Bleeding risk scales in patients with acute coronary syndrome: place of the ORACUL scale

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Aim. To compare the diagnostic value of different bleeding risk scales in patients with acute coronary syndrome (ACS).

Material and methods. The study included 1502 patients with ACS from the observational, open-label, multicenter trial ORACUL II. The mean age was 65,7±12,9 years. At follow-up visits (hospital discharge, 25, 90, 180 and 360 days from the index event), all cases of bleeding were recorded with a description of bleeding characteristics, source, severity, treatment, and classification according to the BARC, TIMI, and ISTH scales.

Results. During the follow-up period, bleeding was recorded in only 170 (11,3%) patients: within the index hospitalization — in 39 (26%), within a year after the index hospitalization — in 131 (8,6%). In 19 (1,2%) patients, recurrent bleeding at several visits was recorded. In comparison with such scores as CRUSADE, ACTION-ICU, ACUITY, PARIS, the ORACUL scale had the highest predictive value in relation to the in-hospital bleeding risk. The only scale with comparable diagnostic value was the BleeMACS score. It should be noted that the ORBIT and HASBLED scores had a lower predictive value for the in-hospital bleeding risk. In general, all scores were better at predicting major bleeding and slightly worse for clinically relevant ones.

Conclusion. The ORACUL scale seems to be the most acceptable tool for assessing the bleeding risk in patients after ACS in actual clinical practice in Russia.

Key words: acute coronary syndrome, bleeding, mortality, risk score.

In the management of patients with acute coronary syndrome (ACS), more and more attention is paid to the prevention of bleeding, which significantly affects the prognosis of patients after ischemic events [1]. The increasing incidence of complications is associated with the need for active antithrombotic therapy (ATT) [2]. Bleeding avoidance strategies is gradually being introduced into practice, aimed at preventing bleeding events. One of the key parts of this strategies is the development of individualized ATT based on the bleeding risk assessment, for which a large number of scales have been developed [3]. At the same time, their diagnostic value in different groups of patients can vary significantly. The developed ORACUL bleeding risk scale, based on observational study, showed good diagnostic value [4]. It should be noted that not all bleeding affects the prognosis. According to BARC (Bleeding Academic Research Consortium) classification [5], an increase in the risk of recurrent ischemic events in patients with ACS is characteristic

of type 2 bleeding and higher, while type 1 does not significantly affect the risk of adverse outcomes [6]. The prognostic value of type 3b bleeding was comparable to the recurrent myocardial infarction (MI), and after type 3 c bleeding, the mortality rate was significantly higher than after MI [7]. To assess the severity of bleeding, other classifications are used — TIMI (Thrombolysis In Myocardial Infarction), ISTH (International Society on Thrombosis and Haemostasis) [8, 9], etc.

The aim was to compare the diagnostic value of different bleeding risk scales in patients with acute coronary syndrome (ACS).

Material and methods

The study included patients from the observational, open-label, multicenter study ORACUL II. The inclusion criteria were the ACS and an indication for percutaneous coronary intervention (PCI) in the current hospitalization, regardless of whether or not PCI was performed. Inclusion in the study was carried out from 2014 to 2017. The inclusion criteria are described in detail in previous publications [10].

The presented analysis included data on 1502 patients who had at least 1 follow-up visit after enrollment in the study. The exclusion criteria were the absence of signed informed consent or the impossibility to contact with the patient after discharge.

All patients received standard therapy based on current guidelines. Of 1502 patients, 560 (34,7%) were included in the study due to ST-segment elevation ACS and 942 (64,3%) due to non-ST-segment elevation ACS. The mean age of the patients was 65,7±12,9 years. The surveyed group included 894 (59,5%) men and 608 (40,5%) women. A total of 1132 (74,7%) patients had a history of coronary artery disease, 466 (31,5%) patients — prior MI, 1320 (87,9%) — history of hypertension (HTN), 769 (51,2%) — heart failure (HF), 216 (14,3%) — gastric and duodenal ulcer, 131 (8,7%) — history of cancer.

