

Possibilities of verification of a short-term functional outcome prognosis in the acute period of spontaneous supratentorial intracerebral hemorrhage using modified variants of the Intracerebral Hemorrhage Scale

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The main purpose of the study was to analyze a diagnostic informative value of modified variants of the Intracerebral Hemorrhage Scale as techniques for detecting adverse functional outcome risk in the acute period of spontaneous supratentorial intracerebral hemorrhage (SSICH).

Materials and methods. A total of 122 conservatively treated patients (mean age was 64.7 ± 1.1 years old) in the acute period of SSICH were enrolled in a prospective study. Clinical and neuroimaging assessment of the patients' condition severity was conducted on admission to hospital using the ICH Scale and its modified versions (mICH-A, mICH-B). The value >3 in accordance with the modified Rankin Scale on the 21st day of disease was considered as unfavourable functional outcome in SSICH. The ROC analysis was used for the comparative analysis of the scales' informative value and for the criteria development.

Results. The unfavourable functional outcome in the acute period of SSICH was registered in 50 (41.0 %) patients. These patients at the disease onset had significantly higher values in accordance with the mICH-A Scale (4 (3; 5) versus 2 (1; 3), $P < 0.0001$) and the mICH-B Scale (3 (2; 4) versus 1 (0; 2), $P < 0.0001$). It was determined that modified versions of the ICH Scale was more accurate than the original ICH Scale as for a short-term functional prognosis verification ($AUC_{mICH-A} 0.81 \pm 0.04$ (0.73–0.88) versus $AUC_{ICH} 0.74 \pm 0.04$, $P = 0.0062$; $AUC_{mICH-B} 0.80 \pm 0.04$ (0.72–0.87) versus $AUC_{ICH} 0.74 \pm 0.04$, $P = 0.0104$), whereas the mICH-A Scale scores >2 became the predictors of an unfavourable functional outcome in the acute period of disease (sensitivity = 76.0 %; specificity = 69.4 %; $RR = 3.6$ (3.1–4.1), $P < 0.0001$) as well as the mICH-B Scale scores >1 (sensitivity = 76.0 %; specificity = 68.1 %; $RR = 3.2$ (2.8–3.6), $P < 0.0001$).

Conclusions. Modified versions of the ICH Scale are informative tools for the verification of a short-term functional prognosis in patients with SSICH.

Key words:
cerebral
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Можливості верифікації короткострокового функціонального прогнозу наслідків гострого періоду спонтанного супратенторіального внутрішньомозкового крововиливу з використанням модифікованих варіантів Intracerebral Hemorrhage Scale

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Мета роботи – здійснити аналіз діагностичної інформативності модифікованих варіантів Intracerebral Hemorrhage (ICH) Scale в детекції ризику несприятливого функціонального виходу гострого періоду спонтанного супратенторіального внутрішньомозкового крововиливу (ССВМК).

Матеріали та методи. Провели проспективне дослідження 122 пацієнтів (середній вік $64,7 \pm 1,1$ року) в гострому періоді ССВМК на тлі консервативної терапії. Клініко-нейровізуалізаційне оцінювання тяжкості стану пацієнтів здійснювали під час надходження в стаціонар з використанням ICH Scale та її модифікованих варіантів (mICH-A, mICH-B). Як несприятливий функціональний результат гострого періоду ССВМК розглядали значення >3 балів за модифікованою шкалою Ренкіна на 21 добу захворювання. Для порівняльного аналізу інформативності використаних шкал і розроблення критеріїв прогнозування, використовували ROC-аналіз.

