



Comparative evaluation of lethal outcome prediction methods in severely burned patients

© Oleg O. Zavorotniy^{1,2*}, Evgeny V. Zinoviev¹, Vladislav G. Volkov¹, Denis V. Kostyakov^{1,2}, Diana H. Halipaeva¹, Alexander V. Semiglazov¹, Tamara Z. Gogohiya¹

¹ Saint-Petersburg I. I. Dzhanelidze Research Institute of Emergency Medicine, Saint-Petersburg, Russian Federation

² Saint-Petersburg State University, Saint-Petersburg, Russian Federation

* Oleg O. Zavorotniy, Saint-Petersburg I. I. Dzhanelidze Research Institute of Emergency Medicine, 3, Budapeshtskaya str., Saint-Petersburg, 192242, o.zavorotniy@hotmail.com

Received: January 19, 2022. Received in revised form: February 15, 2022. Accepted: February 21, 2022.

Abstract

Background: Regarding burn injury there are many approaches to assessing the possibility of death in severely burned patients. Despite the ease of use and the maximum prevalence of existing models, the assessment of the outcome in each of them is questionable, since the emphasis in different indices is on different indicators, avoiding the overall clinical picture of the disease.

Objective: Comparative analysis of the effectiveness of methods for predicting a lethal outcome in patients with extensive skin burns.

Material and methods: Calculated characteristics of known in the literature and widely used Baux rules, Frank index, probit analysis and a new method of logistic regression were obtained and applied to evaluate the results of treatment of 282 adult patients with extensive skin burns, hospitalized in the Department of Anesthesiology and Intensive Care of the Thermal Injuries Unit, Saint-Petersburg I. I. Dzhanelidze Research Institute of Emergency Medicine in the period 2015–2021.

Results: During the study a descriptive characteristic of methods for predicting a lethal outcome was obtained. Based on the data obtained, four-field contingency tables were compiled and a comparative analysis of the effectiveness of the models was carried out.

Conclusion: Despite the high frequency of use of such forecasting methods as the Baux score, the Frank index and probit analysis in the combustiology practice, the results of the calculation indicate that these methods have low efficiency: the Baux score method accuracy of a lethal outcome prediction is 49.7%, the Frank index method – 41.5%, probit analysis method – 60%. The logistic regression model developed by us showed high efficiency compared to those presented earlier (the accuracy of predicting a lethal outcome was 93%), which gives grounds for recommending it for practical application.

Keywords: skin burns, forecast, logistic regression, Baux score, Frank index, probit analysis, burn disease, fatal outcome

Cite this article as: Zavorotniy O.O., Zinoviev E.V., Volkov V.G., Kostyakov D.V., Halipaeva D.H., Semiglazov A.V., Gogohiya T.Z. Comparative evaluation of lethal outcome prediction methods in severely burned patients. *Innovative Medicine of Kuban.* 2022;(1):12–18. <https://doi.org/10.35401/2500-0268-2022-25-1-12-18>

Сравнительная оценка методов прогнозирования летального исхода тяжелообожженных

© О.О. Заворотний^{1,2*}, Е.В. Зиновьев¹, В.Г. Волков¹, Д.В. Костяков^{1,2}, Д.Х. Халипаева¹, А.В. Семиглазов¹, Т.З. Гогохия¹

¹ Санкт-Петербургский научно-исследовательский институт скорой помощи им. И.И. Джанелидзе, Санкт-Петербург, Россия

² Санкт-Петербургский государственный университет, Санкт-Петербург, Россия

* О.О. Заворотний, Санкт-Петербургский научно-исследовательский институт скорой помощи им. И.И. Джанелидзе, 192242, Санкт-Петербург, ул. Будапештская, 3, o.zavorotniy@hotmail.com

Поступила в редакцию 19 января 2022. Исправлена 15 февраля 2022 г. Принята к печати 21 февраля 2022.

