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A scoring system for predicting outcomes of patients in a medical intensive care unit.

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The Hanover Intensive Score (HIS) was modified for simply using in a medical intensive care unit (ICU). The modified score evaluated cerebral, cardiovascular, respiratory, gastrointestinal, renal and immunologic factors of the patients for predicting the severity of the diseases or outcomes (death or survival). One hundred and fifty medical records of the patients admitted in the medical intensive care unit at Chulalongkorn Hospital were retrospectively analyzed to find a new cut-off point of the modified score and additive fifty medical records were used to prove the validation of the new score.

The study revealed that the modified HIS was proved to be of value in predicting the patients's outcomes with 80.7% accuracy which might be helpful to the physicians for decision-making to select the proper patients for admitting in ICU; and this might cause more efficient and effective ICU admission in the future. However, the further prospective test of this new score, and the comparison with other scoring systems appeared warranted.

Key words : *Scoring system, Prediction, Outcomes, Intensive care unit.*

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พลรัตน์ วิไลรัตน์. ระบบคะแนนสำหรับพยากรณ์ผลการรักษาในหอผู้ป่วยหนักทางอายุรกรรม. จุฬาลงกรณ์เวชสาร 2536 มกราคม; 37(1): 37-45

ได้ทำการดัดแปลงระบบคะแนนฮาโนเวอร์ เพื่อทำให้ง่ายต่อการใช้ในหอผู้ป่วยหนักทางอายุรกรรม (ไอซียู) ระบบคะแนนใหม่นี้ได้ประเมินผู้ป่วยทางด้านระบบประสาท ระบบหัวใจและหลอดเลือด ระบบทางเดินหายใจ ระบบทางเดินอาหาร ระบบไต และระบบภูมิคุ้มกัน เพื่อที่จะทำนายความรุนแรงของโรคหรือผลของการรักษาว่าจะเสียชีวิตหรือไม่ โดยได้ศึกษาย้อนหลังจากประวัติผู้ป่วยหนักทางอายุรกรรมของโรงพยาบาลจุฬาลงกรณ์ จำนวน 150 ราย เพื่อหาจุดตัดของระบบคะแนนใหม่ และได้ทดสอบความถูกต้องของระบบคะแนนใหม่นี้ในผู้ป่วยหนักอีกกลุ่มหนึ่ง จำนวน 50 ราย

จากการศึกษาพบว่าระบบคะแนนฮาโนเวอร์ ที่ได้ปรับปรุงใหม่นี้มีคุณค่าในการพยากรณ์ผลการรักษาผู้ป่วย โดยมีความแม่นยำ 80.7% ซึ่งอาจจะเป็นประโยชน์สำหรับแพทย์ในการพิจารณาตัดสินใจผู้ป่วยเข้ารักษาในหอผู้ป่วยหนัก ว่าควรเลือกผู้ป่วยรายใดเข้าก่อน และจะทำให้การรับผู้ป่วยหนักมีประสิทธิภาพและประสิทธิผลมากขึ้นในอนาคต อย่างไรก็ตามการทดสอบระบบคะแนนนี้แบบไปข้างหน้า รวมทั้งการเปรียบเทียบกับระบบคะแนนอื่น ๆ ควรจะได้ทำต่อไป

Decisions for management of patients in a medical intensive care unit (ICU) are complex, compelling, critical, and costly. Classification and aggregation of patients according to differential care needs have been accepted as normal features of contemporary hospital practice. The ICU is a site where the classifications may be useful.

Patients admitted to an ICU are either extremely ill or considered to be at great risk of serious complications requiring the special technology and highly skilled care available in an ICU. . The criteria for ICU admission vary widely, however, depending on patient mix and hospital type.[1]

There were no widely accepted criteria for distinguishing between patients who should be admitted to an ICU and those for whom admission to other hospital units would be appropiate. Thus among different ICU's there are wide ranges in a patient's chances of survival.