At follow-up visits (hospital discharge, 25, 90, 180 and 360 days after the index event), all cases of bleeding were recorded with a description of its characteristics, source, severity, treatment, and classification according to the BARC, TIMI, and ISTH scores.

For a reference assessment of the bleeding risk in this study, the ORACUL scale previously developed by the authors was used [4]. The calculation of the bleeding risk was carried out using factors such as age, hemoglobin level upon admission, glomerular filtration rate, heart failure upon an index event, history of peptic ulcer disease, PCI during index hospitalization, and taking oral anticoagulants (Table 1).

For comparison, risk scales were selected to assess the risk of short-term bleeding in ACS and PCI: Can Rapid risk stratification of Unstable angina patients Suppress ADverse outcomes with Early implementation of the ACC/AHA guidelines (CRUSADE) [11], Acute Coronary Treatment and Intervention Outcomes Network — Intensive Care Unit (ACTION-ICU) [12], ACUITY — Acute Catheterization and Urgent Intervention Triage Strategy and Harmonizing Outcomes with Revascularization and Stents in Acute Myocardial Infarction (HORIZONS) [13], as well as out-of-hospital bleeding: Bleeding complications in a Multicenter registry of patients discharged with diagnosis of Acute Coronary Syndrome (BleeMACS) [14], Patterns of Non-Adherence to Anti-Platelet Regimens in Stented Patients (PARIS) [15]. In addition, some scales for thrombosis risk assessment were tested for the predictive value of bleeding risk — Global Registry of Acute Coronary Events (GRACE) [16] and TIMI [17]. The prognostic value of the Outcomes Registry for Better Informed Treatment (ORBIT) and Hypertension, Abnormal Renal/Liver Function, Stroke, Bleeding History or Predisposition, Labile INR, Elderly, Drugs/Alcohol Concomitantly (HASBLED) scores, designed to assess the bleeding risk during anticoagulation, were also studied. It should be noted that some of the considered risk factors are common in different scores (Table 2). The use of different scales for bleeding risk assessment in patients after ACS was previously used in other studies [18, 19].

Statistical data processing was carried out using the SPSS 23.0 and MedCalc 18.5 software. For continuous traits, the distribution and normality were analyzed, as well as the mean and standard deviations (M±SD) were calculated. With normal distribution, the Student's t-test was used. With non-normal distribution, nonparametric calculation methods were used. Discrete values were compared using Pearson's chi-squared test.

The analysis of diagnostic accuracy was carried out by creating the receiver operator characteristic curves (ROC curves) for each diagnostic criterion and calculating the area under these curves (AUC). Also, for each tested diagnostic criterion, the sensitivity and specificity were calculated.

The tested diagnostic criterion was assessed as effective if the lower limit of AUC confidence interval was >0,5 and p<0,05. The AUC interval from 0,9 to 1,0 corresponded to excellent quality of the diagnostic test, from 0,8 to 0,9 — very good, from 0,7 to 0,8 — good, and from 0,6 to 0,7 — satisfactory. If the AUC was <0,6, the diagnostic test was considered unsatisfactory.

Comparison of the predictive accuracy of different scales was carried out by comparing the AUC using the DeLong's method.

Results

Bleeding in the ORACUL study. During the follow-up period, bleeding was recorded in 170 (11,3%) patients, during the index hospitalization — in 39 (2,6%), and within a year after the index hospitalization — in 131 (8,6%). Nineteen (1,2%) patients had recurrent bleeding. Table 3 shows the characteristics of the incidence and severity of bleeding, assessed on different scales. It should be noted that the severity of bleeding on different scores varied as follows: on the TIMI score, the incidence of major and clinically significant bleeding was less than on the BARC and ISTH scores.