Резюме

Актуальность: В отношении ожоговой травмы существует множество подходов оценки вероятности летального исхода у тяжелообожженных. Несмотря на простоту использования и максимальную распространенность существующих моделей, оценка исхода в каждой из них вызывает сомнения, поскольку упор в разных индексах идет на различные показатели, не учитывая общую клиническую картину заболевания.

Цель: Сравнительный анализ эффективности методов прогнозирования летального исхода у пациентов с обширными ожогами кожи.

Материал и методы: Получена расчетная характеристика известных в литературе и широко используемых правила Вaux, индекса Frank, пробит-анализа и нового метода логистической регрессии, примененных для оценки результатов лечения 282 взрослых пострадавших с обширными ожогами, госпитализированных в отделение анестезиологии и реанимации отдела термических поражений ГБУ «Санкт-Петербургский научно-исследовательский институт скорой помощи им. И.И. Джанелидзе» в период 2015–2021 гг.



Результаты: В ходе исследования получена описательная характеристика методов прогнозирования летального исхода. На основе полученных данных составлены четырехпольные таблицы сопряженности и проведен сравнительный анализ эффективности моделей.

Заключение: Несмотря на высокую частоту использования таких методов прогнозирования в комбустиологической практике, как правило, индексы Ваух, Frank и пробит-анализ, результаты расчета свидетельствуют, что данные методики обладают низкой эффективностью: для индекса Ваух точность прогнозирования летального исхода – 49,7%, для индекса Frank – 41,5%, для пробит-анализа – 60%. Разработанная нами модель логистической регрессии показала высокую эффективность по сравнению с представленными ранее методами (точность прогнозирования летального исхода составила 93%), что дает основание для ее рекомендации к практическому применению.

Ключевые слова: ожоги кожи, прогноз, логистическая регрессия, правило Ваух, индекс Frank, пробит-анализ, ожоговая болезнь, летальный исход

Цитировать: Заворотный О.О., Зиновьев Е.В., Волков В.Г., Костяков Д.В., Халипаева Д.Х., Семиглазов А.В., Гогохия Т.З. Сравнительная оценка методов прогнозирования летального исхода тяжелообожженных. *Инновационная медицина Кубани*. 2022;(1):12–18. <https://doi.org/10.35401/2500-0268-2022-25-1-12-18>

Introduction

Over the past decades the tendencies of assessing the quality of medical care for injured with extensive burns have changed [1]. The paradigm has been altered from staffing departments with healthcare workers and equipment towards the study of hospital mortality, clinical outcomes of diseases and their prediction, as evidenced by most of the current research studies in this field [2, 3]. Considering the high mortality in the Russian Federation when receiving extensive burn injuries equal to 7.9% per one hundred thousand victims, this issue remains relevant in the routine combustiology practice [4].

Regarding burn injury there are many approaches to assessing the fatal outcome possibility in severely burned patients. These methods are based on monitoring the area and depth of the burn, measured in percentage, and the presence of a thermal inhalation injury [5–7]. Some methods used in practice include the physical parameters of patients being treated in the intensive care unit, excluding the pathogenesis and state of burn injury, previous surgical treatment (VAC therapy, wound dressings, cellular technologies) that improve the outcome of treatment [8, 9]. Despite the ease of use and the maximum prevalence of existing models, the assessment of the outcome in each of them is questionable, since the emphasis in different indices is on different indicators, avoiding the overall clinical picture of the disease [10–12].

The developed method of logistic regression with the derivation of the calculation formula, based on a retrospective analysis of the case histories of 330 victims with a burn injury, takes into consideration patient's input data such as age, area and depth of the burn; clinical and biochemical blood parameters, the main parameters of a general urine test, the respiratory function of the body in the form of oxygen concentration in the inhaled mixture, as well as the volume of infusion therapy and an assessment of its effectiveness by the amount of daily diuresis in the first three days of inpatient treatment. This model demonstrated a high predictive value of death and recovery in severely burned patients in 93% and 87% respectively [13]. However, for a more in-depth analysis we compared

this method with the most commonly used models: the Baux score, the Frank index, and probit analysis.