Several classification or scoring systems have been devised for ICU patients.[2] They may be used to determine whether a suspected risk factors is important in predicting outcome and symptoms with prognosis. The accept form for such classification involves both identifying and quantifying risk factors as they may be predictive of death. Some of the better known systems include the Therapeutic Intervention Scoring System (TISS), the Acute Physiology and Chronic Health Evaluation (APACHE and APACHE II), the Acute Physiology Score (APS), and the Simplified Acute Physiology Score (SAPS).[3-7]

Most scoring systems use many physiologic, laboratory, and clinical data involving the complicated mathematic conversions to come to a single prognostic number. A perfect scoring system should be simple. The requisite data should be easily obtained and analyzed. Of importance is that the resulting numerical score should have a high sensitivity and specificity or accuracy when tested independently in different clinical surroundings.[1,2]

The Hanover Intensive Score (HIS) was recently developed for predicting the lethal outcomes in surgical intensive care unit.[2] The risk factors involved 6 organ systems: cerebral, cardiovascular, respiratory, gastrointestinal, renal, and immunologic systems. The HIS had superior accuracy in prediction of the lethal outcomes and also was easier to score than APACHE which was one of the popular scoring systems presently in use. However, the HIS had a few surgical requisite data. If the HIS was modified by excluding the surgical data, it might be used for predicting outcomes of the patients in a medical ICU.

The objectives of the present study were 1) to modify the HIS in order to use in a medical intensive care unit, and 2) to evaluate the diagnostic validation of the new modified score.

Patients and methods

Patients

Between February and September 1989, the available medical records of 150 patients admitted to the medical ICU, Chulalongkorn Hospital were retrospectively studied.

The patients (the first group, n = 150) were 69 males (46%) and 81 females (54%). Age ranged from 15-91 years and 16-101 years with an average of 57.1 years and 60.6 years in males and females respectively (Table 1 and Fig. 1A). The systems of diseases on admission were cardiovascular (75.3%), respiratory (8%), infectious (10.7%), renal or toxicologic (5.3%), and endocrine (0.7%) systems. The causes of death in the patients (with mortality prevalence = 38/150 = 25.3%) were septic shock (52.6%), cardiogenic shock (15.8%), pulmonary edema (2.6%), respiratory failure (18.4%), acute myocardial infarction (7.9%), and others (2.7%).

Additional validation of the modified HIS was carried out in another 50 patients (the second group) admitted in the medical ICU. The patients comprised 23 males (46%) and 27 females (54%). Age ranged from 18-71 years and 18-82 years with an average of 56.6 years and 57.0 years in males and females respectively (Table 1 and Fig. 1B). The causes of death in this group (with mortality prevalence = 13/50 = 26%) were septic shock (53.8%), cardiogenic shock (15.4%), respiratory failure (15.4%), and arrythmia (15.4%).

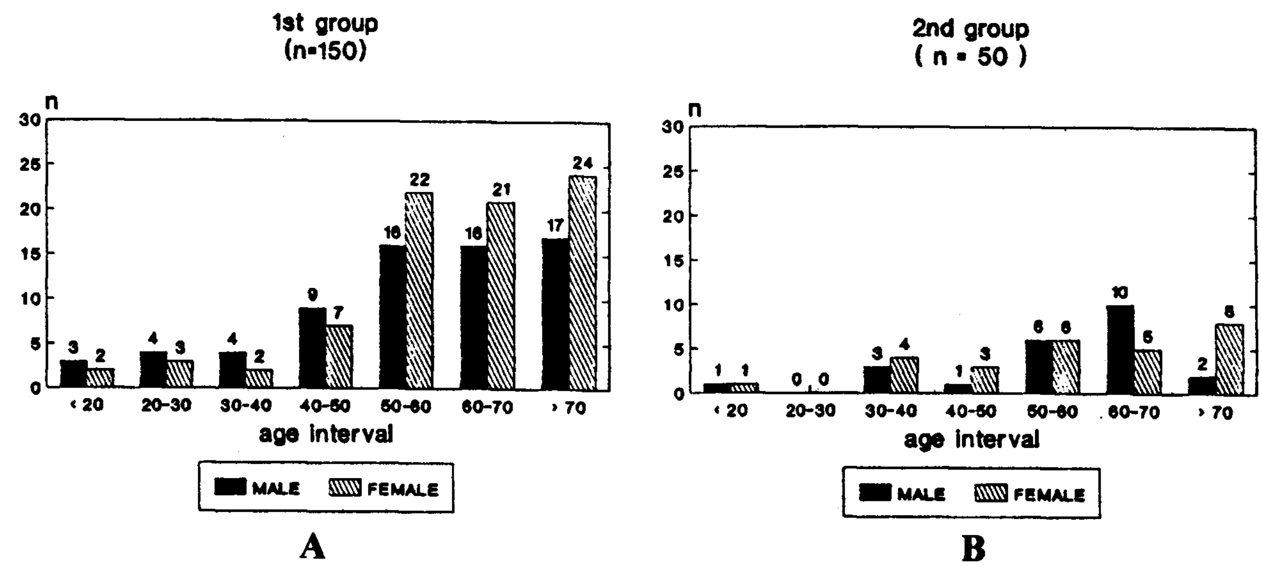


Figure 1. Age distribution of the first group (A) and the second group (B).

