

Prediction of Development of Acute Gastroduodenal Complications in Patients With Severe Burns

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ABSTRACT

OBJECTIVES: Our aim was to find whether we could predict the likelihood of acute gastroduodenal complications developing in patients with severe burns.

MATERIALS AND METHODS: From 2018 to 2020, there were 85 patients with extensive thermal injury and severe burns who were hospitalized at our burn department (Samarkand City Medical Association). Of these, 45 patients (53%) developed acute gastroduodenal complications in the first 7 days postinjury and 40 (47%) did not develop these complications in the first 2 weeks after admission. We analyzed the following 7 parameters: admission time and initiation of intensive care after 12 hours, total burn area of $\geq 40\%$, deep burn area $\geq 10\%$, lesion severity index (Frank index) of ≥ 130 units, development of thermal inhalational lesion in the respiratory tract, duration of mechanical ventilation of > 48 hours, and history of peptic ulcer disease of > 5 years.

RESULTS: We found that 57.8% of patients who had postponed hospitalization in a specialized medical institution and started intensive therapy > 12 hours later developed acute gastroduodenal complications versus 42.2% of patients without these factors. In those with total burn area $< 40\%$ and $\geq 40\%$, 28.9% versus 71.1% developed acute gastroduodenal complications. At week 2 of burn disease, in patients with deep burn areas $\geq 10\%$, acute gastroduodenal complications developed 1.5 times more often. Among patients whose Frank index was ≥ 130 units, acute gastrodu-

odenal complications developed 9 times more often than among those with Frank index ≤ 70 units.

CONCLUSIONS: The 7 parameters that we used as prognostic criteria could assess patients with extensive thermal injury complicated by the development of burn disease. With these criteria, a scale was created to predict the development of acute gastroduodenal complications. This scale could allow better preparation to treat these complications and to take timely preventive measures.

KEY WORDS: Burn disease, Burn injury, Injury severity index, Ulcers

INTRODUCTION

Despite new achievements in surgery, burn medicine, and resuscitation, the diagnosis, prevention, and treatment of acute gastroduodenal complications in patients with burn injuries remain not fully understood, resulting in reliance on finding treatment criteria based on an individual approach.^{1,2} The most common type of gastroduodenal complication in patients with severe burns is hemorrhagic syndrome of the upper gastrointestinal tract.³ The central link in the pathogenesis of erosive and ulcerative lesions of the stomach and duodenum in burn disease is damage to the mucous membrane, which is caused by an imbalance of protective mechanisms during the growth of endotoxemia and impaired microcirculation in the submucous layer.^{4,5} In clinical practice, the development of ischemic lesions to necrosis can occur as a result of a variety of gastric and intestinal motility disorders (motor-evacuation disorders), including bleeding from erosive and ulcerative lesions of the stomach and duodenum. These complications can dictate treatment tactics in this category of patients, which should include drugs that improve the rheological parameters of the blood, stabilize the processes of lipid peroxidation, and restore the parameters of tissue respiration.^{6,7}

According to Bobrovnikov and Krutikov,⁸ acute erosions and ulcers of the gastrointestinal tract can be observed

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in 30.3% to 66.1% of patients with burn injury. In addition, Wagner and colleagues^{9,10} found that 10% to 30% of patients with thermal shock injury had gastrointestinal bleeding. Mortality in this category of patients can reach up to 80%, which determines the urgency of this problem in modern burn medicine.^{9,10} In this study, our aim was to find factors that could predict the likelihood of development of acute gastroduodenal complications in patients with severe burns.

MATERIALS AND METHODS

From 2018 to 2020, there were 85 patients with extensive burns who were treated in our burn department in Samarkand City, Uzbekistan. We reviewed medical records and data on the course of burn disease (complicated and uncomplicated) along with development of acute gastroduodenal complications. Among total patients, 45 patients (53%) developed acute gastroduodenal complications in the first 7 days after burn injury and 40 patients (47%; control group) did not develop acute gastroduodenal complications in the first 2 weeks after admission. Patients with acute gastroduodenal complications received H2-blockers of histamine receptors.