Objective

Analysis of the effectiveness of lethal outcome prediction methods in patients with extensive skin burns.

Material and methods

The work was performed on the basis of a statistical analysis of the results of treatment of 282 adult patients with extensive deep skin burns, hospitalized in the department of anesthesiology and resuscitation of the thermal injury department of the Saint-Petersburg I. I. Dzhanelidze Research Institute of Emergency Medicine in the period 2015–2021, excluding patients whose comorbid condition was complicated by the presence of a confirmed new coronavirus infection COVID-19. The following models were used to determine the probability of death and to compile a comparative characteristic: the Baux score, the Frank index, the probit analysis method, and the logistic regression model. The data obtained were taken into account in the construction of four-field contingency tables for further evaluation of the effectiveness of these methods.

Comparative analysis and construction of four-field contingency tables were carried out in the SPSS Statistics 27.0.1.0 program. The calculation of the logistic regression model was carried out in Microsoft Excel.

Results

When using the Baux score method, the sum of the burn area index calculated in percentage and the parameter of the age of the severely burned person were included in the calculation. According to this forecasting technique, the obtained values were divided into three groups: with values of 100 and above points the prognosis was assessed as unfavorable, with results of 100–75 points the probability of death was 50%, with 75 points and below it was regarded as a high probability of recovery. Table 1 presents the results of a comparative analysis between the two groups – survivors and patients with a fatal outcome.

The results obtained in Table 1 allow us to conclude that the use of the Baux score method in the analysis of two groups of patients leads to a high probability of an inaccurate prediction. Thus, the highest error rate was recorded during the statement of a lethal outcome – 22 patients (29.3%) were discharged for outpatient treatment after a burn disease. With a mortality rate of 50% recovery and unfortunate outcome were 65.7% and 34.3%, respectively, which contradicts an equal distribution in this group. With a favorable prognosis the death rate was 15.2% (16 cases). For further comparison of this method with existing models for predicting lethal outcome in severely burned patients a four-field contingency table was compiled. Values of 75–100 points (50% probability of death) were assigned to the group with an unfavorable prognosis. The data obtained are presented in Table 2.

The data presented in Table 2 allow us to conclude that despite the high predictive value of the Baux score for a favorable prognosis (84.8%), an increased level of error in predicting a lethal outcome in patients with extensive burn injury plays an equally important role. The results of the analysis indicate the dubious effectiveness of the presented model, despite its daily use in domestic practice and abroad.

The Frank index method was used as the second model for predicting the lethal outcome in severely burned patients. During the application of this model the sum of the indicators of the area of a superficial burn and a deep lesion, multiplied by 3, calculated as a percentage, was used. The results were divided into 4 groups:

1) less than 30 units – a favorable prognosis;

- 2) 30–60 units – a relatively favorable prognosis;
- 3) 61–90 units – a dubious prognosis;
- 4) 90 units or more – unfavorable prognosis.

Table 3 presents the results of a comparative analysis between the two groups – survivors and patients with a fatal outcome using the Frank index method.

According to the data presented in Table 3, the following conclusion can be drawn that in two groups of severely burned patients with values of 90 units or more, the probability of recovery and death was 49% and 51%, respectively. When making a dubious forecast, i.e., value of 61–90 units, the ratio of results was 15.1% for patients with an unfavorable prognosis and 84.9% for those who recovered. With a relatively favorable prognosis (values of 30–60 units), the accuracy of the model for survivors was 28.1%, and for patients with a fatal outcome – 71.9%. In the case of predicting a favorable course of burn disease, these indicators were equal to 80% and 20%, respectively. The results of the comparative analysis show the high predictive ability of this model in forecasting a favorable prognosis and at the same time indicate the dubious effectiveness of this index in relation to the lethal outcome. At this stage of the study, it can be concluded that despite the high prevalence of the use of this method in modern combustiology, it is necessary to reconsider its accuracy and validity of application.