Результати. Несприятливий функціональний вихід гострого періоду ССВМК зареєстрований у 50 (41,0 %) пацієнтів. Пацієнти з несприятливим функціональним виходом гострого періоду ССВМК у дебюті захворювання статистично значущо відрізнялися вищими значеннями за шкалами mICH-A (4 (3; 5) проти 2 (1; 3), $p < 0,0001$) та mICH-B (3 (2; 4) проти 1 (0; 2), $p < 0,0001$). Встановили, що модифіковані варіанти ICH Scale перевищують оригінальну шкалу ICH за точністю верифікації короткострокового функціонального прогнозу ($AUC_{mICH-A} 0,81 \pm 0,04$ (0,73–0,88) проти $AUC_{ICH} 0,74 \pm 0,04$, $p = 0,0062$; $AUC_{mICH-B} 0,80 \pm 0,04$ (0,72–0,87) проти $AUC_{ICH} 0,74 \pm 0,04$, $p = 0,0104$), при цьому предикторами несприятливого функціонального виходу гострого періоду захворювання є значення >2 балів за шкалою mICH-A (чутливість = 76,0 %; специфічність = 69,4 %; $RR = 3,6$ (3,1–4,1), $p < 0,0001$) та >1 бала за шкалою mICH-B (чутливість = 76,0 %; специфічність = 68,1 %; $RR = 3,2$ (2,8–3,6), $p < 0,0001$).

Висновки. Модифіковані варіанти ICH Scale є інформативними інструментами верифікації короткострокового функціонального прогнозу в пацієнтів із ССВМК.

Ключові слова:
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Возможности верификации краткосрочного функционального прогноза исхода острого периода спонтанного супратенторіального внутримозгового кровоизлияния с использованием модифицированных вариантов Intracerebral Hemorrhage Scale

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Цель работы – провести анализ диагностической информативности модифицированных вариантов Intracerebral Hemorrhage (ICH) Scale в детекции риска неблагоприятного функционального исхода острого периода спонтанного супратенторіального внутримозгового кровоизлияния (ССВМК).

Ключевые слова:
внутримозговое
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Материалы и методы. Проведено проспективное исследование 122 пациентов (средний возраст $64,7 \pm 1,1$ года) в остром периоде ССВМК на фоне консервативной терапии. Клинико-нейровизуализационная оценка тяжести состояния пациентов проведена при поступлении с использованием ICH Scale и ее модифицированных вариантов (mICH-A, mICH-B). В качестве неблагоприятного функционального исхода острого периода ССВМК рассматривали значение >3 балла по модифицированной шкале Рэнкина на 21 сутки заболевания. Для сравнительного анализа информативности использованных шкал и разработки критериев прогнозирования, использовали ROC-анализ.

Результаты. Неблагоприятный функциональный исход острого периода ССВМК зарегистрирован у 50 (41,0 %) пациентов. Пациенты с неблагоприятным функциональным исходом острого периода ССВМК в дебюте заболевания статистически значительно отличались более высокими значениями по шкалам mICH-A (4 (3; 5) против 2 (1; 3), $p < 0,0001$) и mICH-B (3 (2; 4) против 1 (0; 2), $p < 0,0001$). Установлено, что модифицированные варианты ICH Scale превосходят оригинальную шкалу ICH по точности верификации краткосрочного функционального прогноза ($AUC_{mICH-A} 0,81 \pm 0,04$ (0,7–0,88) против $AUC_{ICH} 0,74 \pm 0,04$, $p = 0,0062$; $AUC_{mICH-B} 0,80 \pm 0,04$ (0,72–0,87) против $AUC_{ICH} 0,74 \pm 0,04$, $p = 0,0104$), при этом предикторами неблагоприятного функционального исхода острого периода заболевания выступают значения >2 балла по шкале mICH-A (чувствительность = 76,0 %; специфичность = 69,4 %; $RR = 3,6$ (3,1–4,1), $p < 0,0001$) и >1 балла по шкале mICH-B (чувствительность = 76,0 %; специфичность = 68,1 %; $RR = 3,2$ (2,8–3,6), $p < 0,0001$).

Выводы. Модифицированные варианты ICH Scale являются информативными инструментами верификации краткосрочного функционального прогноза у пациентов со ССВМК.