An analysis of clinical, laboratory, and instrumental data reflecting the condition of patients with severe burn injury allowed us to identify 7 parameters that were the most informative in terms of detection in complicated and uncomplicated burn disease. These parameters included (1) delay in admission and initiation of intensive care more than 12 hours later, (2) total burn area of $\geq 40\%$, (3) deep burn area of $\geq 10\%$, (4) severity index of ≥ 130 units, (5) development of thermal inhalation damage to the respiratory tract, (6) duration of mechanical ventilation of > 48 hours, and (7) history of concomitant peptic ulcer disease for > 5 years. We analyzed whether these parameters could be used to develop a scale to predict the likelihood of acute gastroduodenal complication development in patients with severe burns.

Risk of likelihood of acute gastroduodenal complications in our patients was based on results shown on day 3 after injury, data shown during the period of burn shock and burn toxemia, and correlation analyses.

Studies involving human subjects were approved by our ethics committee before the study began, with all protocols conforming to the ethical guidelines of the 1975 Helsinki Declaration. Patients or their guardians provided consent for use of their data during admission.

RESULTS AND DISCUSSION

Because patients did not complain of complications of the digestive system before burn injury, including in some patients with esophagogastroduodenoscopy tests before burn injury, we considered that changes shown during endoscopic examinations were directly related to thermal injury factors. Among the 45 patients with acute gastroduodenal complications after burn injury, which were revealed during esophagogastroduodenoscopy, we found that there were 3 main groups of complications: (1) inflammatory lesions of the mucous membrane of the stomach and duodenum, (2) erosive and ulcerative lesions, and (3) gastric and intestinal motility disorders. Moreover, 1 patient had a combination of these complications. In patients in the control group, the above complications were not observed; therefore, no comparative analysis of the characteristics between the 2 groups was performed.

With regard to patients with inflammatory lesions of the mucous membrane of the stomach and duodenum, reflux esophagitis, catarrhal, and hemorrhagic gastroduodenitis were noted (Figure 1 and Figure 2). Among patients with erosive and ulcerative complications, shown in esophagogastroduodenoscopies, superficial (erosive) lesions, deep (ulcerative) lesions, and a combination of both lesions were noted (Figure 3 and Figure 4). Figure 5 and Figure 6 show examples of gastric and intestinal motility disorders, which were aggravated during the course of burn disease.

FIGURE 1. Inflammatory Complications on Day 3 After Burn Injury (N = 45)