For further comparison of this index with existing methods for predicting a lethal outcome in patients with extensive burn injury, a four-field contingency table was constructed with a cutoff of 50%. In the process of building the table, the values of dubious and unfavorable

Table 1
Comparative analysis between two patient samples using the Baux score
Таблица 1

Сравнительный анализ двух образцов пациентов с использованием правила Баух

Prognosis	Outcome of injury, number of patients		Total
	fatal outcome (projected)	survivors (projected)	
Favorable	16 15.2%	89 84.8%	105 100.0%
Lethality 50%	35 34.3%	67 65.7%	102 100.0%
Unfavorable	53 70.7%	22 29.3%	75 100.0%
Total	104 36.9%	178 63.1%	282 100.0%

Table 2
Four-field contingency table for assessing the level of predictability of the Baux score
Таблица 2

Таблица сопряженности для оценки уровня прогнозируемости правила Баух

Outcome	Fatal outcome	Recovery	Model Accuracy
Recovery (projected)	16	89	84.8%
Fatal outcome (projected)	88	89	49.7%

Table 3
Comparative analysis between two patient samples using the Frank index
Таблица 3

Сравнительный анализ двух образцов пациентов с использованием индекса Франка

Prognosis	Outcome of injury, number of patients		Total
	fatal outcome	survivors	
favorable	5 20.0%	20 80.0%	25 100.0%
Relatively favorable	16 28.1%	41 71.9%	57 100.0%
Dubious	8 15.1%	45 84.9%	53 100.0%
Unfavorable	75 51.0%	72 49.0%	147 100.0%
Total	104 36.9%	178 63.1%	282 100.0%

Table 4
Four-field contingency table for assessing the level of predictability of the Frank index
Таблица 4

Таблица сопряженности для оценки уровня прогнозируемости индекса Франка

Outcome	Fatal outcome	Recovery	Model Accuracy
Recovery (projected)	117	83	74.4%
Fatal outcome (projected)	61	21	41.5%

Total, burn area, %	Age																	
	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-96	
83 and more	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	
78-82	.9	.9	.9	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	
73-77	.8	.8	.8	.9	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	
68-72	.7	.7	.7	.8	.9	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	
63-67	.6	.6	.6	.7	.9	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	
58-62	.5	.5	.5	.6	.8	.9	.9	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	
53-57	.4	.4	.4	.5	.8	.8	.8	.8	1.	1.	1.	1.	1.	1.	1.	1.	1.	
48-52	.3	.3	.3	.4	.6	.7	.7	.7	.9	.9	1.	1.	1.	1.	1.	1.	1.	
43-47	.3	.3	.3	.3	.5	.5	.6	.6	.8	.8	.9	.9	1.	1.	1.	1.	1.	
38-42	.2	.2	.2	.2	.4	.4	.5	.5	.7	.7	.9	.8	.9	1.	1.	1.	1.	
33-37	.1	.1	.1	.2	.3	.3	.4	.4	.5	.6	.8	.7	.8	1.	1.	1.	1.	
28-32	.1	.1	.1	.1	.2	.2	.3	.3	.4	.5	.6	.6	.7	1.	1.	1.	1.	
23-27	0	0	0	0	.1	.1	.2	.2	.3	.3	.5	.5	.6	.9	.9	1.	1.	
18-22	0	0	0	0	0	0	.1	.1	.2	.2	.3	.3	.5	.7	.8	.9	1.	
13-17	0	0	0	0	0	0	0	.1	.1	.1	.2	.2	.3	.5	.5	.8	1.	
8-12	0	0	0	0	0	0	0	0	0	0	.1	.1	.2	.3	.4	.5	.9	
3-7	0	0	0	0	0	0	0	0	0	0	0	0	.1	.1	.2	.4	.5	
0-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.1	.1	.1	

Figure 1. Coordinate grid of estimated probability of death for various combinations of age and area of burns

Рисунок 1. Координатная сетка предполагаемой вероятности смерти при различных сочетаниях возраста и площади ожогов

prognosis were combined into the group of lethal outcome, and the favorable and relatively favorable course of burn disease were combined into the group of survivors. The data obtained are presented in Table 4.

