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Determining the severity concomitant abdominal injuries in individuals of various ages methods and approaches

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ABSTRACT

The studies conducted to determine the prognostic significance and statistical validity of empirically selected anthropometric, clinical, instrumental, and laboratory parameters allowed us to develop integral scales for predicting the probability of a severe course of CAT in different age groups of patients. Our proposed new integral scales for predicting the likelihood of a severe course of CAT in different age groups of patients have a high sensitivity and specificity. Its widespread use will therefore allow an objective assessment of the severity of the course of CAT in different age groups of patients, which will consequently lead to improved treatment outcomes in these patients.

1. INTRODUCTION

Predicting the severity category of the existing injuries is important for choosing a reasonable treatment tactic in patients with combined abdominal trauma. It is obvious that such prediction will not only allow choosing the tactics of treatment but also make it possible to determine the scope of necessary measures of preoperative and postoperative intensive care [1], [2], [8], [11], [13], [16]. It should be noted that in addressing the problem of fully assessing the severity of existing combined injuries, numerous studies have focused on the search for independent prognostic factors (referred to in the current literature as predictors) of their outcome. It is generally accepted that predictors can be in the form of anatomical criteria that determine injury severity, and physical parameters that express the response of the body's functional systems to the injuries sustained [3], [6], [7], [12], [14]. For example, the authors consider age, gender, comorbidities, all clinical parameters, index of acidosis, coagulopathy, oxidative stress, inflammatory response, acute diagnosis and quality of treatment, and the need for various emergency interventions to be independent predictors of mortality of combined

injuries. By incorporating predictors into multiple point scales and statistical models, researchers try to quantitatively rank injury severity in defined intervals and calculate survival probabilities. Best known among the latter are the Injury Severity Score (ISS), the Revised Trauma Score (RTS), and the Simplified Assessment of Physiological Disorders Scale (SAPS) [4], [5], [9], [10], [13], [18].

It should be noted that the development of a universal scale is hampered by the wide range of lesions and disorders occurring in the body after a combined injury and the lack of study of predictors of injury outcome. For this reason, the above scales have certain limitations [3], [5], [11], [15], [17].

One of the most significant is the lack of age-specific ranking scales for the severity of combined injuries for different age groups. Furthermore, the scoring mechanism utilized in these scales to evaluate chosen predictors is subjective in character and is based mostly on the clinical expertise of professionals. In addition, the ratings cannot fully express the degree of change in the predictors, i.e., their predictive 'weight' in assessing the severity of the existing co-injury course.

The aim of the study was to develop integral scales for predicting the severity of combined abdominal injuries for different age groups of patients.

2. Materials and methods

We attempted to address this problem by modifying and adapting the well-known ISS and SAPS scales to combined abdominal injuries. Along with this, retrospective probing was carried out to determine the prognostic significance and statistical reliability of anthropometric, clinical, instrumental, and laboratory indicators of the risk of developing a severe course of combined abdominal injuries, that were selected from the above scales.

Statistical analyses were performed on discrete groups of patients who had no history of severe combined abdominal trauma and on groups of patients who had a history of severe abdominal trauma: children (0-18 years) - 48 patients, adults (19-60 years) - 52 patients, and the elderly (over 60 years) - 34 patients.

3. Results and discussion

We calculated the $\chi 2$ values for each of the selected indicators. The maximum value of the latter was 3.84. The excess of the foreseen indicators $\chi 2$ of this critical value was assessed by us as evidence of the statistical reliability of this indicator ($P < 0.01$) (Tables 1, 2, 3).

Table 1. Reliability and probability of developing a severe course of CAT in the presence of the investigated factors in children (n=48)