Comparison of the predictive value of the ORACUL scale with other models

The ORACUL scale had the highest predictive value for in-hospital bleeding risk, surpassing in importance such scores as CRUSADE, ACTION-ICU, ACUITY, and PARIS. The only scale with comparable

Table 1

ORACUL scale

Parameters	
Age:	
≤55 years	0 points
56-65 years	8 points
66-75 years	16 points
>75 years	24 points
Hemoglobin at admission:	
>125 g/l	0 points
100-125 g/l	48 points
<100 g/l	96 points
Killip class at admission:	
Class 1	0 points
Class 2-4	17 points
Creatinine clearance:	
>90 ml/min	0 points
60-89 ml/min	6 points
<60 ml/min	12 points
History of gastric or duodenal ulcer	20 points
Anticoagulation in combination with antiplatelet agents after ACS (dual or triple therapy)	36 points
PCI during index hospitalization	38 points

Table 2

Bleeding and ischemic risk scores used in the study

Score	Parameters	Disease	Predicted outcome	Characteristics of the prototype study		
				Number of patients	Age	Area under the ROC curve
ACTION [12]	Age, creatinine, SBP, HR, hemoglobin, weight, sex, warfarin, diabetes mellitus, HF, peripheral arterial disease	ACS	Hospital major bleeding (decrease in hemoglobin by 4 g/dL, intracranial, retroperitoneal bleeding, blood transfusion)	72131	64	0,73
CRUSADE [11]	Hematocrit, creatinine clearance (Cockcroft-Gault), HR, SBP, peripheral arterial disease, diabetes, HF, sex	ACS	Hospital bleeding (intracranial, retroperitoneal bleeding, hematocrit decrease ≥12%, any blood transfusion)	71277	67	0,71
ACUITY-HORIZONS [13]	Age, sex, creatinine, WBC count, anemia, ST depression, ATT	ACS	Major bleeding (TIMI0 within 30 days)	17421	62	0,74
PARIS [15]	Age, BMI, smoking, anemia, creatinine clearance, triple ATT	PCI	Major bleeding (BARC type 3-5) within 24 months	4190	65	0,73
BleeMACS [14]	Age, hypertension, peripheral arterial disease, history of bleeding, cancer, creatinine, hemoglobin	ACS+PCI	Significant bleeding (TIMI type II-III) within 12 months	10750	63,6	0,71
ORBIT [18]	Age, decreased hemoglobin, hematocrit, anemia, decreased GFR, history of bleeding, antiplatelet therapy	Atrial fibrillation	Major bleeding (ISTH) within 1 year	10132	75	0,67
HAS-BLED [19]	Age, hypertension, impaired renal function, alcohol, prior stroke, prior bleeding, antiplatelet therapy	Atrial fibrillation	Major bleeding (ISTH) within 1 year	3456	66,8	0,72
GRACE [16]	Age, SBP, HR, creatinine, HF, prior myocardial infarction, ST changes, PCI, dynamics of myocardial damage markers	ACS	Death within 6 months	15007	65	0,81 death 0,61 major bleeding
TIMI [17]	Age, SBP, heart rate, ST changes, history of risk factors, ASA intake	ACS	Death and ischemic events within 14 days	3910	65	0,65

Note: ASA — acetylsalicylic acid, SBP — systolic blood pressure, GFR — glomerular filtration rate, BMI — body mass index.

diagnostic value was the BleeMACS score. It should be noted that the ORBIT and HASBLED scores had a lower predictive value for in-hospital bleeding risk. In general, all scores were better at predicting major bleeding and slightly worse for clinically significant ones. The diagnostic value for out-of-hospital bleeding was lower in all scores than for in-hospital ones. The ORACUL scale had a good diagnostic value for out-of-hospital bleeding and the AUC was the highest among all scores (Tables 4-6).