Table 5 presents the results of a comparative analysis between the two groups – survivors and patients with a fatal outcome using a probit analysis model.

The results obtained in Table 4 allow us to conclude that the predictive ability of this model is 74.4% for a favorable course of burn disease and 41.5% for severe burns with a fatal outcome. This also confirms the low predictivity of this model in relation to predicting an unfavorable prognosis. Despite the widespread use of this model

in the Russian Federation to determine the probability of death in patients with extensive burn injury, the Frank index has questionable effectiveness and requires further revision and re-evaluation.

The latest domestic development in relation to predicting the death of severely burned patients is the method of probit analysis. The basis of this method was the ratio of the age of the patient with extensive burn injury and the standard Frank index (the sum of the area of the superficial burn and the deep lesion, multiplied by 3, calculated as a percentage). Further, as a result of the probit analysis, a coordination grid was built to determine the probability of a lethal outcome in percentage, shown in Figure 1.

Table 5
Comparative analysis between two patient samples using a probit analysis model
Таблица 5

Сравнительный анализ двух образцов пациентов с использованием модели пробит анализа

Prognosis	Outcome of injury, number of patients		Total
	fatal outcome	recovery	
1	1 5.9%	16 94.1%	17 100.0%
2	0 0%	7 100.0%	7 100.0%
3	0 0%	4 100.0%	4 100.0%
4	0 0%	3 100.0%	3 100.0%
5	2 28.6%	5 71.4%	7 100.0%
6	1 7.7%	12 92.3%	13 100.0%
8	2 50.0%	2 50.0%	4 100.0%
9	0 0%	1 100.0%	1 100.0%
10	0 0%	12 100.0%	12 100.0%
15	3 20.0%	12 80.0%	15 100.0%
20	3 27.3%	8 72.7%	11 100.0%
25	2 20.0%	8 80.0%	10 100.0%
30	2 20.0%	8 80.0%	10 100.0%
35	0 0%	7 100.0%	7 100.0%
40	3 21.4%	11 78.6%	14 100.0%
45	1 14.3%	6 85.7%	7 100.0%
50	5 29.4%	12 70.6%	17 100.0%
55	2 22.2%	7 77.8%	9 100.0%
60	1 20.0%	4 80.0%	5 100.0%
65	8 50.0%	8 50.0%	16 100.0%
70	6 46.2%	7 53.8%	13 100.0%
75	6 54.5%	5 45.5%	11 100.0%
80	6 60.0%	4 40.0%	10 100.0%
85	4 66.7%	2 33.3%	6 100.0%
90	2 50.0%	2 50.0%	4 100.0%
95	1 100.0%	0 0%	1 100.0%
100	43 89.6%	5 10.4%	48 100.0%
Total	104 36.9%	178 63.1%	282 100.0%

Table 6

Four-field contingency table for assessing the level of predictability of the probit analysis model

Таблица 6

Таблица сопряженности для оценки уровня прогнозируемости пробит-анализа

Outcome	Fatal outcome	Recovery	Model Accuracy
Recovery (projected)	20	122	85.9%
Fatal outcome (projected)	84	56	60.0%

The data obtained in Table 5 allow us to conclude that this model is highly effective in predicting both a favorable prognosis and a lethal outcome. In determination of the probability of an unfavorable course of the disease and recovery with minimal values on the coordination grid, the results showed 94.1% and 5.9%, respectively. At the maximum values these parameters were equal to 89.6% and 10.4%, respectively. However, at rates of 50% the accuracy of this model is questionable since the ratio of the death probability was 29.4% for survivors and 70.6% for severely burned with a fatal outcome. In this connection a contingency table was built with a cutoff of 50% for further comparative analysis. For the data isolation values from 1 to 45 were combined into the group with a favorable prognosis, and 50–100 – into the group of patients with a fatal outcome. The results are presented in Table 6.

