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A New Scale For Assessing the Severity of the Condition and Prediction of Neuroreanimational Patients

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Abstract: The methodological development is devoted to improving the methods for assessing the outcome, predicting and treating patients with acute traumatic and vascular diseases of the brain. The results of studying the effectiveness and determining the outcome according to the proposed new scale based on objective clinical and laboratory studies are presented.

Keywords: Glasgow scale, cerebral edema, score, neuroresuscitation.

Relevance. One of the rapidly progressing areas in clinical medicine is undoubtedly the prediction of diseases using special models and scales. The usual empirical approach is limited by the capabilities of a specialist, cannot be used by young doctors, does not always give a stable result, is not transparent, and is limited in improving diagnostic capabilities. One of the ways to improve the efficiency of tasks solved by a doctor is the use of special scales to assess the likelihood of diseases at the current time (diagnosis) or in the future (prognosis) [5].

The main task of the anesthesiologist - resuscitator is the timely identification of patients with an initially high risk of prognosis and the desire to minimize their development through strict adherence to preventive measures and closer and longer monitoring of these patients in the ICU. For this, a necessary condition is an adequate assessment of the severity of the patient's condition upon admission to the intensive care unit.

In medical practice, there is a method for determining the severity of a patient's condition based on the experience of a doctor - a subjective expert assessment that allows you to analyze any period of the disease and divide the condition into "satisfactory", "moderately severe", "severe" and "extremely severe". Such an assessment of the condition does not have clear criteria and a single interpretation, but is often used in practical medicine. But the experience and knowledge of clinicians is not always sufficient to make the only correct decision regarding the assessment of the outcome in a particular patient, the choice of the method of intensive care, as well as the predictive assessment of the results of each treatment option. Adequate assessment of the severity of the condition and prediction of the further course of the disease, based on an assessment of the dynamics of organ and functional disorders, allows you to more carefully determine the indications for transferring the patient to the intensive care unit (ICU), as well as the timely transfer of the patient from the ICU to the specialized department. Difficulties often arise when it is necessary to predict the patient's outcome in the short term. In this situation, it is difficult to imagine a comparable alternative to prognostic scales [2]. It is also necessary to take into account modern legal aspects of medicine, when the primary objective assessment of the severity of the patient's condition upon admission to the ICU, through the use of objective methods, allows one to reasonably protect the honor and dignity of medical staff in case of unjustified accusations of their involvement in the onset of an adverse outcome in a serious patient [2,7].

Assessment of the severity of the condition of intensive care patients is necessary to solve problems, the main of which are not only medical, but also legal. The experience and knowledge of clinicians is not always sufficient to make decisions regarding the assessment of the outcome in a particular patient,

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the choice of a method of therapy, as well as the prognostic assessment of the results of each treatment option. Decisions involving predicting the likelihood of developing a particular outcome, including death or disability, are often based on the personal experience of the doctor and are not always scientifically confirmed. Particular difficulties arise when it is necessary to predict the patient's outcome in the short term. At the same time, predicting the outcome of an intensive care patient is the direct responsibility of the attending anesthesiologist-resuscitator. This is necessary in order to optimally allocate resources (human, medicinal, technical, financial) and select adequate therapeutic and diagnostic strategies. Based on these considerations, the prediction of disease outcomes remains the most important aspect of clinical medicine. The interest in predicting outcome as a tool for decision-making stems from the need to improve predictive estimates in the face of limited clinician experience and limited scientific evidence in this area.

The volume of data obtained using clinical, laboratory and instrumental research methods has grown exponentially over the past few decades. The increased volumes of information potentiate great difficulties in integrating these data in order to obtain reliable estimation and prognostic decisions. The need to simultaneously use large amounts of information can lead to inefficient decision-making, unjustified differences in treatment approaches, and errors. An incorrectly assessed prognosis in an intensive care unit patient is fraught with either an unjustified escalation of therapy, which is often itself unsafe, or, on the contrary, a refusal of therapy in favor of elementary life support measures [11,12].

Choosing the right solution is critical to choosing an adequate intensive care strategy. In order to make the right decision regarding the assessment of severity and prognosis regarding the patient of the intensive care unit, it is necessary to use special tools - scales for assessing severity and predicting outcome [4].