Predictors	Total patients	These predictors were		$\chi 2$	Predictive Confidential (PC)
		In the non-serious course of CAT (n=19)	In the severe course of CAT (n=29)		
ISS ≥35	48	2	23	21,76	0,88
Blood loss Infants > 150.0 ml	48	2	24	13,89	0,90

older children > 500,0 ml		5	25	17,57	0,51
Weight, kg	48				
infants <10		8	21	4,41	0,23
older children <20		9	22	4,07	0,20
Systolic BP	48				
Infants ≤ 90 mmHg.		2	26	29,57	0,93
older children ≤ 80 mmHg.		4	24	17,98	0,59
Heart rate, per 1 min	48				
infants <119 or >160		4	28	29,44	0,66
older children <149 or >200		8	23	6,95	0,27
Breath rate in 1 min	48				
infants <50 or >90		6	24	12,83	0,42
older children <30 or >70		9	22	4,07	0,20
Glasgow scale consciousness <11	48	4	26	23,05	0,63
Blood Hb <70 mg/mL	48	5	22	11,45	0,46
Blood leukocytes <3,000, or> 40,000 (cl/mm3)	48	7	24	10,58	0,35
Platelets (cells per mm3) <120.0	48	9	23	5,27	0,22
Blood clotting time <2.0 min	48	10	25	6,55	0,21
Fibrinogen amyloidosis <3,0 m mol/l	48	8	21	4,41	0,24
Creatinine (mg/dL) > 10.0	48	10	23	5,27	0,18
Diuresis (ml / kg / hour) <1.0	48	9	22	4,07	0,20
Total bilirubin (mg / dL)> 3.5	48	10	23	5,27	0,18
Potassium, in mEq/L < 2.5, or> 8.0	48	7	24	10,58	0,35
Abdominal bloating	48	5	26	20,13	0,53
The presence of dullness in the sloping places of the abdomen	48	3	28	32,73	0,79
Weakened or absence of intestinal motility	48	4	27	26,5	0,65
Free air in the abdominal cavity (R-graphy)	48	2	27	34,59	0,95
FAST protocol fluid in:	48				
abdominal cavity		2	28	36,25	0,96
pleural cavity		4	26	23,05	0,63
The presence of retroperitoneal hematoma (MSCT)	48	7	23	8,83	0,33

Table 2. Significance and likelihood of developing a severe course of CAT in the presence of the studied factors in adults (n = 52)

	T ot	These predictors were		

Predictors		In the non-serious course of CAT (n=22)	In the severe course of CAT (n=30)	$\chi 2$	PC
ISS ≥25	52	2	28	36,90	1,01
Blood loss >1000 ml	52	1	27	37,29	1,30
Age >50 years	52	8	25	3,86	0,36
Obesity (BMI >30)	52	3	26	27,44	0,80
System. BP> 190 or <70	52	2	29	40,43	1,03
Heart rate, per 1 min >180 or <40	52	3	28	33,48	0,84
Breath rate in 1 min >50 or <6	52	5	29	30,66	0,63
Glasgow consciousness <11	52	4	28	30,29	0,71
Blood hemoglobin <90 mg/ml	52	7	25	14,23	0,42
Blood hematocrit <42%	52	6	26	18,92	0,50
Blood leukocytes(kl/mm3)>7000	52	8	26	14,19	0,34
Blood clotting time<3.0 min	52	9	27	14,36	0,34
Fibrinogen amyloidosis <3,2 m mol/l	52	7	26	16,47	0,44
Creatinine (mg/dL) > 10,0	52	9	22	5,54	0,25
Diuresis (ml/kg/hour) < 1.0	52	8	24	10,21	0,34
Total bilirubin (mg/dL)> 25.5	52	10	23	5,33	0,23
Potassium, in mEq/L <2.5, or > 7.0	52	6	25	21,54	0,49
Abdominal bloating	52	4	27	27,19	0,69
Presence of bluntness in the recesses of the abdomen	52	3	29	36,97	0,85
Weakened or absent intestinal peristalsis	52	4	28	30,29	0,71
Presence of free air in the abdominal cavity (R-graphy)	52	2	29	40,43	1,03
FAST protocol fluid in:	52				
abdominal cavity		1	29	44,13	1,33
pleural cavity		4	28	30,29	0,71
The presence of retroperitoneal hematoma (MSCT)	52	6	28	24,47	0,53

Table 3. Reliability and probability of developing a severe course of CAT in the presence of the studied factors (n=34) in the elderly

Predictors	Total patients	These predictors were		$\chi 2$	PC
		In a not serious course CAT (n=12)	In the severe course of CAT (n=22)		