As a result of the construction of a four-field contingency table data were obtained that indicate the high efficiency of this model in predicting a favorable prognosis – 85.9% and questionable accuracy in predicting a lethal outcome in patients with extensive burn injury – 60.0%.

Despite the simplicity of applying this model in practice, it is difficult to speak about its effectiveness in making an accurate prognosis for the death of severely burned patients.

Discussion

During the comparative analysis of existing forecasting models through the construction of four-field contingency tables, it can be concluded that these indices are highly predictive in terms of a favorable outcome of burn disease, are quite simple and easy to use, but raise doubts about accuracy of the results of a fatal outcome prediction in severely burned patients. The presented methods are based on determining the area of superficial and deep burns, excluding clinical features and the main links in the pathogenesis of burn disease, which also casts doubt on the objectivity of their use. The new logistic regression method, which takes into account clinical data, parameters of laboratory and instrumental studies, as well as the volume of infusion therapy and its effectiveness through indications of daily diuresis, results of previous surgical treatment, not only has a high prediction accuracy, but also allows to evaluate the quality of therapy at an early stage, which confirms the importance of its use in current combustiology practice.

Conclusion

1. The Baux score, the Frank index, and the probit analysis model are highly effective in predicting a favorable course of burn disease and are of questionable in terms of determining the death possibility in severely burned patients, which requires further evaluation in a larger group of patients with extensive burns.

2. The new forecasting model based on the logistic regression method showed high performance in predicting both a favorable prognosis and a lethal outcome forecast with a low probability of error compared to its predecessors. These factors can be considered as the basis for using this method in everyday practice.

References/Литература

1. Burns. *World Health Organization*. 2018. (In Russ.). Ожоги. *Всемирная организация здравоохранения*. 2018.
2. Evdokimov VI, Kourov AS. Genesis of research on burn injury (analysis of domestic articles in 2005–2017). *Medico-biological and socio-psychological problems of safety in emergency situations*. 2018;4:108–120. (In Russ.). <https://doi.org/10.25016/2541-7487-2018-0-4-108-120>
3. Евдокимов В.И., Коуров А.С. Генезис научных исследований по ожоговой травме (анализ отечественных журнальных статей в 2005–2017 гг.). *Медико-биологические и социально-психологические проблемы безопасности в чрезвычайных ситуациях*. 2018;4:108–120. <https://doi.org/10.25016/2541-7487-2018-0-4-108-120>
4. Hussain A, Dunn K. Burn related mortality in Greater Manchester: 11-year review of Regional Coronial Department Data. *Burns*. 2015;41(2):225–234. PMID: 25468472. <http://doi.org/10.1016/j.burns.2014.10.008>
5. Woods JCF, Quinlan CS, Shelley OP. Predicting Mortality in Severe Burns—What Is the Score? Evaluation and Comparison of 4 Mortality Prediction Scores in an Irish Population. *Plast Reconstr Surg Glob Open*. 2016;4(1):606. PMID: 27104105. PMID: PMC4801096. <http://doi.org/10.1097/GOX.0000000000000584>
6. Douglas HE, Ratcliffe A, Sandhu R, et al. Comparison of mortality prediction models in burns ICU patients in Pinderfields Hospital over 3 years. *Burns*. 2015;41(1):49–52. PMID: 24986595. <http://doi.org/10.1016/j.burns.2014.05.009>
7. Matveenko AV. Predicting the outcome of thermal burns. *Grekov's Bulletin of Surgery*. 2009;168(6):101–104. (In Russ.). Матвеевко А.В. Прогнозирование исхода термических ожогов. *Вестник хирургии имени И.И. Грекова*. 2009;168(6):101–104.
8. Fistol EYa, Guryanov VG, Soloshenko VV. Mathematical model of forecasting for outcomes in victims of methane-coal mixture explosion. *Russian Sklifosovsky Journal "Emergency Medical Care"*. 2016;3:43–47. (In Russ.).