Discussion

Bleeding events in patients with ACS can be one of the most important unfavorable prognostic factors that often precede recurrent ischemic events [20]. Currently, in clinical practice, several scores are used to assess the bleeding risk. The most common scores are presented in Table 2. It should be noted that the factors used in bleeding risk scores are often at the same time risk factors for ischemic events. These factors are the blood pressure (BP), heart rate (HR), age, renal function, comorbidities (hypertension, diabetes, peripheral arterial disease, etc.). In a number of studies, to assess bleeding risk, risk assessment scores for ischemic events (such as GRACE and TIMI) are used. In the presented work, the diagnostic value of these scores was compared with the model developed by the authors for assessing the bleeding risk.

In clinical practice, the GRACE score is used to assess the risk of coronary events in patients with non-ST-segment elevation ACS. The calculation is of fundamental importance in choosing the management strategy, therefore, it is used in most patients. An attempt was made to assess whether it can be used to assess the bleeding risk. The GRACE score had a good predictive value for the risk of major and minor bleeding and insufficient for BARC type 3-5 bleeding. Previously, it was shown that the GRACE score may have even greater diagnostic value than the CRUSADE score [21]. In the meta-analysis of 9 studies that included >13700 patients with ACS, the GRACE score was comparable to the ACTION, CRUSADE, and ACUITY scores in relation to the bleeding risk [22].

TIMI score is used to stratify the risk of ACS complications in the first 14 days after the hospitalization. It correlates not only with the risk of coronary events, but also with the bleeding risk. On the TIMI score,

high-risk patients have the bleeding risk >4 times higher than in low-risk patients [23]. The TIMI area under the receiver-operating characteristics curve (AUROC) for major bleeding was 0,71 [24]. In the present study, it was slightly less — 0,61.

To predict the risk of major bleeding after discharge from the hospital, the scores originally developed for assessing the in-hospital bleeding risk (CRUSADE, ACTION, and ACUITY-HORIZONS) were also used. These scores have been repeatedly validated in cohorts of ACS patients. So, according to the Italian registry of ACS patients, the AUROC for the CRUSADE score was 0,69, and for ACUITY-HORIZONS — 0,73 [3]. In the Chinese registry of patients after ACS, the AUROC for major bleeding risk after discharge was 0,579 and 0,591, respectively [25]. The CRUSADE score better predicts the risk of major bleeding within 1 month after PCI in ACS patients than VerifyNow platelet function assay (AUROC: 0,81 and 0,61, respectively) [26].

CRUSADE is one of the most accurate bleeding risk scores, the sensitivity and specificity of which is 80% and 73%, respectively [27]. The ORACUL score was comparable to CRUSADE in specificity, but inferior in sensitivity. The diagnostic value of the CRUSADE score in this study was slightly lower in relation to major bleeding within the year. In patients with ACS and comorbidities, the value of the

Table 3

**The incidence and severity
of bleeding in the ORACUL II study**

Score	Hospital bleeding during index hospitalization	All bleeding in 1-year follow-up
BARC		
5 (fatal)	1 (0,06%)	5 (0,3%)
4 (related to CABG)		2 (0,1%)
3 (Major)	8 (0,5%)	16 (1,06%)
2 (minor)	19 (1,3%)	43 (2,9%)
1 (minor, not requiring medical attention)	11 (0,7%)	104 (6,9%)
TIMI		
III (major)	5 (0,3%)	13 (0,8%)
II (minor)	24 (1,6%)	49 (3,3%)
I (minimal)	10 (0,67%)	108 (7,2%)
ISTH		
Major	10 (0,6%)	33 (2,2%)
Clinically significant minor	24 (1,6%)	58 (3,9%)
Not significant	5 (0,3%)	79 (5,2%)

Note: CABG — coronary artery bypass grafting.