The durations of admission in both groups were shown in Table 1.

Table 1. Demographic data of the patients in the medical ICU.

Data	1st group (n = 150)		2nd group (n = 50)	
	male	female	male	female
Number (%)	69 (46)	81 (54)	23 (46)	27 (54)
Sex ratio:				
male:female	1:1.2		1:1.2	
Age (yrs):				
range	15-91	16-101	18-71	18-82
$\overline{X} \pm SD$	57.1 ± 18.3	60.5 ± 15.9	56.6 ± 13.9	57.0 ± 17.1
ICU days:				
range	1-61	1-22	1-30	1-14
$\overline{X} \pm SD$	6.6 ± 8.5	5.4 ± 4.7	7.1 ± 6.4	4.4 ± 3.7
Scores:				
range	0-16	0-13	1-30	1-14
$\overline{X} \pm SD$	4.8 ± 3.8	4.2 ± 3.3	4.4 ± 2.9	4.4 ± 3.7

Methods

The HIS[2] was modified by excluding the following requisite data: bowel obstruction, anatomosis leakage, disseminated intravascular coagulation (DIC), partial prothrombin time (PTT), antithrombin III (AT III), and creatinine clearance (Ccr). The SI units were changed to the current units used at Chulalongkorn Hospital. Blood glucose and prothrombin time (%) were also changed to plasma glucose and prothrombin time (ratio) respectively.

The data recorded in the modified HIS, the new score, were demonstrated in Table 2. The risk factors involving 6 organ systems were identified and quantified, each to a maximum of 3 points.

Table 2. Data record in the modified HIS.

