

# A Comparison of Mortality Predictive Abilities Between NISS and ISS in Trauma Patients†

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## Abstract

Previously published investigations have suggested that the Injury Severity Score (ISS) can be replaced by the New Injury Severity Score (NISS) which takes into account the three most severe injuries regardless of body region. This study was conducted to evaluate whether NISS can also give a better mortality prediction than ISS in a different setting. The objective of this study was to compare the accuracy between ISS and NISS in predicting mortality of trauma patients. The study population consisted of trauma patients admitted to a 650-bed university hospital in Thailand from June 1996 to May 1999. Data of patients admitted to the hospital were prospectively collected to identify the injuries and outcomes of treatment. Each injury was reviewed and coded according to the Abbreviated Injury Scale 1990 revision (AIS-90) and computed for ISS and NISS. Areas under receiver operating characteristic (ROC) curves were employed to compare the abilities of the ISS and the NISS in predicting patients' mortality. The results of the study showed that 2,044 trauma patients were admitted to the hospital during the three-year study period and 114 patients died in the hospital. The median scores of the ISS and the NISS of the survivors were 4 and 8 respectively. The median scores of the ISS and the NISS of the non-survivors were 25 and 38 respectively. The area under ROC curve derived from the ISS (0.966; 95% C.I = 0.965 - 0.967) was significantly ( $p < 0.05$ ) less than the NISS (0.974; 95% C.I = 0.973 - 0.975). We concluded, under our setting, that NISS also performed the mortality prediction in trauma patients better than ISS and confirmed the results of the previous studies.

**Key word :** Severity of Illness Index, Severity Score, Trauma, Injury

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Over the two decades that several trauma severity scoring systems have been developed and evaluated, the Injury Severity Score (ISS)(1) has become the most popular scoring system employed to assess severity of injury and to compare the quality of care. The ISS is a scoring system based on patients' anatomic profiles to provide a summary measure of injury severity. In calculating ISS, one has to use the highest Abbreviated Injury Scale (AIS)(2) score of the three most severely injured body regions. The way that the ISS uses only the single most severe AIS score per body region was questioned and tested(3,4). The results of the studies indicated that using the three highest AIS scores regardless of body region was more accurate and the New ISS (NISS) was introduced.

The authors conducted this prospective study in a university hospital in Thailand to compare the validity of ISS and NISS in predicting mortality in trauma patients.

## MATERIAL AND METHOD

Songklanagarind Hospital is a university hospital belonging to the Faculty of Medicine, Prince of Songkla University. The hospital is a 650-bed facility serving as a medical school and referral center for the southern part of Thailand. The Emergency Department of the hospital treated an average of 38,000 emergency cases with 8,300 accident cases per year.

There is no ambulatory Emergency Medical Service available for the hospital. The trauma patients are taken to the hospital by the first responder. Generally there is no communication between the trauma scene and the hospital, and no provision for treatment on route to the hospital.

All trauma patients admitted to Songklanagarind Hospital from June 1996 to May 1999 were eligible for this study. Patients admitted to other hospitals before transfer to Songklanagarind Hospital were excluded from the study. The study did

**Table 1. Frequency distributions of various causes of injuries.**

External causes of injury	Number	Percentage
Transport accidents in:-		
Pedestrian	74	3.6
Pedal cyclist	14	0.7
Motorcyclist	1,067	52.2
Occupant of three-wheeled motor vehicle	1	0.05
Car occupant	59	2.9
Occupant of pick-up truck or van	113	5.5
Occupant of heavy transport vehicle	17	0.8
Bus occupant	3	0.1
Other land transport accidents	14	0.7
Unspecified transport accidents	3	0.1
Total	1,365	66.8
Other external causes of accidental injury		
Falls	240	11.7
Exposure to inanimate mechanical force	202	9.9
Exposure to animate mechanical force	12	0.6
Exposure to electric current	21	1.0
Exposure to fire or flames	8	0.4
Contact with heat and hot substances	12	0.6
Exposure to acid	1	0.05
Exposure to unspecified factor	1	0.05
Total	497	24.3
Intentional self-harm	5	0.2
Assaults	177	8.7
Grand total	2,044	100.0

**Table 2.** The distributions of ISS and NISS in survivors and non-survivors.

		ISS					Total
		1 – 15	16 – 30	31 – 45	46 – 60	61 – 75	
Survivor	n	1,693	222	12	1	2	1,930
	%	87.7	11.5	0.6	0.1	0.1	100
Non-survivor	n	5	68	29	7	5	114
	%	4.4	59.6	25.4	6.1	4.4	100
Total	n	1,698	290	41	8	7	2,044
	%	83.1	14.2	2.0	0.4	0.3	100

		NISS					Total
		1 – 15	16 – 30	31 – 45	46 – 60	61 – 75	
Survivor	n	1,584	292	47	5	2	1,930
	%	82.1	15.1	2.4	0.3	0.1	100
Non-survivor	n	1	27	46	30	10	114
	%	0.9	23.7	40.4	26.3	8.8	100
Total	n	1,585	319	93	35	12	2,044
	%	77.5	15.6	4.5	1.7	0.6	100