The choice of optimal tactics for patient management with spontaneous supratentorial intracerebral hemorrhage (SSICH) is one of the most difficult and, unfortunately, still unsolved problems in modern neurology [1]. It is highly important from the medical and social point of view due to leading positions of this pathology in the cause-of-death and disability structure among the adult population in most countries of the world [2,3].

One of the most effective ways of solving the problem is to develop a differentiated approach to the optimal treatment strategy choice, taking into consideration an individual short-term prognosis [1,4]. In this context, it is appropriate to use the tools of clinical neuroimaging assessment of the severity at the disease onset. The "gold standard" in this area is the original Intracerebral Hemorrhage (oICH) Scale, which demonstrated a high informative value when used to detect the risk for a lethal outcome of acute hemorrhagic stroke [5,6].

At the same time, the results of our previous study showed a significantly lower informative value of the oICH Scale when used to evaluate a short-term functional prognosis in this cohort of patients [7]. All of the above justifies the search for alternative tools for clinical neuroimaging scoring. In view of these facts, our attention was drawn to modified versions of the oICH Scale [8]. Available research literature did not reveal any information on the studies related to the development of criteria for the short-term functional outcome after SSICH in the acute period using modified oICH Scale variants.

The aim

The aim of the study was to analyze a diagnostic informative value of modified variants of the Intracerebral Hemorrhage Scale as techniques for detecting adverse functional outcome risk in the acute period of SSICH.

Materials and methods

The study included 122 patients with SSICH (65 men and 57 women, the mean age was 64.7 ± 1.1 years old) who were admitted to the Brain Circulation Disorders Department of the Municipal Institution "Zaporizhzhia City Clinical Hospital No 6" within the first 24 hours from the disease onset and underwent conservative therapy.

The diagnosis was confirmed by the results of a neuroimaging study, which was performed on admission with the use of a computed tomography scanner "Siemens Somatom Spirit". The site and size of lesion, midline shift and a secondary intraventricular hemorrhage (SIVH) presence were assessed. The lesion size (ICH volume) was calculated based on ellipsoid formula: ICH volume (mL) = $a \cdot b \cdot c$, where a, b and c are linear sizes of lesion (mm). The severity of a SIVH was evaluated using the Graeb Scale.

Integral clinical and neuroimaging assessment of the patients' condition severity was conducted using the oICH score and its modified versions (mICH-A, mICH-B). The functional outcome of SSICH in the acute period was assessed using the modified Rankin Scale (mRS), thus mRS score >3 on the 21st day after admission was considered as unfavourable functional outcome of the disease.

Statistical analysis of the obtained data was conducted using Statistica 13.0 software (StatSoft Inc., USA, series number JPZ8041382130ARCN10-J) and MedCalc (version 16.4). Shapiro–Wilk criterion was used in order to assess the distribution normality. As the distribution of the majority of indexes differed from a normal one, descriptive statistics were presented as a median and interquartile range. The intergroup differences were compared based on the Mann–Whitney criterion. A ROC analysis was carried out to develop prognosis criteria and to evaluate their informative value. A P-value < 0.05 was considered to be statistically significant.

Results

The unfavourable functional outcome in the acute period of SSICH was registered in 50 (41 %) patients. The frequency of the unfavourable outcome in the acute period of SSICH in patients with different values of the mICH-A Scale score and mICH-B Scale score is presented in Tables 1 and 2.

Based on comparison analysis, it was found that patients with unfavourable outcome in the acute period of SSICH had statistically higher values of the mICH-A Scale score (4 (3; 5) versus 2 (1; 3), $P < 0.0001$), the mICH-B Scale score (3 (2; 4) versus 1 (0; 2), $P < 0.0001$) and the oICH Scale score (1 (1; 2) versus 0 (0; 1), $P < 0.0001$) at the disease onset.