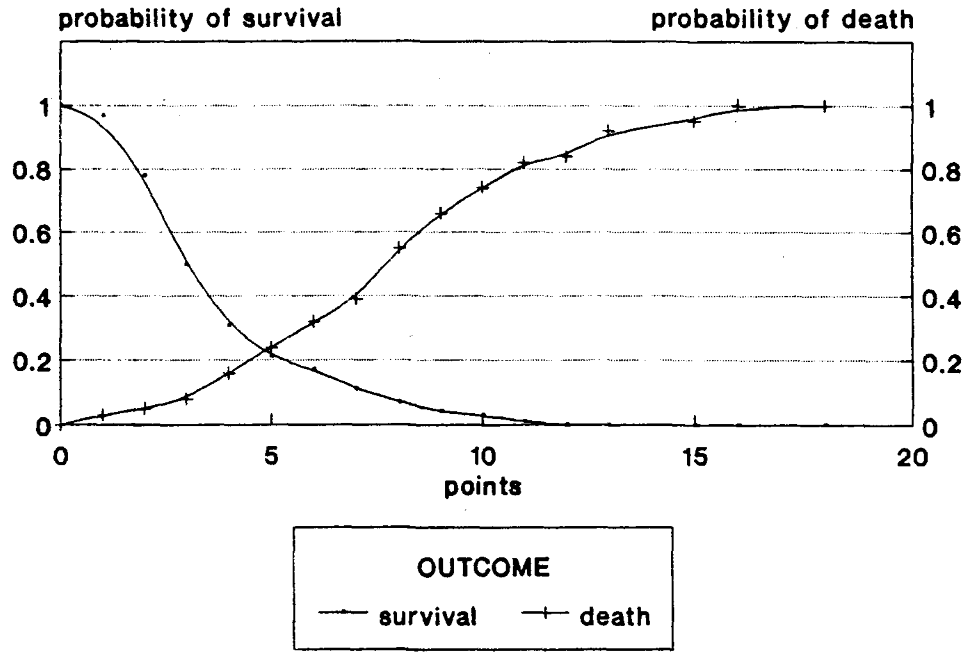
points

organ function	0	1	2	3	additional points	SUM
cerebral function CNS Glasgow Coma Scale	oriented 13-15	purposeful response to pain 7-12	unmotivated reaction to pain 4-6	no pain reaction <3	fits, extention-spasm extensor plantar response	
cardiovascular function HR/BP syst HR (f/min)	≤0.85 70-110	0.86-0.99 111-140	1.0-1.2 141-180	>1.2 >180 <40	resuscitation dopamine >200 mg/day, other catecholamine VES, SVES antiarrythmics	
respiratory function PEEP/CPAP FiO_2	spontaneous breathing 0.21	controlled ventilation mech. support ≤10 cm H_2O ≤0.4	augmented ventilation IRV >10 cm H_2O ≤0.6	>0.6	pneumothorax, thoracic drainage	
gastrointestinal function liver prothrombin time (ratio) plasma glucose (mg/dl)	normal	OT,PT>200 U Bilirubin amylase>500 U >2	OT,PT>100 U cirrhosis jaundice >3.9		infusion of clotting factors <36 >546	
renal function S-creat (mg/dl) BUN (mg/dl) urine output S-potassium	<2.3 19.8-40.2	<4.5 >40.2 diuretics	<8 oliguria polyuria	>8 uremia anuria >6	macro-hematuria	
immunologic function temperature (C) WCC/mm^2 platelets/mm^2	36.5-38.5 3000-14900	38.5-38.9 33.9-36.4 15000-19900	39.0-40.9 < 34.0 20000-29900 <3000	>41 >30000	pos. blood culture < 120000	
					TOTAL	

Within each organ-function group, only one degree (0-3) is to be marked. Additional points can be added according to the table. The sum of all organ-function groups reflects the final score.

CNS = central nervous system, HR = heart rate, BP syst = systolic blood pressure, VES = ventricular extrasystoles, SVES = supraventricular extra-systoles, PEEP = positive end-expiratory pressure, CPAP = continuous positive airway pressure, mech = mechanical, IRV = inversed-ratio ventilation, FiO_2 = inspiratory concentration of O_2, OT/PT = SGOT/SGPT (liver enzymes), S-creat = serum creatinine, WCC = white cell count, pos = postive.

Each patient was "scored" under evaluation within the initial 24 hours following the ICU admission. Fig. 2 showed the curves of the probabilities of survival and death plotted together in order to find the new cut-off point of the modified score in predicting the lethal outcome. The right curve of "the probability of death" was the score sensitivity of death (the percentage of the dead patients who were detected as dead by each score point on X-axis). And the left curve of "the probability of survival" was the score specificity (the percentage of the survival patients who were labelled by each score point on X-axis as survival or non-dead).(2,8)



The overlapping distribution of the score points in the dead patients and survival (non-dead) patients using the cut-off point at score = 5. Changing the cut-off point affected the sensitivity and specificity of the test of the modified HIS eg., moving the cut-off point to the left increased sensitivity and decreased specificity (high false positive) and moving the cut-off point to the right increased specificity and decreased sensitivity (low false positive). (see text)

Figure 2. Prognostic probability of the modified score for death and survival.

Statistics

Differences between groups of patients were assessed using Chi-squared test for quanlitative data.

Result

The relationship between the probabilities of survival and death of all 150 patients (the first group) was shown in Fig. 2 with the new cut-off point of 5. The patients with admission score over 8 had more than 50% ICU mortality rate.

The diagnostic evaluation of the new score was demonstrated in Table 3A with the accuracy of 80.7%. In the first group, there were six non-survival patients with score less than 5. The first was liver cirrhotic patient with pneumonia, respiratory failure and suddenly died from septic shock. The second was chronic obstructive pulmonary disease (COPD) patient with pneumonia and respiratory failure. The third was the patient with diabetes melitus and hypertension admitted owing to acute pulmonary edema complicating acute myocardial infarction and died from respiratory failure. The forth was toxic goiter patient with pneumonia and respiratory failure and died from septic shock. The fifth was the patient with acute myocardial infarction, arrythmia and pulmonary edema; repiratory failure was the cause of death. The last patient had underlying COPD admitted owing to pneumonia with respiratory failure and died from septic shock.

The modified HIS was evaluated for the validation in another 50 patients (the second group)

(Table 3B). The accuracy of the tested group was 82%. There was no dead patient with score less than 5 in this group.