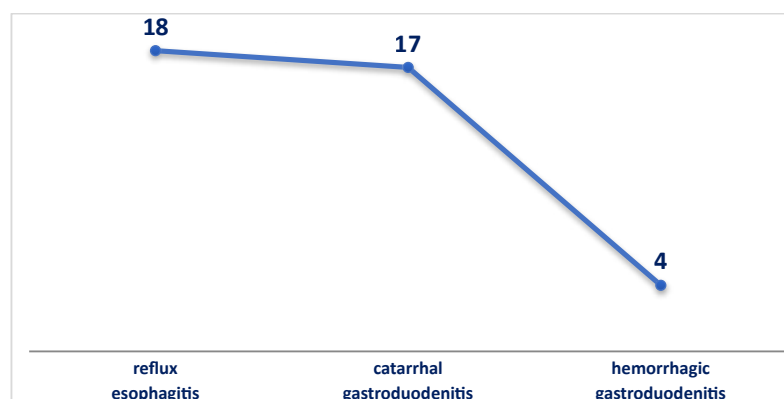
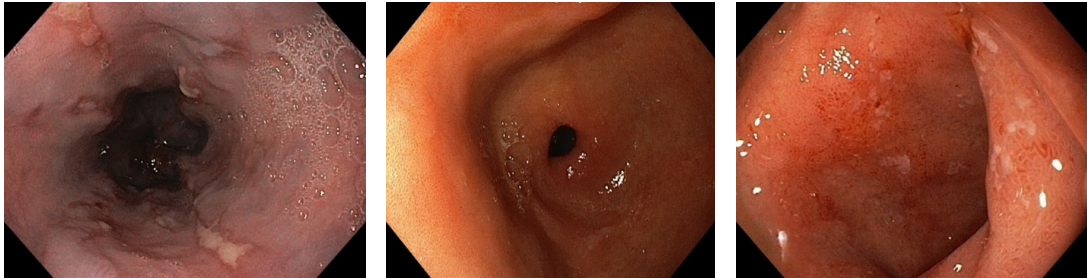
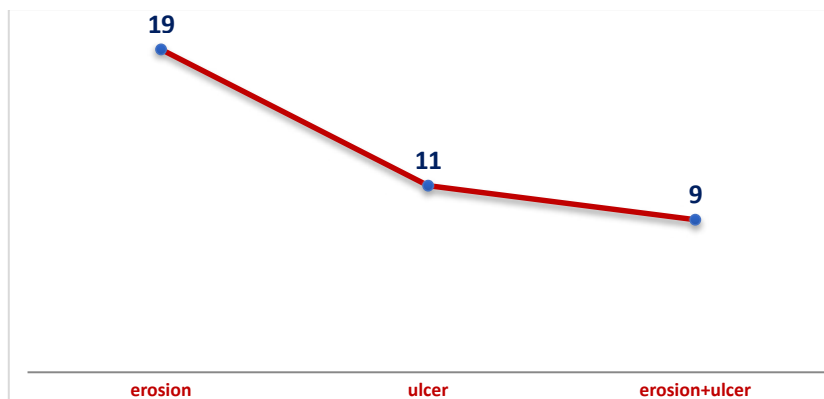
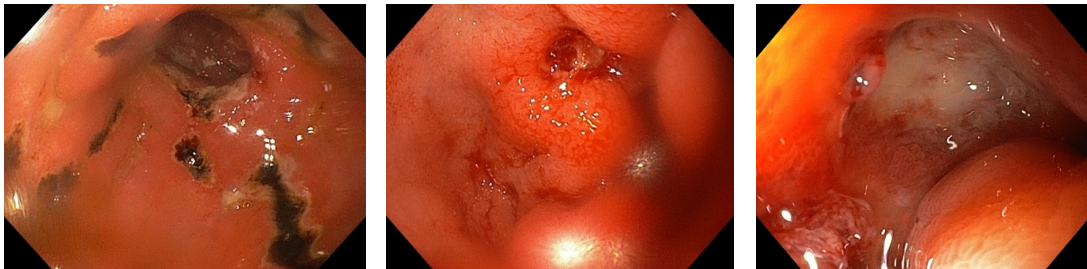
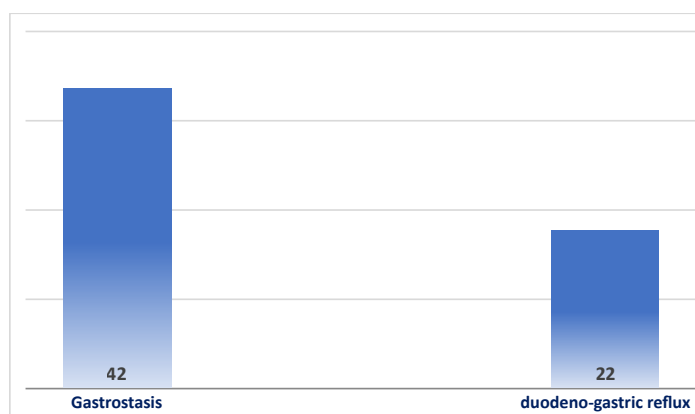


FIGURE 2. Endoscopic Images of Inflammatory Lesions of Mucous Membrane of Esophagus and Stomach**(Left)** Reflux esophagitis. **(Middle)** Catarrhal gastritis. **(Right)** Hemorrhagic gastritis.**FIGURE 3.** Erosive and Ulcerative Complications on Day 3 After Burn Injury (N = 45)**FIGURE 4.** Endoscopic Images of Erosive and Ulcerative Lesions of Stomach and Duodenum**(Left)** Multiple erosions of the antrum of the stomach, complicated by stopped bleeding. **(Middle)** Chronic ulcer of the duodenal bulb, complicated by ongoing bleeding. **(Right)** Chronic duodenal ulcer, complicated by stopped bleeding.**FIGURE 5.** Gastric and Intestinal Motility Complications on Day 3 After Burn Injury (N = 45)

Despite ongoing intensive conservative therapy, inflammatory changes in patients persisted for up to 2 weeks from the moment of burn injury. We noted that, if the

FIGURE 6. Image of Gastric and Intestinal Motility Complication in Burn Disease: Duodenogastric Bile Reflux With Gastrostasis



inflammatory process in the esophageal mucosa decreased, then, in relation to the gastric and duodenal mucosa, the opposite dynamics were observed (Figure 7).