Фисталь Э.Я., Гурьянов В.Г., Солошенко В.В. Математическая модель прогнозирования исхода у пострадавших при взрывах метано-угольной смеси. *Журнал им. Н.В. Склифосовского «Неотложная медицинская помощь»*. 2016;3:43–47.

8. Riley RD, Ensor J, Snell KI, et al. External validation of clinical prediction models using big datasets from e-health records or IPD meta-analysis: opportunities and challenges. *BMJ*. 2016;41:353. <https://doi.org/10.1136/bmj.i31140>

9. Pantet O, Faouzi M, Brusselsaers N, et al. Comparison of mortality prediction models and validation of SAPS II in critically ill burns patients. *Ann Burns Fire Disasters*. 2016;29(2):123–129. PMID: 28149234. PMCID: PMC5241191

10. Bogdanov SB, Marchenko DN, Polyakov AV, et al. Novel ways of vacuum therapy application in burn injury medicine. *Innovative medicine of Kuban*. 2020;1(17):36–40. (In Russ.). <https://doi.org/10.35401/2500-0268-2020-17-1-36-40>

Богданов С.Б., Марченко Д.Н., Поляков А.В., и др. Новые варианты применения вакуумной терапии в комбустиологии. *Инновационная медицина Кубани*. 2020;1(17):36–40. <https://doi.org/10.35401/2500-0268-2020-17-1-36-40>

11. Bogdanov SB, Gilevich IV, Fedorenko TV, et al. Cell therapy application on skin grafting surgery. *Innovative medicine of Kuban*. 2018;3(11):16–21. (In Russ.).

Богданов С.Б., Гилевич И.В., Федоренко Т.В. и др. Возможности применения клеточной терапии в кожно-пластических операциях. *Инновационная медицина Кубани*. 2018;3(11):16–21.

12. Polyakov AV, Bogdanov SB, Afanasov IM, et al. Application of chitosan-based wound coatings ‘ChitoPran’ in the treatment of patients with burn trauma. *Innovative medicine of Kuban*. 2019;3(15):25–31. (In Russ.). <https://doi.org/10.35401/2500-0268-2019-15-3-25-31>

Поляков А.В., Богданов С.Б., Афанасов И.М., и др. Использование раневых покрытий на основе хитозана «Хитопран» в лечении больных с ожоговой травмой. *Инновационная медицина Кубани*. 2019;3(15):25–31. <https://doi.org/10.35401/2500-0268-2019-15-3-25-31>

13. Zavorotniy OO, Zinoviev EV, Kostyakov DV. Predicting for mortality rate using regression analysis in patient with burn injury. *Grekov's Bulletin of Surgery*. 2020;179(5):21–29. (In Russ.). <https://doi.org/10.24884/0042-4625-2020-179-5-21-29>

Заворотный О.О., Зиновьев Е.В., Костяков Д.В. Возможности прогнозирования летального исхода тяжело-обожженных на основе методов регрессионного анализа. *Вестник хирургии имени И.И. Грекова*. 2020;179(5):21–29. <https://doi.org/10.24884/0042-4625-2020-179-5-21-29>

Author credentials

Oleg O. Zavorotniy, Surgeon of Thermal Injuries Unit, Saint-Petersburg I. I. Dzhanelidze Research Institute of Emergency Medicine; Assistant of the Department of General Surgery, Saint-Petersburg State University (Saint-Petersburg, Russian Federation). <https://orcid.org/0000-0002-1097-1519>