Table 3. Diagnostic evaluation* of the modified score for death (score ⩾ 5) and survival (score < 5) in the first group (A) and the second group (B)

A

1st group

(n=150)

Score	Outcome: Death	Outcome: Survival	Total
≥ 5	32 (a)	23 (b)	55
< 5	6 (c)	89 (d)	95
Total	38	112	150

Sensitivity (%)	= 84.2
Specificity (%)	= 79.5
Positive predictive value (PPV) (%)	= 58.2
Negative predictive value (NPV) (%)	= 93.7
Accuracy (%)	= 80.7

B

2nd group

(n=50)

Score	Outcome: Death	Outcome: Survival	Total
≥ 5	13 (a)	9 (b)	32
< 5	0 (c)	28 (d)	28
Total	13	37	50

Sensitivity (%)	= 100
Specificity (%)	= 75.7
Positive predictive value (PPV) (%)	= 40.6
Negative predictive value (NPV) (%)	= 100
Accuracy (%)	= 82

* sensitivity = a/(a+c), specificity = d/(b+d), positive predicive value (PPV) = a/(a+b), negative predictive value (NPV) = d/(c+d), accuracy = (a+d)/(a+b+c+d)

The overall mortalities of the first (25.3%) and the second (26%) groups of patients showed no statistically difference (P>0.05). The diagnostic accuracies between both groups had also no significant difference (P>0.05).

Discussion

Severity-of-illness classification systems have been suggested for improving staging of disease of case-mix analysis, comparison of ICU treatment and performance (quality assessment), and possibly clinical decision-making by providing an objective estimate of hospital mortality. Although numerous classification systems have been suggested, very few are applicable to general medical/surgical ICU patients.[9-12] These patients typically have complex conditions involving numerous organ systems and hemodynamic, neurological, and repiratory instability.

The number and diversity of the scoring systems for disease intensivity that have been developed within the past few years attest both to our confusion as how to best reduce to a simple number, the complexities or seriousness of illness and to the need for such a system.[2] Expected outcomes of treatment are only valid if comparisons are made between the groups of patients with equivalent severity of illness.

However this is arrived at, it is the essence of a scoring system.

In this study, the HIS was selected to be modified because of its simple use with high accuracy. The author chosed the requisite laboratory data which could be quickly and easily performed in a short time, as well as, inexpensive and also available in many hospitals. The surgical data were all excluded and the SI units of laboratory parameters were changed to the current units used at Chulalongkorn Hospital which were also more familiar to many doctors in Thailand. The overall mortalities of both groups of the patients were not so much different from the previous study at the same medical ICU in 1986.(13) The score had high accuracy of diagnostic test of about 81%. The validation test (Table 3B) confirmed that the modified score had a consistent diagnostic accuracy of predicting outcomes.

The ability to predict death is one of the important features for the patient assessment. Thus, the physician can treat patients who may benefit from vigorous intervention. This may be especially important when there are several severely ill patients admitted in the hospital at the same time. Thus, costs of intensive care facilities may be reduced if such a scoring system is used. Jacobs el al found that use of such facilities in Canada amounted to 42 patient days/1000 population in 1986 and 108 patient days/1000 population in the USA; total intensive care costs were estimated at 20% of all inpatient costs in the USA.(14) In 1988 the Society of Critical Care Medicine recommended that objective measures should be used for admission criteria to intensive care whenever possible, with less priority given to patients with poor outlook when there is high intensive care use and beds are scarce.(15) Statistical analysis of an ethical issue such as survival prediction should be used with caution, because any statistical method includes a margin of error. In this study, the sensitivity of predictive death (the probability curve of death in Fig. 2) could be increased by adjusting the cut-off point in the modified score to be lower than 5, however the specificity and the accuracy of the score would be reduced.(8)

Although the APACHE and APACHE II are popular scoring systems presently in use, they involves 12 variables including rectal temperature, mean arterial pressure, heart rate, arterial oxygen pressure, arterial pH, hematocrit, and serum levels of potassium, sodium, and creatinine, leukcocyte count and a form of the Glasgow Coma Scale.(5,6) As might be imagined, this mixture of many physiologic, laboratory, and clinical data involves a complicated mathematic conversion to come to a single prognostic number. Therefore, the APACHE and APACHE II may not be easy and practical for use in clinical practice.

The modified HIS fulfilled two important points for a predictive outcome score; it used a few simple variables for rapid assessment of the patient and it showed a high accurate prediction of non-survival. The author believed that the use of the new modified score would provide a simple way to make an early prediction about the probability of patients' outcomes.

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