ISS ≥10	34	1	21	25,81	1,06
Blood loss >1000 ml	34	2	21	18,74	0,76
Concomitant diseases:	34				
cardiovascular		3	20	15,41	0,56
respiratory		4	19	9,98	0,41
hepatobiliary		5	21	12,48	0,36
oncological		6	20	7,22	0,26
Diabetes mellitus	34	3	21	18,56	0,58
Obesity (BMI>30)	34	5	21	12,48	0,36
System. BP >190 or <70	34	2	21	22,02	0,76
Pulse rate per minute >180 or <40	34	3	20	15,41	0,56
Presence of arrhythmias	34	4	19	9,98	0,41
Breath per minute >50 or <6	34	5	21	12,48	0,36
Glasgow scale consciousness <13	34	2	21	22,02	0,76
Blood hemoglobin <90 mg/ml	34	4	19	9,98	0,41
Blood hematocrit <42%	34	7	20	5,04	0,19
Blood leukocytes (kl/mm3) >7000	34	5	19	7,47	0,32
Blood clotting time <3,0 min.	34	6	20	7,22	0,23
Fibrinogen amyloidosis <3,2 m mol/l	34	7	21	7,36	0,21
Creatinine (mg/dL) > 10.0	34	8	20	5,04	0,13
Diuresis (ml/kg/hour) < 1.0	34	6	21	9,81	0,28
Total bilirubin (mg/dL) >25.5	34	8	18	5,04	0,08
Potassium, in eq/L < 2.5, or > 7.0	34	4	19	9,98	0,41
Abdominal bloating	34	3	20	15,41	0,56
Presence of bluntness in the recesses of the abdomen	34	2	21	22,02	0,76
Weakened or absent intestinal peristalsis	34	2	20	18,74	0,74
Presence of free air in the abdominal cavity (R-graphy)	34	1	21	25,81	1,06
FAST protocol fluid in:	34				
abdominal cavity		1	21	25,81	1,06
pleural cavity		3	20	15,41	0,56
The presence of retroperitoneal hematoma (MSCT)	34	4	20	12,40	0,44

When analyzing the data given in Tables 1, 2, and 3, there are some differences that draw attention to, both in the quantitative criteria for evaluating the predictors, and in the predictors themselves in general. All of this is a result of the differences in CAT courses in different age groups that we discovered.

Thus, numerous studies have confirmed that children are much more resistant to injury and are distinguished by large physiological reserves to exclude the consequences of injury. The compensatory mechanism of

children is much larger than that of an adult. In this regard, the difference in the severity of trauma according to the ISS scale in predicting death and, accordingly, the severity of the course of polytrauma in adults and children was established. If mortality in adults is associated with ISS> 15, then in children this value is at ISS> 25. Observations show that ISS> 15 is an erroneous value for determining the severity of trauma in children, which leads to incorrect predictions of the chances of death, observation in the department of resuscitation and disability prediction. An ISS with a value of ≥25 was defined as the optimal threshold for predicting mortality in children, as it had better diagnostic characteristics compared to the generally accepted ISS> 15 in the adult population. Moreover, such a threshold was observed in children with both trauma of one system and trauma of several systems (fig.1).