To solve the problem of an objective assessment of the severity of polytrauma, numerous studies focus on the search for independent prognostic factors of a lethal outcome, many of which are included in scoring scales and statistical models that make it possible to quantitatively rank the severity of an injury in established intervals and calculate the probability of survival. More than 50 different scales have been created, but only the most effective and easy to use are discussed in the literature [1,10].

When assessing the severity of polytraumas, it is generally accepted to take into account the anatomical criteria that determine the severity of injuries, and the physiological parameters that characterize the response of the body's functional systems to the injuries received. If the morphological component of polytrauma is relatively stable, then the physiological parameters are labile and can change during intensive care and at different periods of traumatic disease [9,15].

An objective analysis of the results of treatment of patients in single-profile departments is not possible without clear criteria for the severity of the condition, on the basis of which the outcome of the disease is predicted. Existing systems for assessing multiorgan damage have almost the same methodological approach, however, the effectiveness of different scales for assessing the severity of the condition is different depending on the nature of the initial primary pathology. It was shown that the correct prognosis of the outcome of neurosurgical patients was 85.5% on the APACHE III scale, 77.5% on the APACHE II scale, and 75% on the Glasgow Coma Scale (GCS). The APACHE III system showed better results for survival prognosis than the Glasgow and APACHE II scales ($p<0.01$) [3]. APACNE III correlated better with outcomes in patients with severe traumatic brain injury than did the Glasgow Coma Scale (Lai et al., 1998). According to V. Gasparovic [13], APACHE II does not replace GCS in assessing the severity of the condition and predicting outcomes in patients in non-traumatic coma. To assess mortality, GCS is the most convenient approach for these patients (simple, fast, effective in an emergency) [6].

At the same time, many modern methods of instrumental and laboratory diagnostics are used, and their data can be used in various scales. The lack of time for mathematical calculations, the constant improvement and change in medical technologies, the different equipment of trauma hospitals cast doubt on the possibility of establishing a single standard for an objective assessment of the severity of

injuries in trauma centers. There are 4 main tasks that different authors tried to solve by inventing a new diagnostic scale: 1 - classification of injuries, 2 - sorting of victims, 3 - an objective assessment of the severity of the injury, 4 - the most accurate prediction of the outcome of the injury [14]. These tasks have something in common with each other, since the more severe the injury, the faster the need to provide assistance and the worse the prognosis of its outcome [14,16].

The predictive value of the scale is of particular importance in the hospital, since the exact probability of the outcome of an injury can affect the calculation of the cost of treating a patient, and also help to assess the quality of care retrospectively [8].

GCS is the most common and well-known system for assessing the severity of a condition. Pupillary, motor, and speech responses are included in the GCS, and these data have been used alone or in combination with other neurological data to describe the severity of brain injury in patients with head trauma, cardiac arrest, intracerebral hemorrhage, cerebral infarction, sepsis, and other non-traumatic coma. GCS has also been included in the most modern systems for assessing the severity of the condition, including the assessment of the probability of death (MRM II); simplified scale of acute conditions (SAPS II); the risk of mortality in pediatrics (PRISM); and the Acute Physiological Disorders and Chronic Conditions Assessment Scale (APACHE II and III). GCS has also been used to create computer programs in determining outcome in patients with severe head injury and to measure impairment of these outcomes in patients during treatment (Murray et al. 1993). Despite its worldwide acceptance and predictive value, GCS has several important limitations.

First, the scale is not suitable for the initial assessment of patients with severe head trauma. This is because highly trained emergency medical personnel must intubate, sedate, or myoplegate these patients before being transported to the hospital. As a result, it is not possible to accurately determine the GCS score in almost 50% of patients with brain injury who are in a coma at the ambulance stage.

Second, patients with severe head trauma often need to use sedatives, narcotics, and muscle relaxants to control elevated intracranial pressure. Thus, it is difficult to accurately determine the daily GCS score for these patients while they are in the neurocritical care unit.

Third, periorbital swelling, hypotension, hypoxia, and intubation may be associated with scoring bias.

Therefore, recommendations developed to address these issues include:

1. Determine GCS scores within 1-2 hours after injury;

2. Do not determine until stabilization of hypotension or hypoxia;

3. Use reactions from the eyes - 1 point in patients with severe periorbital tumor;

4. Strictly adhere to the instructions set out in the original GCS;

5. Postpone the determination for 10-20 minutes to determine the half-life of drugs that led to sedation or paralysis;

6. Record GCS scores if there is no previous determination and sedatives and myoplegics cannot be reduced. Currently, there are no sensitive scales that allow assessing the state of cerebral functions. Thus, alone or in combination with APACHE III, or another prognostic system (eg, PRISM), GCS is an important prognostic criterion for disease outcome. That is why every effort should be made to implement GCS assessment in all ICUs.