Table 4

**Predictive value of bleeding risk assessment scores (in- and out-of-hospital)
in clinical practice (ORACUL study) using various bleeding criteria**

Score	BARC 2-5		BARC 3-5		TIMI III		TIMI II-III		ISTH major		ISTH major+significant	
	AUC 95% CI	p*	AUC 95% CI	p	AUC 95% CI	p*	AUC 95% CI	p*	AUC 95% CI	p*	AUC 95% CI	p*
ORACUL	0,762 [0,727-0,795]		0,794 [0,761-0,825]		0,739 [0,712-0,764]		0,699 [0,658-0,737]		0,642 [0,600-0,682]		0,696 [0,655-0,734]	
CRUSADE	0,702 [0,665 -0,737]	0,185	0,643 [0,604-0,680]	0,04	0,651 [0,616-0,684]	0,11	0,652 [0,609-0,690]	0,41	0,652 [0,611-0,692]	0,80	0,628 [0,586-0,669]	0,144
ACTION-ICU	0,524 [0,491-0,557]	0,002	0,605 [0,572-0,637]	0,01	0,502 [0,471-0,534]	0,049	0,565 [0,522-0,607]	0,03	0,512 [0,469-0,555]	0,05	0,555 [0,512-0,597]	0,004
ACUITY-HORIZONS	0,647 [0,617-0,675]	0,117	0,630 [0,600-0,659]	0,03	0,633 [0,607-0,659]	0,05	0,592 [0,558-0,624]	0,05	0,592 [0,550-0,634]	0,57	0,581 [0,548-0,613]	0,07
BleeMACS	0,642 [0,613-0,670]	0,032	0,693 [0,665-0,720]	0,32	0,661 [0,635-0,685]	0,47	0,624 [0,591-0,656]	0,13	0,711 [0,670-0,749]	0,34	0,594 [0,561-0,626]	0,17
PARIS	0,657 [0,628- 0,684]	0,05	0,601 [0,572-0,630]	0,04	0,669 [0,643-0,695]	0,29	0,644 [0,611-0,675]	0,38	0,625 [0,583-0,666]	0,55	0,642 [0,600-0,683]	0,24
ORBIT	0,675 [0,630-0,718]	0,09	0,661 [0,616-0,705]	0,20	0,532 [0,485-0,579]	0,03	0,626 [0,580-0,671]	0,17	0,598 [0,551-0,644]	0,31	0,587 [0,540-0,633]	0,03
HASBLED	0,512 [0,465-0,559]	0,003	0,525 [0,478-0,572]	0,012	0,514 [0,467-0,561]	0,02	0,515 [0,467-0,562]	0,037	0,533 [0,486-0,580]	0,26	0,516 [0,469-0,563]	0,02
GRACE	0,609 [0,577-0,641]	0,003	0,561 [0,491-0,613]	0,004	0,507 [0,476-0,538]	0,01	0,586 [0,552-0,619]	0,02	0,610 [0,558-0,643]	0,52	0,571 [0,538-0,604]	0,03
TIMI	0,611 [0,580-0,641]	0,003	0,618 [0,587-0,649]	0,01	0,677 [0,649-0,704]	0,97	0,585 [0,551-0,617]	0,04	0,601 [0,559-0,643]	0,41	0,617 [0,574-0,658]	0,13

Note: p* — compared with the AUC for ORACUL scale. CI — confidence interval.

Predictive value

■ Excellent and very good   ■ Good   □ Satisfactory   ■ Low   ■ No value   ■ Not calculable