Evgeny V. Zinoviev, Dr. Sci. (Med.), Professor, Head of the Thermal Injuries Unit, Saint-Petersburg I. I. Dzhanelidze Research Institute of Emergency Medicine (Saint-Petersburg, Russian Federation). <https://orcid.org/0000-0002-2493-5498>

Denis V. Kostyakov, Cand. Sci. (Med.), Research Fellow of the Thermal Injuries Unit, Saint-Petersburg I. I. Dzhanelidze Research Institute of Emergency Medicine; Assistant Professor

of the Department of General Surgery, Saint-Petersburg State University (Saint-Petersburg, Russian Federation). <https://orcid.org/0000-0001-5687-7168>

Vladislav G. Volkov, Surgeon of the Thermal Injuries Unit, Saint-Petersburg I. I. Dzhanelidze Research Institute of Emergency Medicine (Saint-Petersburg, Russian Federation). <https://orcid.org/0000-0002-9029-6014>

Alexander V. Semiglazov, Surgeon of the Thermal Injuries Unit, Saint-Petersburg I. I. Dzhanelidze Research Institute of Emergency Medicine (Saint-Petersburg, Russian Federation). <https://orcid.org/0000-0003-2022-1014>

Tamara Z. Gogohiya, Surgeon of the Thermal Injuries Unit, Saint-Petersburg I. I. Dzhanelidze Research Institute of Emergency Medicine (Saint-Petersburg, Russian Federation). <https://orcid.org/0000-0002-1230-1412>

Diana H. Halipaeva, Anesthesiologist, Intensivist of the Thermal Injuries Unit, Saint-Petersburg I. I. Dzhanelidze Research Institute of Emergency Medicine (Saint-Petersburg, Russian Federation). <https://orcid.org/0000-0002-0742-0417>

Conflict of interest: none declared.

Сведения об авторах

Заворотный Олег Олегович, врач-хирург отдела термических поражений, Санкт-Петербургский научно-исследовательский институт скорой помощи имени И.И. Джанелидзе; ассистент кафедры общей хирургии, Санкт-Петербургский государственный университет (Санкт-Петербург, Россия). <https://orcid.org/0000-0002-1097-1519>

Зиновьев Евгений Владимирович, д. м. н., профессор, руководитель отдела термических поражений, Санкт-Петербургский научно-исследовательский институт скорой помощи имени И.И. Джанелидзе (Санкт-Петербург, Россия). <https://orcid.org/0000-0002-2493-5498>

Костяков Денис Валерьевич, к. м. н., научный сотрудник отдела термических поражений, Санкт-Петербургский научно-исследовательский институт скорой помощи имени И.И. Джанелидзе; доцент кафедры общей хирургии, Санкт-Петербургский государственный университет (Санкт-Петербург, Россия). <https://orcid.org/0000-0001-5687-7168>

Волков Владислав Григорьевич, врач-хирург отдела термических поражений, Санкт-Петербургский научно-исследовательский институт скорой помощи имени И.И. Джанелидзе (Санкт-Петербург, Россия). <https://orcid.org/0000-0002-9029-6014>

Семглазов Александр Владимирович, врач-хирург отдела термических поражений, Санкт-Петербургский научно-исследовательский институт скорой помощи имени И.И. Джанелидзе (Санкт-Петербург, Россия). <https://orcid.org/0000-0003-2022-1014>

Гогохия Тамара Зауровна, врач-хирург отдела термических поражений, Санкт-Петербургский научно-исследовательский институт скорой помощи имени И.И. Джанелидзе (Санкт-Петербург, Россия). <https://orcid.org/0000-0002-1230-1412>

Халипаева Диана Халипаевна, врач анестезиолог-реаниматолог отдела термических поражений, Санкт-Петербургский научно-исследовательский институт скорой помощи имени И.И. Джанелидзе (Санкт-Петербург, Россия). <https://orcid.org/0000-0002-0742-0417>

Конфликт интересов

Авторы заявляют об отсутствии конфликта интересов.