The relatively simple APACHE II scale is still widely used. Significant changes in the treatment of patients since the time the scale was created have led to a decrease in the accuracy of the prognosis.

Disadvantages of the APACHE II scale.

1. The inability to use up to 18 years.

2. The general state of health should be assessed only in seriously ill patients, otherwise the addition of this indicator leads to an overestimation.

3. No score prior to admission to the intensive care unit, (appeared in the APACHE III scale).

4. In case of death within the first 8 hours after admission, data evaluation is meaningless.

5. In sedated, intubated patients, the score on the Glasgow scale should be equal to 15 (normal), in the case of a history of neurological pathology, this score can be reduced.

6. With frequent reuse, the scale gives a slightly higher score.

7. A number of diagnostic categories are omitted (pre-eclampsia, burns and other conditions), and the ratio of the damaged organ does not always give an accurate picture of the condition.

8. With a lower diagnostic coefficient, the scale score is more significant.

Subsequently, the scale was transformed into the APACHE III scale. APACHE III was developed in 1991 to extend and improve the APACHE II predictive scores [2].

It is important to emphasize that prognosis scales are not designed to predict the death of an individual patient with 100% accuracy. High scores on the scale do not mean complete hopelessness, just as low scores do not insure against the development of unforeseen complications or accidental death. Although the prediction of death using APACHE III scores obtained on the first day of ICU stay is reliable, it is rarely possible to determine an accurate prognosis for an individual patient after the first day of intensive care. The ability to predict a patient's individual likelihood of survival depends, among other things, on how he or she responds to therapy over time. Clinicians using predictive models should be aware of the possibilities of modern therapy and understand that the confidence intervals for each value are expanding with each passing day increasing the number of positive results, which tend to be more important than absolute values, and that some factors and response rates for intensive care are not determined by acute physiological abnormalities.

Thus, the question of the effectiveness of different systems in neurocritical patients remains insufficiently studied.

A topical issue today can be considered the expediency of using rating scales in providing care to patients with severe concomitant traumatic brain injury at the hospital stage.

Material and research methods. An analysis of the objective status was carried out in 105 patients admitted to the neuro-reanimation department of the Bukhara branch of the Republican Scientific Center for Emergency Medical Care during 2021-2022. The severity of the condition was assessed at admission using the Glasgow and Glasgow Pittsburgh Coma Scale. The patients were divided into 2 groups: 1st - patients with traumatic brain injury (n=39), 2nd - patients with non-traumatic brain injury (n=66). All patients received standard intensive therapy: mechanical ventilation, correction of hemodynamics (ensuring cerebral perfusion pressure >70 mm Hg), water and electrolyte balance, acid-base, gas and temperature homeostasis, early enteral nutritional support from 2-3 days, antibiotic therapy, and as well as the prevention of exacerbations and the treatment of comorbidities.

Results of the study and their discussion. When evaluating on a new predictive scale, the outcome of the disease was compared with other traditional scales (APACHE III, SAPS II, Glasgow scale) with depression of consciousness of 8 points or less, and 9 points or more (outside coma). We have received the following data (table 1).

Comparison of the severity of the condition on various scales in surviving and deceased patients
Table 1

Patients	**Dead**	**Survivors**	**p**
The severity of the condition according to the Glasgow coma scale			
Traumatic brain injuries	6,2±2,7	8,7±3,2	0,0002
Non-traumatic injuries	9,95±3,6	11,6±3,1	0,08
The severity of the condition according to APACHE III			
Traumatic brain injuries	79,1±24,4	61,4±28,7	0,0002
Non-traumatic injuries	70,9±25,5	55,1±20,4	0,004

The severity of the condition according to SAPS II			
Traumatic brain injuries	33,8±10,2	25,2±10,7	0,000003
Non-traumatic injuries	22,6±11,7	19,5±10,7	0,15
The severity of the condition according to the new scale			
Traumatic brain injuries	23,5±2,4	18,1±1,1	0,000003
Non-traumatic injuries	14,6±2,2	8,5±1,3	0,15

As can be seen from the table, the results of assessing the condition and prognosis of the disease showed a direct correlation with traditional scales (APACHE III, SAPS II). It should be noted that to calculate the prognosis using the above traditional scales, complex laboratory and instrumental tests are required, which is beyond the power of every medical institution. On the contrary, the use of the new scale requires minimal laboratory, instrumental and clinical data, which makes it convenient, simple and low-cost .