Table 5

Predictive value of in-hospital bleeding risk scores

Score	BARC 2-5		BARC 3-5		TIMI III		TIMI II-III		ISTH major		ISTH major+significant	
	AUC 95% CI	p*	AUC 95% CI	p	AUC 95% CI	p*	AUC 95% CI	p*	AUC 95% CI	p*	AUC 95% CI	p*
ORACUL	0,777 [0,739-0,812]		0,951 [0,929-0,967]		0,586 [0,543-0,628]		0,713 [0,673-0,751]		0,620 [0,578-0,662]		0,658 [0,616-0,698]	
CRUSADE	0,746 [0,707-0,782]	0,75	0,688 [0,647-0,727]	0,0003	0,519 [0,476-0,562]	0,77	0,688 [0,647-0,727]	0,78	0,728 [0,688-0,765]	0,34	0,669 0,628-0,709	0,87
ACTION-ICU	0,676 [0,635-0,716]	0,67	0,802 [0,766-0,835]	0,001	0,599 [0,556-0,641]	0,94	0,595 [0,552-0,637]	0,26	0,649 [0,607-0,690]	0,91	0,545 [0,502-0,588]	0,08
ACUITY-HORIZONS	0,750 [0,711-0,786]	0,77	0,604 [0,561-0,646]	0,0001	0,561 [0,518-0,604]	0,92	0,645 [0,602-0,685]	0,71	0,617 [0,574-0,658]	0,75	0,585 [0,542-0,627]	0,12
BleeMACS	0,817 [0,782-0,849]	0,34	0,996 [0,987-1,000]	0,99	0,817 [0,782-0,849]	0,50	0,769 [0,731-0,804]	0,32	0784 [0,747-0,818]	0,82	0,693 [0,653-0,732]	0,34
PARIS	0,717 [0,677-0,755]	0,54	0,610 [0,567-0,652]	0,001	0,550 [0,507-0,593]	0,84	0,675 [0,633-0,714]	0,31	0,650 [0,609-0,691]	0,42	0,647 [0,605-0,688]	0,78
ORBIT	0,662 [0,616-0,706]	0,017			0,585 [0,538-0,631]	0,8	0,660 [0,614-0,703]	0,20	0,511 [0,464-0,558]	0,048	0,661 [0,615-0,704]	0,82
HASBLED	0,575 [0,528-0,621]	0,009			0,549 [0,502-0,596]	0,69	0,514 [0,467-0,561]	0,005	0,594 [0,548-0,640]	0,95	0,505 [0,458-0,552]	0,005
GRACE	0,678 [0,646-0,726]	0,42	0,694 [0,653-0,733]	0,0003	0,567 [0,524-0,610]	0,92	0,646 [0,604-0,686]	0,41	0,701 [0,660-0,740]	0,54	0,614 [0,571-0,655]	0,45
TIMI	0,798 [0,762-0,831]	0,081	0,626 [0,584-0,667]	0,003	0,718 [0,678-0,755]	0,23	0,678 [0,637-0,718]	0,82	0,718 [0,678-0,756]	0,99	0,636 [0,593-0,676]	0,66

Note: p* — compared with the AUC for ORACUL scale. CI — confidence interval.

Predictive value

🟩 Excellent and very good 🟩 Good ⬜ Satisfactory 🟧 Low 🟧 No value 🟫 Not calculable

Table 6

Predictive value of bleeding risk scores within 1 year after index hospitalization