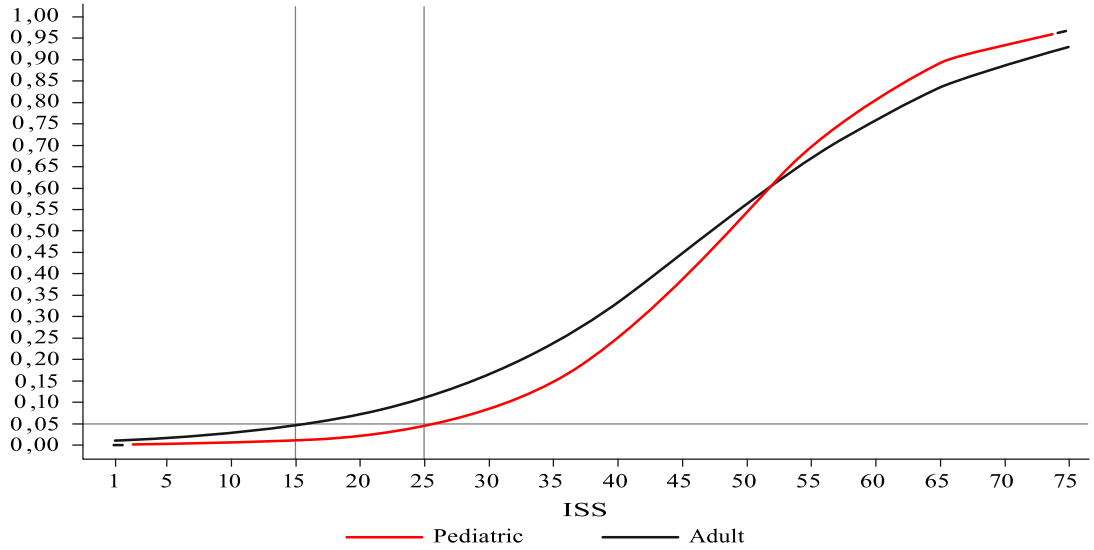

Figure 1. Predictors of mortality in terms of severity of injury in children and adults

Regarding the indicator of blood loss in children, attention is drawn to the existing low threshold of sensitivity of this contingent to the lost blood volume. According to the data given in Table 1, in infants it is in the range >150.0 ml, in kids >500.0 ml, which is much lower than the indicators of the adult contingent of patients with CAT. Most likely, this is due to the fact that the ratio of circulating blood volume to weight in children is much lower than that of the adult contingent.

In addition, the data presented in Table 1 indicate that the most acceptable indicator of coagulopathy in children, in contrast to adults, is the number of blood platelets. The latter is more consistently informative in comparison with other indicators of coagulopathy (BCT, fibrinogen, etc.).

With regard to elderly patients with concomitant abdominal injuries, it should be noted that with the same injuries, this contingent has a significant increase in the risk of death compared to adults. It is quite obvious that this is due to polymorbidity and physiological changes occurring as a result of natural aging processes, a decrease in physiological reserves and compensatory mechanisms as a result of the effects of concomitant injuries. Along with this, the presence of various concomitant diseases has an important effect on the results of treatment in concomitant abdominal injuries in elderly patients.

In connection with the above features, it was found that elderly patients are less resistant to injury and have less physiological reserves to eliminate the consequences of injury. According to this, the optimal threshold for predicting the severe course of associated trauma and, accordingly, death in elderly patients is lower than

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in adults and is at the level of ISS >10 (Fig. 2), which is reflected in Table. 3.

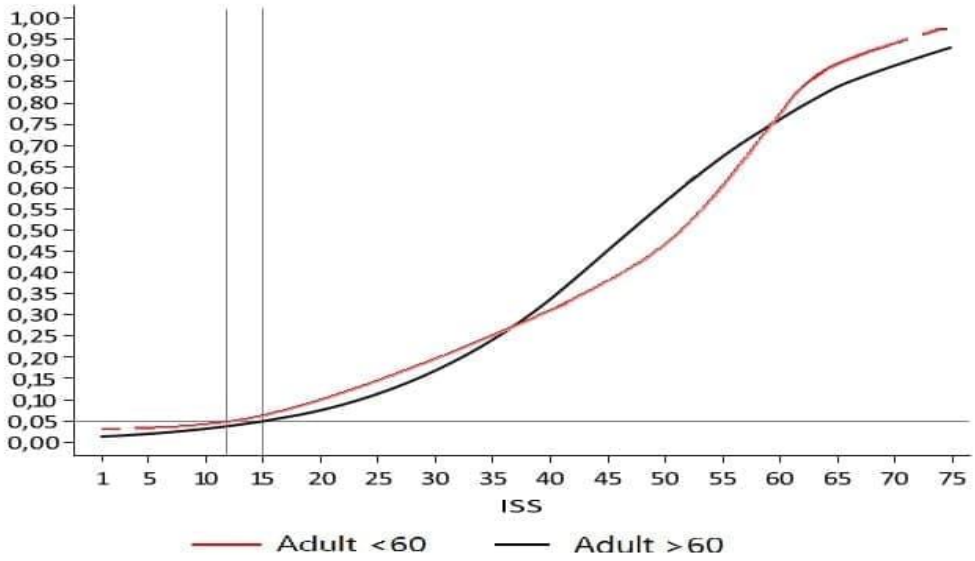

Figure 2. Predictors of mortality in terms of severity of injury in the elderly and adults

When analyzing the data in Table 3, it can be stated that among the predictors of predicting the severity of the course of concomitant abdominal trauma in the elderly patients, we assigned a large place to concomitant diseases. Among the latter, the leading place is occupied by cardiovascular diseases. A special place among other concomitant pathologies we have assigned to endocrine diseases, in particular diabetes mellitus. In addition, as predictors of prognosis in the group of elderly patients, we identified such factors as obesity, heart rhythm disturbances.