The SAPS II score consists of 12 physiological variables and 3 disease-related variables. The worst physiological parameters will be collected during the first 24 hours after admission to the intensive care unit. The "worst" dimension will be defined as the dimension that correlates with the highest score. The study did not perform continuous SAPS II scoring after the first 24 hours of stay in the intensive care unit. The SAPS II score ranges from 0 to 163 points.

The APACHE II score also consists of 12 physiological variables and 2 disease-related variables. During the 24 hour study period, 87% of all ICU patients will have all 12 physiological measurements available. The worst physiological parameters will be collected within the first 24 hours after admission to the intensive care unit. The "worst" dimension will be defined as the dimension that correlated with the highest score. The study did not perform continuous APACHE II scoring after the first 24 hours of stay in the intensive care unit. The APACHE II score ranges from 0 to 71 points; however, no patient rarely scores more than 55 points.

The **Glasgow Coma Scale** (GCS, Glasgow Coma Severity Scale) is an assessment of the level of impaired consciousness and the degree of coma. Three tests serve as diagnostic criteria: eye opening, speech and motor reactions of the patient. The Coma Scale was published in 1974 by the University of Glasgow, Scotland. For each test, a certain number of points is awarded: in total, the minimum number of points is 3 (deep coma), the maximum is 15 (clear consciousness).

When developing a new scale, the factors influencing the outcome of the disease in neurocritical patients were divided into extracranial and intracranial. Of the laboratory analyzes, only the index of the ratio of stab neutrophils to lymphocytes (IRNL) was used, which is important in assessing the effectiveness of treatment, determining the outcome and predicting the disease in neurocritical patients.

When calculating the scores, a direct proportional relationship was found between the mortality rate and the total score, the higher the total score, the higher the risk of death. Based on this, 3 categories were identified: category 1, in which the total score was up to 15 points, the probability of lethality corresponds to less than 25%, in the second category, where the total score ranged from 16 to 25 points, the probability of lethality corresponds to 50%. In the third category, where the total score ranged from 26 to 33 points, the probability of lethality corresponds to 75%.

Thus, the simplicity of this scale makes it possible to use it every day to assess the effectiveness of ongoing intensive care and will enable timely correction. The new scale can be used in any intensive care unit to assess the prognosis of the outcome of the disease.

A new scale for assessing the outcome of the disease in neurocritical patients. Table 2.

Factors	Indicators	Maximum and minimum scores	Patient scores by day		
			1	2	3
Intracranial factors	Volume of hematoma/ischemic focus	More than 30 cm3 - 3 points Less than 30 cm3 - 1 point			
	Severity of cerebral edema on MSCT (smoothness of tuberosity of the cerebral cortex, compression of cisterns and ventricles - underlined)	The presence of signs - 3 points Absence of signs - 0 point			
	Dislocation of median structures	More than 5 mm -2 points Less than 5 mm - 1 point			
	Involvement in the pathological process of brain stem structures	Yes - 3 points No - 0 point			
	violation of liquor circulation (occlusive hydrocephalus)	Есть – 1 балл Нет – 0 балл			
	Depth of disturbance of consciousness	Less than 5 points on the GCS - 3 points 5-10 points on the GCS - 2 points More than 10 GCS points - 1 point			
Extracranial factors	The presence of respiratory disorders	Yes - 2 points No - 0 point			
	Hemodynamic instability	Yes - 2 points No - 0 point			
	Damage to other organs or systems	Yes - 2 points No - 0 point			
	blood loss	Yes - 2 points No - 0 point			
	state of shock	Yes - 2 points No - 0 point			
	IRNL - index of the ratio of neutrophils to lymphocytes.	More than 4 - 3 points Less than 3 - 1 point			
	Comorbidities	Yes - 2 points No - 0 point			
	Delivery time of the patient from the onset of the disease	More than 6 hours - 2 points Less than 6 hours - 1 point			
	ALV	Yes - 3 points No - 0 point			
Total score from 5 to 33 points					

Interpretation of results:
up to 15 points, the probability of lethality is less than 25%,
from 16 to 25 points, the probability of lethality is up to 50%.
from 26 to 33 points, the probability of lethality is up to 75%.

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