The gradations distribution of the mICH-A Scale and mICH-B Scale substest values in comparison with the func-

Table 1. The frequency of the unfavourable outcome in the acute period of SSICH in patients with different values of mICH-A Scale score

mICH-A Scale score	Total number of patients (n)	Unfavourable functional outcome (%)
0	4	25.0
1	22	4.5
2	36	27.8
3	26	42.3
4	18	61.1
5	10	100.0
6	3	100.0
7	2	100.0
8	1	100.0

Table 2. The frequency of the unfavourable outcome in the acute period of SSICH in patients with different values of the mICH-B Scale score

mICH-B Scale score	Total number of patients (n)	Unfavourable functional outcome (%)
0	21	9.5
1	40	25.0
2	23	34.8
3	21	71.4
4	11	81.8
5	2	100.0
6	3	100.0
7	1	100.0

tional outcome in the acute period of SSICH is presented in Tables 3 and 4.

As the data shows, the presence and severity of SIVH (Pearson's chi-squared test statistic = 32.8 for the mICH-A Scale, $P < 0.0001$; Pearson's chi-squared test statistic = 32.6 for the mICH-B Scale, $P < 0.0001$), as well as the patient's age (Pearson's chi-squared test statistic = 17.0 for the mICH-A Scale, $P = 0.0002$; Pearson's chi-squared test statistic = 15.0 for the mICH-B Scale, $P < 0.0001$) were associated with the functional outcome in the acute period of SSICH. At the same time, patients with different variants of the functional outcome of SSICH in the acute period were not only of different ages and the Graeb Scale score at the disease onset, but also they had different the Glasgow Coma Scale score and intracerebral hemorrhage volume (Table 5).

It was determined that the ICH Scale were less informative than the mICH-A Scale ($AUC \pm SE$ (95 % CI) 0.74 ± 0.04 (0.65–0.81) versus 0.81 ± 0.04 (0.73–0.88), $P = 0.0062$) and the mICH-B Scale ($AUC \pm SE$ (95 % CI) 0.74 ± 0.04 (0.65–0.81) versus 0.80 ± 0.04 (0.72–0.87), $P = 0.0104$) as a technique for detecting adverse functional outcome risk in the acute period of SSICH, whereas the mICH-A and mICH-B Scales did not differ (the values $AUC \pm SE$ (95 % CI) accounting for 0.81 ± 0.04 (0.73–0.88) and 0.80 ± 0.04 (0.72–0.87), $P = 0.2771$, respectively) (Fig. 1).

The ROC-analysis showed, that mICH-A Scale score >2 (Se = 76.0 %; Sp = 69.4 %) and mICH-B Scale score >1 (Se = 76.0 %; Sp = 68.1 %) were the predictors of unfavourable functional outcome in the acute period of

Table 3. The gradations distribution of the mICH-A Scale subtest values in comparison with the functional outcome in the acute period of SSICH

Subtest	Favourable functional outcome (n=72)	Unfavourable functional outcome (n=50)	Pearson's chi-squared test statistic	P
Age, years				
<50	9 (12.5 %)	1 (2.0 %)	17.0	0.0002
50–65	35 (48.6 %)	11 (22.0 %)		
>65	28 (38.9 %)	38 (76.0 %)		
Glasgow Coma Scale score				
14–15	55 (76.4 %)	32 (64.0 %)	6.6	0.0851
9–13	17 (23.6 %)	14 (28.0 %)		
6–8	0 (0.0 %)	2 (4.0 %)		
3–5	0 (0.0 %)	2 (4.0 %)		
Intracerebral hemorrhage volume, mL				
<30	64 (88.9 %)	37 (74.0 %)	4.7	0.0959
30–50	5 (6.9 %)	9 (18.0 %)		
>50	3 (4.2 %)	4 (8.0 %)		
Graeb Scale score				
0	49 (68.1 %)	16 (32.0 %)	32.8	<0.0001
1–4	22 (30.6 %)	14 (28.0 %)		
5–8	1 (1.3 %)	18 (36.0 %)		
≥ 9	0 (0.0 %)	2 (4.0 %)		

