion and Implications for Nursing Practice

Nearly half of injured patients (47.6%) were categorized inaccurately into a triage group. Of these, 25.5% were over-triaged and 15.2% were under-triaged. This finding triggers an urgent need to improve nurses' competency in triage in order to achieve more triage accuracy. Nurses who worked in ED for >10 years were more likely to perform over-triaged. Although this was often a safety mechanism for trauma patients, over-triage led to ED being overcrowded and inappropriate use of resources. Thus, it is recommended that nurses who work in ED >10 years require refresher courses on triage to improve their competencies and knowledge in triage. This study was congruent with the Donabedian framework of structure, process and outcome which are related to each other. In order to obtain good outcomes or accuracy of triage, there should be a policy to improve the quality of structure which referred to the competency of ED nurses on

triage skills. In addition, the process of utilizing the ESI-version 4 should be monitored using a chart audit system to ensure that nurses could follow the triage algorithm accurately and to better ensure their accuracy on patient triage. Thus, patients with trauma will be appropriately assigned into their genuine level of acuity leading to appropriate treatment at the right time. Finally, nurses who work in ED should be educated to more aware of performing pain assessment and management in patients with trauma.

Acknowledgements

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ปัจจัยที่มีอิทธิพลต่อความแม่นยำในการคัดแยกผู้ป่วยบาดเจ็บของพยาบาลวิชาชีพ

ทัศนีย์ สุนทร ยาใจ สิทธิมงคล อรพรรณ โตสิงห์* ชูเกียรติ วิวัฒน์วงศ์เกษม

บทคัดย่อ: การคัดแยกผู้ป่วยบาดเจ็บอย่างแม่นยำตามระดับความรุนแรงจะช่วยให้ผู้ป่วยได้รับการรักษาที่เหมาะสม มีผลต่อการลดอัตราตายและความพิการของผู้ป่วยได้ การศึกษาครั้งนี้มีจุดประสงค์เพื่อประเมินความแม่นยำในการคัดแยกของพยาบาลในแผนกฉุกเฉินและศึกษาปัจจัยที่อาจจะมีอิทธิพลต่อความแม่นยำในการคัดแยก เป็นการศึกษาเชิงสังเกตในแผนกฉุกเฉินของโรงพยาบาลศูนย์ระดับภูมิภาคทางภาคใต้ของประเทศไทย 5 แห่ง โดยศึกษากลุ่มตัวอย่าง 2 กลุ่ม คือพยาบาลวิชาชีพ จำนวน 109 คน และผู้ป่วยอุบัติเหตุ จำนวน 1,090 คน วัดความแม่นยำของการคัดแยกโดยคำนวณค่าความแตกต่างระหว่างผลการคัดแยกผู้ป่วยบาดเจ็บโดยพยาบาลวิชาชีพกับการคัดแยกของผู้วิจัยโดยใช้แนวทางตามเครื่องมือการคัดแยก Emergency Severity Index ฉบับปรับปรุงครั้งที่ 4

ผลการศึกษาพบว่าผู้ป่วยเพียงร้อยละ 52.4 ที่ถูกคัดแยกเหมาะสมกับระดับความรุนแรงของการบาดเจ็บ จำนวนปีของประสบการณ์ในการปฏิบัติงานในแผนกฉุกเฉินของพยาบาลวิชาชีพเป็นปัจจัยที่ทำให้เกิดความเสี่ยงต่อผลลัพธ์การคัดแยกที่ไม่แม่นยำ (ระบุระดับความรุนแรงของการบาดเจ็บสูงกว่าเกณฑ์) สำหรับลักษณะของผู้ป่วยพบว่า ผู้ป่วยที่เกิดการบาดเจ็บจากแรง กระแทกร่วมกับการบาดเจ็บจากของมีคม ผู้ป่วยบาดเจ็บหลายระบบ และผู้ป่วยที่มีระดับการรู้สึกตัวที่ผิดปกติแรกรับที่ห้องฉุกเฉิน มีแนวโน้มในการได้รับการระบุระดับความรุนแรงของการบาดเจ็บสูงกว่าเกณฑ์ ผลการศึกษาครั้งนี้สามารถนำไปใช้เป็นข้อมูลเชิงประจักษ์ในการสนับสนุน นโยบายเพื่อนำเครื่องมือการคัดแยกตามรูปแบบ Emergency Severity Index ฉบับปรับปรุงครั้งที่ 4 ไปใช้เป็นเครื่องมือมาตรฐานในการคัดแยกผู้ป่วยที่ได้รับการบาดเจ็บ ณ ห้องฉุกเฉิน ร่วมกับการถ่ายทอดสู่ผู้ปฏิบัติอย่างเป็นรูปธรรมเพื่อให้เกิดความแม่นยำการคัดแยกผู้ป่วยบาดเจ็บ

คำสำคัญ : ความแม่นยำ การคัดแยก ผู้ป่วยบาดเจ็บ การดูแลในภาวะฉุกเฉิน พยาบาลวิชาชีพ

ทัศนีย์ สุนทร, *PhD. Candidate. นักศึกษาหลักสูตรปรัชญาดุษฎีบัณฑิต สาขาการพยาบาล (หลักสูตรนานาชาติและหลักสูตรร่วมกับมหาวิทยาลัยในต่างประเทศ) โครงการร่วม คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี และคณะพยาบาลศาสตร์ มหาวิทยาลัยมหิดล เลขที่ 2 ถนนวังหลัง แขวงศิริราช เขตบางกอกน้อย กรุงเทพฯ 10700 E-mail: srirat_5001@yahoo.com*

*ยาใจ **สิทธิมงคล**, PhD. (Nursing). รองศาสตราจารย์ คณบดีคณะพยาบาลศาสตร์ มหาวิทยาลัยมหิดล เลขที่ 2 ถนนวังหลัง แขวงศิริราช เขตบางกอกน้อย กรุงเทพฯ 10700 E-mail: yajai.sit@mahidol.ac.th*

ติดต่อที่: *อรพรรณ **โตสิงห์*** PhD. (Nursing). รองศาสตราจารย์ หัวหน้าภาควิชาการพยาบาลศัลยศาสตร์ คณะพยาบาลศาสตร์ มหาวิทยาลัยมหิดล เลขที่ 2 ถนนวังหลัง แขวงศิริราช เขตบางกอกน้อย กรุงเทพฯ 10700 E-mail: orapan.tho@mahidol.ac.th*

ชูเกียรติ วิวัฒน์วงศ์เกษม, *PhD., Biostatistics. รองศาสตราจารย์ ภาควิชาชีวสถิติ คณะสาธารณสุขศาสตร์ มหาวิทยาลัยมหิดล เลขที่ 420/1 ถนนราชวิถี เขตราชเทวี กรุงเทพฯ 10400. E-mail: chukiat.viw@mahidol.ac.th*