After establishing the statistical significance of all the predictors presented in the research groups, we had to determine their predictive value ("weight"). For this purpose, we have made the appropriate calculations according to the formula for calculating the prognostic coefficients (PC). DC is considered to be the logarithm of the ratio of the probabilities of symptoms in diseases B1 and B2, taken with two decimal places and multiplied by 100. In cases where the accuracy of determining the probability ratio is small, it is more convenient to use the logarithm with one decimal place and multiply it by 10:

$$PC = 10 \cdot \lg \frac{P(x_i/B_1)}{P(x_i/B_2)}$$

where: PC - prognostic coefficient;

x_i - studied feature;

B_1 - disease 1;

B_2 - disease 2;

P – feature probability.

After that, the obtained prognostic coefficients were summed up in each group of patients separately. Based on the amount obtained, we developed the gradation of the forecast of the severity category of the course of associated abdominal injuries for each study group (Table 4).

Table 4. Gradations of the probability forecast of a CAT severe course

Gradations of the probability forecast of a CAT severe course	Sum of prognostic coefficients (PC)		
	Children (from 0 to 18 years)	Adults (from 19 to 60 years)	Elderly people (older than 60)
Low probability	from 0 to 3.36	from 0 to 3,98	from 0 to 3,66
Average probability	from 3.37 to 9.12	from 3.99 to 11,96	from 3.67 to 7.33
High probability	from 9.13 to 11.16	from 11.97 to 15.92	from 7.34 to 14.67

Our prospective studies to identify the effectiveness of these scales for predicting the likelihood of a severe course of combined abdominal injuries in the examined 72 patients allowed us to conclude that there is more than 80% similarity between the preliminary determination of the likelihood of a severe course of combined abdominal injuries and the final diagnosis. This provision served as the primary basis for the assumption about the reliability and adequacy of our proposed integral prediction scales for different age groups of patients.

Thus, for an even greater correspondence of the forecast of the likelihood of a severe course of CAT according to the integral scales produced, the principles of evidence-based medicine, we calculated their "sensitivity" and "specificity". In this case, the concept of "sensitivity" means the proportion of patients with the severity of the disease in which the diagnostic test is positive, and "specificity" is the proportion of patients with the severity of the disease in which the diagnostic test is negative (according to R. Fletcher "Clinical Epidemiology"). These results are shown in Table 5.

Table 5. Indicators of "sensitivity" and "specificity" of the scales for predicting the likelihood of CAT severe course in different age groups of patients

Coincidence of the prognosis scale results and the outcomes	Children (from 0 to 18 years)		Adults (from19 to 60 years)		Elderly people (older than 60)	
	have	Have not	Have	Have not	Have	Have not
Positive (coincidence)	16	4	15	3	16	3
Negative (discordance)	3	1	4	2	4	1
Sensitivity (Se) = a/(a+c)	80,0%		83,3%		84,2%	
Specificity (Sp) = b/(b+d)	75,0%		67,8%		80,0%	
Overall accuracy (Ac)= (Se + Sp)/2	77,5%		75,6%		82,1%	

As can be seen from the data presented in Table 5, the proposed integral scales for predicting the likelihood of a severe course of CAT in different age groups of patients are characterized by increased sensitivity (on average 82.5%), specificity (on average 74.3%) and overall accuracy (on average 78.4%).

4. Conclusion

Thus, conducting retrospective studies to determine the prognostic significance and statistical reliability of

empirically selected anthropometric, clinical, instrumental and laboratory indicators allowed us to develop integral scales for predicting the likelihood of severe CAT in different age groups of patients.

The proposed integral scales for predicting the likelihood of a severe course of CAT in different age groups of patients have high sensitivity, specificity and fully comply with the requirements of practical emergency surgery.

In this regard, its widespread use will make it possible to objectify the assessment of the severity of the course of CAT in different age groups of patients, which, accordingly, will lead to an improvement in treatment results in these patients.

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