Table 4. The gradations distribution of the mICH-B Scale subtest values in comparison with the functional outcome of SSICH acute period

Subtest	Favourable functional outcome (n = 72)	Unfavourable functional outcome (n = 50)	Pearson's chi-squared test statistic	P
Age, years				
<65	44 (61.1 %)	12 (24.0 %)	15.0	<0.0001
≥ 65	28 (38.9 %)	38 (76.0 %)		
Glasgow Coma Scale score				
14–15	55 (76.4 %)	32 (64.0 %)	6.6	0.0851
9–13	17 (23.6 %)	14 (28.0 %)		
5–8	0 (0.0 %)	4 (8.0 %)		
3–4	0 (0.0 %)	0 (0.0 %)		
Intracerebral hemorrhage volume, mL				
<30	64 (88.9 %)	37 (74.0 %)	4.7	0.959
30–50	5 (6.9 %)	9 (18.0 %)		
>50	3 (4.2 %)	4 (8.0 %)		
Graeb Scale score				
0	49 (68.1 %)	16 (32.0 %)	32.6	<0.0001
1–3	19 (26.4 %)	9 (18.0 %)		
>3	4 (5.5 %)	25 (50.0 %)		

SSICH, whereas the accuracy of a short-term functional prognosis verification using the mICH-A and mICH-B Scales accounted for 75.1 % and 77.1 %, respectively, (Pearson's chi-squared test statistic = 1.01, $P = 0.2945$).

It was determined that the mICH-A Scale score >2 and the mICH-B Scale score >1 were associated with the risk of an unfavourable functional outcome of SSICH in the acute period, multiplied by 3.6 (RR 95 % CI 3.1–4.1, $P < 0.0001$) and 3.2, respectively, (RR 95 % CI 2.8–3.6, $P < 0.0001$) (Table 6).

Discussion

In the course of the study, it was determined that the modified versions of the oICH Scale were informative tools to detect an individual risk for an unfavourable functional

Table 5. Comparative analysis of clinical and neuroimaging criteria in patients with SSICH in comparison with the functional outcome in the acute period of disease

Subtest	Favourable functional outcome (n = 72)	Unfavourable functional outcome (n = 50)	P
Age, years	63.0 (56.0; 72.0)	72.0 (65.0; 76.0)	<0.0001
Glasgow Coma Scale score	15 (14; 15)	14 (12; 15)	0.0439
Intracerebral hemorrhage volume, mL	6.0 (3.0; 15.9)	13.9 (4.7; 30.1)	0.0152
Graeb Scale score	0 (0; 1)	3 (0; 5)	<0.0001

Table 6. The resulting comparison of the mICH-A Scale and the mICH-B Scale scores with the functional outcome of SSICH in the acute period.

Scale, score	Frequency of unfavourable functional outcome	RR (95% CI)	P
mICH-A	≤2 (n = 61)	3.6 (3.1–4.1)	<0.0001
	>2 (n = 61)		
mICH-B	≤1 (n = 61)	3.2 (2.8–3.6)	<0.0001
	>1 (n = 61)		