**Table 3.** Summary mortality rates, severity scores, and area under ROC curves from various studies.

	Osler et al <sup>(3)</sup>		Brenneman et al <sup>(4)</sup>	Present study
	Albuquerque	Portland		
Country	USA	USA	Canada	Thailand
No. of subjects	3,136	3,449	2,328	2,044
Year	1991 – 1994	1991 – 1994	1992 – 1996	1996 – 1999
Mortality rate	9%	7%	13%	5.6%
ISS				
Mean	-	-	25	7.4
Median	11	9	-	4
AUC	0.869	0.896	0.799	0.965
NISS				
Mean	-	-	33	9.1
Median	17	11	-	8
AUC	0.896	0.907	0.852	0.974

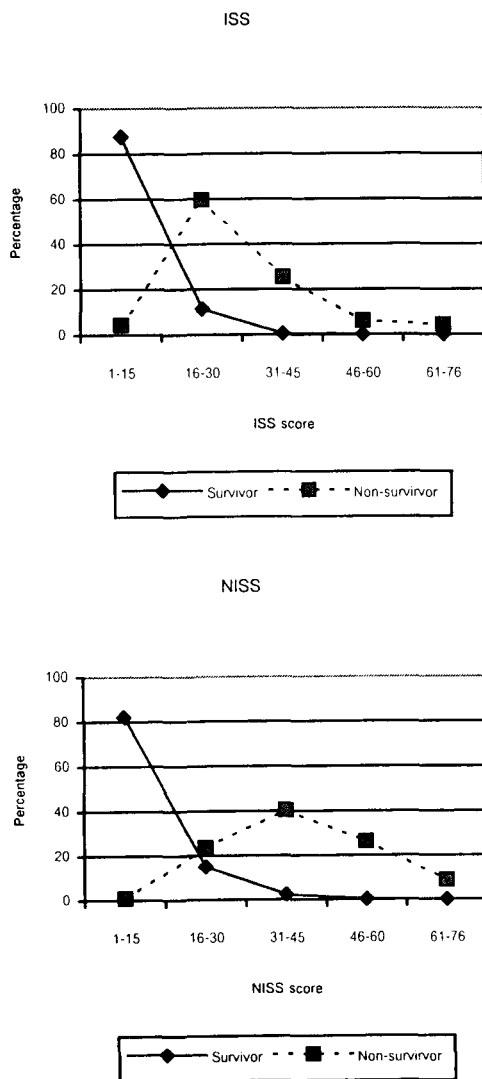
AUC, Area under ROC curve.

not include cases who were dead on arrival or died in the emergency room.

Information from the emergency department used in the study regarding patients' age, sex, time at arrival to emergency room, time that the injury occurred, cause of injury, type of injury (blunt or penetrating), provisional diagnosis, history of alcohol intake, blood alcohol level, respiratory rate, blood pressure, Glasgow coma score, and status of patient when discharged from emergency room was recorded. Information from the emergency department was

gathered by nurses in charge of the emergency room. Nurses assigned to collect the data had been trained on how to collect the pertinent data.

Data of the patients admitted to the hospital were prospectively collected by the investigators to identify the injuries and outcomes of treatment. Medical treatment and surgical procedures were reviewed including antibiotic administration, bladder catheterization, mechanical ventilation support, and intravascular line placement. The results of diagnostic imaging, blood chemistry, blood alcohol level,



**Fig. 1. The distribution of ISS and NISS in survivor and non-survivors.**

urine analysis, microbiology investigation, and other laboratory results were reviewed.

Each injury of the admitted patients was reviewed and coded according to the AIS-90 (Abbreviated Injury Scale 1990 revision)(2). The ISS was calculated by the sum of the squares of the highest AIS grade in each of the three most severely injured body regions. The NISS was calculated from the sum of the squares of AIS scores of the patient's three most severe injuries, regardless of body region.

The areas under receiver operating characteristic (ROC) curves(5) were employed to compare the accuracy of the ISS and the NISS in predicting mortality outcome. The area under ROC curves and corresponding 95 per cent confidence interval (95% C.I.) were estimated by nonparametric Wilcoxon statistics(6). The statistical significance of the difference of the area under ROC curves was tested by the method of Hanley and McNeil(7) for paired data.

## RESULTS

During the three-year period from 1 June 1996 to 31 May 1999, 2,044 traumatic injured patients were admitted to Songklanagarind Hospital. Among these patients, 114 patients (5.6%) died after admission. There were 19 patients who were admitted to the hospital more than once for trauma treatment.

The frequencies of causes of injuries are listed in Table 1. Traffic accidents were the most common cause of injury, accounting for 66.8 per cent of the overall cases. About one half (52.2%) of the accidents occurred in motorcyclists. The second most frequent cause of injury was falls. Among 240 fall injuries, 124 or 51.7 per cent were low falls.