Score	BARC 2-5		BARC 3-5		TIMI III		TIMI II-III		ISTH major		ISTH major+significant	
	AUC 95% CI	p*	AUC 95% CI	p	AUC 95% CI	p*	AUC 95% CI	p*	AUC 95% CI	p*	AUC 95% CI	p*
ORACUL	0,748 [0,692-0,798]		0,769 [0,714-0,817]		0,722 [0,687-0,755]		0,693 [0,652-0,731]		0,633 [0,596-0,668]		0,674 [0,633-0,713]	
CRUSADE	0,665 [0,606-0,720]	0,26	0,609 [0,549-0,667]	0,14	0,729 [0,690-0,766]	0,91	0,613 [0,570-0,654]	0,24	0,604 [0,562-0,645]	0,63	0,587 [0,545-0,629]	0,11
ACTION-ICU	0,542 [0,481-0,601]	0,01	0,503 [0,443-0,564]	0,03	0,638 [0,596-0,678]	0,06	0,516 [0,473-0,559]	0,02	0,531 [0,488-0,573]	0,28	0,530 [0,488-0,573]	0,01
ACUITY-HORIZONS	0,687 [0,629-0,741]	0,47	0,676 [0,617-0,730]	0,40	0,755 [0,717-0,790]	0,62	0,611 [0,568-0,652]	0,31	0,582 [0,540-0,624]	0,49	0,605 [0,563-0,647]	0,27
BleeMACS	0,546 [0,509-0,583]	0,05	0,643 [0,597-0,669]	0,37	0,546 [0,527-0,601]	0,05	0,509 [0,472-0,546]	0,02	0,575 [0,549-0,602]	0,06	0,549 [0,523-0,576]	0,06
PARIS	0,615 [0,578-0,651]	0,43	0,633 [0,596-0,669]	0,38	0,643 [0,607-0,678]	0,40	0,551 [0,513-0,588]	0,59	0,595 [0,558-0,632]	0,43	0,525 [0,488-0,562]	0,012
ORBIT	0,607 [0,570-0,643]	0,30	0,647 [0,611-0,683]	0,40	0,654 [0,617-0,689]	0,39	0,530 [0,493-0,568]	0,03	0,613 [0,576-0,649]	0,77	0,523 [0,485-0,560]	0,10
HASBLED	0,517 [0,475-0,559]	0,008	0,555 [0,513-0,597]		0,508 [0,466-0,551]	0,02	0,548 [0,506-0,590]	0,10	0,566 [0,524-0,608]	0,06	0,540 [0,497-0,582]	0,08
GRACE	0,552 [0,515-0,589]	0,04	0,579 [0,541-0,615]	0,012	0,512 [0,475-0,550]	0,05	0,555 [0,518-0,592]	0,64	0,526 [0,489-0,563]	0,024	0,500 [0,463-0,538]	0,03
TIMI	0,508 [0,470-0,545]	0,01	0,591 [0,553-0,627]	0,25	0,550 [0,513-0,588]	0,07	0,544 [0,507-0,582]	0,58	0,521 [0,483-0,558]	0,21	0,500 [0,463-0,537]	0,05

Note: p* — compared with the AUC for ORACUL scale. CI — confidence interval.

Predictive value

🟩 Excellent and very good 🟩 Good ⬜ Satisfactory 🟧 Low 🟧 No value 🟫 Not calculable

scores may decrease. If for all patients with ACS the AUROC is 0,71, then in patients with chronic kidney disease it is lower — 0,65 [28]. In patients >75 years of age, the CRUSADE score loses its predictive value (AUROC, 0,51), although the GRACE score retains a sufficient predictive value in relation to death and MI risks [29].

The PARIS score in the original study showed a high predictive value for major bleeding (AUROC, 0,71) [30]. In the presented study, the PARIS score allowed to assess the risk of both major and minor bleeding. Although its diagnostic value was lower than the developed scale.

One of the novel risk scores created to assess the risk of bleeding in patients with ACS is the BleeMACS score, developed on the basis of same-name registry, which included 15401 ACS patients observed in 15 hospitals in 10 countries in America, Europe and Asia. All patients underwent PCI. The mean age of patients was 63,6 years, which is close to the age of patients in the current registry. The incidence of major bleeding according to BARC in the 1st year after discharge from the hospital was 3,6 per 100 patient years (in this registry, there were lower number of such patients — 1,3%). The BleeMACS score includes factors such as age, creatinine level, history of bleeding and cancer, hemoglobin level, history of hypertension and vascular disease. External validation of the score was carried out on a cohort of ACS patients from Swedish Web System for Enhancement and Development of Evidence-Based Care in Heart Disease Evaluated According to Recommended Therapies Registry (SWEDEHEART), which included 96239 patients with ACS after PCI and 93150 patients who did not undergo PCI. In the original study, the AUROC was 0,71, while in the SWEDEHEART cohort — 0,63 and 0,61 for patients with and without PCI, respectively, which demonstrates good predictive value and goodness of fit (p>0,2 according to the Hosmer-Lemeshow test) [14]. In the present study, the diagnostic value of the BleeMACS score was 0,691 for major bleeding and was the only score comparable with ORACUL. For major and minor bleeding, the diagnostic value of BleeMACS was significantly lower.

Conclusion

The ORACUL scale seems to be the most acceptable tool for assessing the bleeding risk in patients after ACS in actual clinical practice in Russia.

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