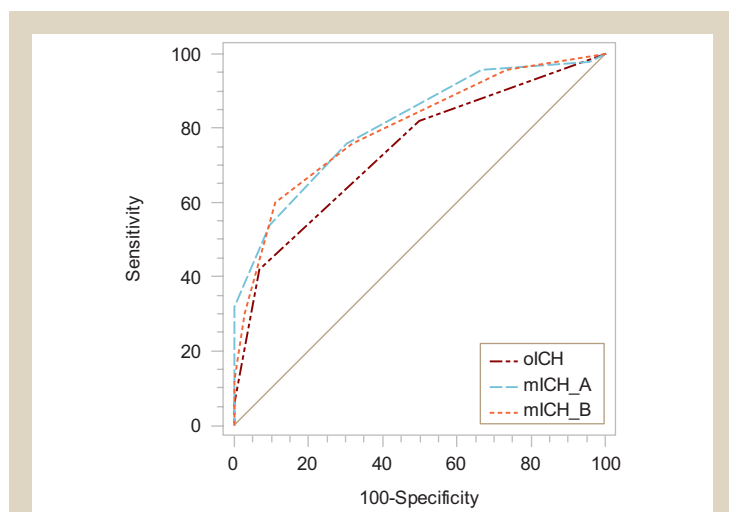


Fig. 1. Results of the ROC-analysis of the informative value of the oICH, mICH-A and mICH-B Scales as techniques for detecting a short-term functional prognosis in the acute period of SSICH.

outcome of SSICH in the acute period. The AUC values of the specified scales (≥ 0.80) corresponded to the gradation “very good” in accordance with the International Expert Scale for the quality of binary classifiers assessment (1993) [9]. In our opinion, a high informative value of these scales was supported by the integral assessment of clinical and neuroimaging data, which were associated with the outcome of disease in the acute period. The obtained data are consistent with the results of meta-analysis, which proved the prognostic value of the patient’s age, initial level of consciousness and intracerebral hemorrhage volume in patients with cerebral hemorrhagic hemispheric stroke [10].

Based on the ROC analysis, the mICH-A Scale score (>2) and the mICH-B Scale score (>1) were determined along with an optimal sensitivity and specificity ratio, being associated with the risk of the mRS score >3 on

the 21st day of the disease, multiplied by 3.6 (RR 95 % CI 3.1–4.1, $P < 0.0001$) and 3.2, respectively, (RR 95 % CI 2.8–3.6, $P < 0.0001$). The accuracy of functional prognosis verification for SSICH outcome in the acute period using these criteria exceeded 75.0 %, while there were no statistically significant differences in the AUC values between the mICH-A and mICH-B Scales ($P = 0.2771$). At the same time, these scales had a higher informative value in comparison with the oICH Scale with regard to detection of an individual risk for an unfavourable functional outcome of SSICH in the acute period, which, in our opinion, was attributed to a quantitative assessment of SIVH severity, unlike the oICH Scale. The interrelation between the Graeb Scale score and the functional outcome of SSICH in the acute period was revealed (Pearson’s chi-squared test $P < 0.0001$ for both scales), which proves the above-mentioned hypothesis. The obtained data are consistent with the results of other studies, which demonstrated the negative effect of SIVH severity on the SSICH outcome [11, 12].

All of the above justifies the expediency of using the modified versions of the oICH Scale in order to make a short-term functional prognosis of SSICH outcome in the acute period.

Conclusions

1. Modified variants of the ICH Scale are informative tools for the verification of a short-term functional prognosis in patients with SSICH and are more accurate than the ICH Scale to detect an individual risk for an unfavourable functional outcome of disease in the acute period ($AUC_{mICH-A} 0.81 \pm 0.04 (0.73–0.88)$ versus $AUC_{oICH} 0.74 \pm 0.04, P = 0.0062$; $AUC_{mICH-B} 0.80 \pm 0.04 (0.72–0.87)$ versus $AUC_{oICH} 0.74 \pm 0.04, P = 0.0104$).

2. Predictors of the mRS score >3 on the 21st day of SSICH are the mICH-A Scale score >2 (Se = 76.0 %; Sp = 69.4 %; RR 95 % CI = 3.6 (3.1–4.1), $P < 0.0001$) and the mICH-B Scale score >1 (Se = 76.0 %; Sp = 68.1 %; RR 95 % CI = 3.2 (2.8–3.6), $P < 0.0001$).

The perspective for the further scientific research is to assess the informative value of modified versions of the ICH Scale for a short-term vital prognosis determination in patients with SSICH.

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