There were 3,409 significant injuries in 2,044 patients. Most of the injuries were blunt injury (91.3%). The most common sites of injury were the extremities (53.3%). The distributions ISS and NISS are summarized in Table 2 and in Fig. 1. The mean  $\pm$  SD of ISS in survivors, ISS in non-survivors, NISS in survivors, and NISS in non-survivors was  $7.4 \pm 6.5$ ,  $30.3 \pm 13.5$ ,  $9.1 \pm 8.3$ , and  $40.7 \pm 14.9$  respectively. The median score of ISS in survivors, ISS in non-survivors, NISS in survivors, and NISS in non-survivors was 4, 25, 8, and 38 respectively.

The area under the ROC curves derived from the ISS (0.966; 95% C.I. = 0.965 - 0.967) was statistically significantly ( $p < 0.05$ ) less than from the NISS (0.974; 95% C.I. = 0.973 - 0.975).

## DISCUSSION

The ISS method has been widely used for a long time as an instrument for controlling the severity of injuries by trauma registries and researchers. It is included as an essential part for calculating the Trauma Injury Severity Score (TRISS)(8). However, Osler et al(3) and others(4) have shown that the ISS can be replaced by the NISS for better performance. Our primary intention was to evaluate whether the

NISS can also better predict the mortality outcome of trauma patients in our setting.

The authors employed the ROC curve as a mean to evaluate the predictive abilities of the two scoring systems<sup>(5)</sup>. We judged the relative ability between the ISS and the NISS by the area under ROC curves<sup>(6)</sup>. The area under the ROC curve ranges from 0.5 to 1.0 and the larger area indicates a better accuracy of a prediction model.

The results of the study demonstrated that the predictive accuracy of ISS and NISS was slightly different, however, statistical significance was detected. The area under ROC curves derived from the ISS and from the NISS were both relatively larger than previous studies summarized in Table 3. The explanation concerning the discrepancy of the area under ROC curves among studies may be based

on the principles<sup>(9)</sup> that the area under ROC curves will be minimized and the difference will be maximized if the cases of intermediate prognosis are evaluated. It can be seen from the Table 2 that about 80 per cent of our patients were in the least severe group. In Table 3 which summarizes the results from previous studies and our study, the severity scores and mortality rate of our patients were the lowest while the area under ROC curves were the highest. This phenomenon may be due to the majority of our patients being relatively less severe, making it easier to predict the mortality.

The authors concluded, under our setting, that NISS predicted the mortality rate in trauma patients better than ISS and confirmed the results of previous studies.

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## ความสามารถของ NISS และ ISS ในการพยากรณ์อัตราการตายของผู้ป่วยบาดเจ็บ†

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จากรายงานผลการศึกษาก่อนหน้านี้มีผู้แสดงให้เห็นว่าการวัดความรุนแรงของการบาดเจ็บในรูปของ New Injury Severity Score (NISS) จะให้ผลถูกต้องกว่าแบบดั้งเดิมคือ Injury Severity Score (ISS) การศึกษานี้จึงต้องการศึกษาว่าสิ่งนี้เป็นจริงหรือไม่เมื่อนำมาใช้ในประเทศไทย โดยศึกษาเปรียบเทียบความแม่นยำของวิธีทั้งสองในการพยากรณ์การเสียชีวิตในผู้ป่วยบาดเจ็บที่เข้ารับการรักษาในโรงพยาบาลสงขลานครินทร์ตั้งแต่มีนาคม 2539 ถึงพฤษภาคม 2542 ข้อมูลการบาดเจ็บของผู้ป่วยจะถูกรวบรวมและเข้ารหัสตาม AIS-90 แล้วคำนวณหาค่า ISS และ NISS วิธีการเปรียบเทียบความแม่นยำทำได้โดยใช้พื้นที่ใต้ receiver operating curves (ROC curves) ผลการศึกษาพบว่า ในจำนวนผู้ป่วยที่เข้ารับการรักษาในโรงพยาบาล 2,044 รายนั้น มีผู้เสียชีวิต 114 ราย ค่ามัธยฐานของค่า ISS และ NISS ในผู้ป่วยที่เสียชีวิตคือ 4 และ 8 ตามลำดับ ค่ามัธยฐานของค่า ISS และ NISS ในผู้ป่วยที่รอดชีวิตคือ 25 และ 38 ตามลำดับ พื้นที่ใต้ ROC curve ของ NISS (0.966; 95% C.I. = 0.965 – 0.967) มากกว่าของ ISS (0.974; 95% C.I. = 0.973 – 0.975) อย่างมีนัยสำคัญทางสถิติ ( $p < 0.05$ ) ผลการวิจัยสนับสนุนผลการวิจัยก่อนหน้านี้ที่ว่า NISS สามารถพยากรณ์อัตราการตายในผู้ป่วยบาดเจ็บได้ดีกว่า ISS ผู้วิจัยจึงเสนอให้ใช้ NISS แทน ISS ในการวัดความรุนแรงของการบาดเจ็บ

**คำสำคัญ :** การบาดเจ็บ, ความรุนแรง, การวัด

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