In patients who had erosive and ulcerative complications, we found that, on day 7 after thermal injury, 100% of patients had superficial and/or deep damage to the mucous membrane of the stomach and duodenum, which in some cases was complicated by hemorrhagic syndrome (Figure 8). At week 2 after injury, patients with uncomplicated burn disease had only scarring of chronic duodenal ulcers; these complications were not included as gastroduodenal complications.

Gastric and intestinal motility disorders responded well to conservative therapy, resulting in both a substantial decrease in frequency of their detection and the degree of severity (Figure 9).

FIGURE 7. Dynamics of Inflammatory Complications in Burn Disease (N = 45)

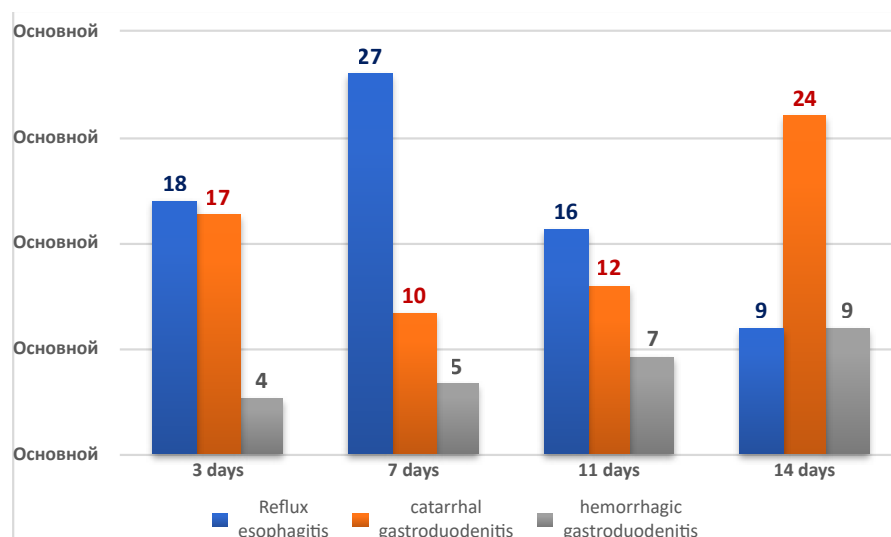


FIGURE 8. Dynamics of Erosive and Ulcerative Complications in Burn Disease (N = 45)

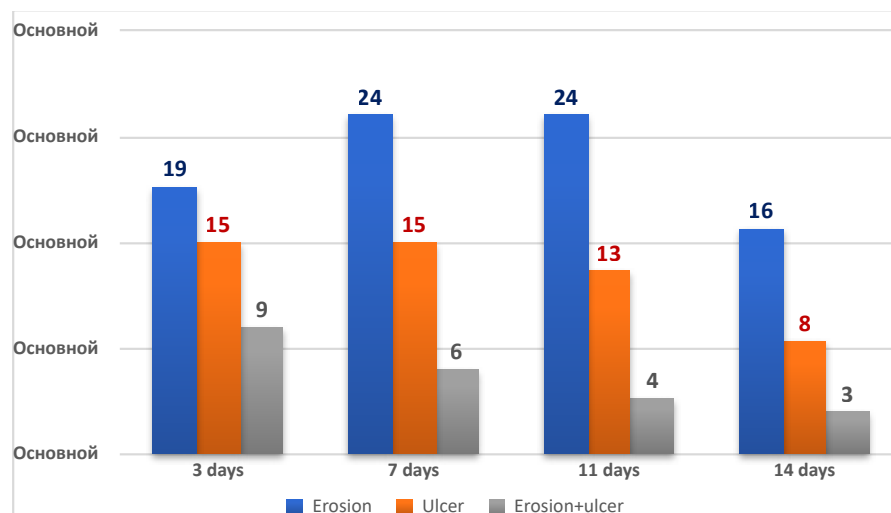
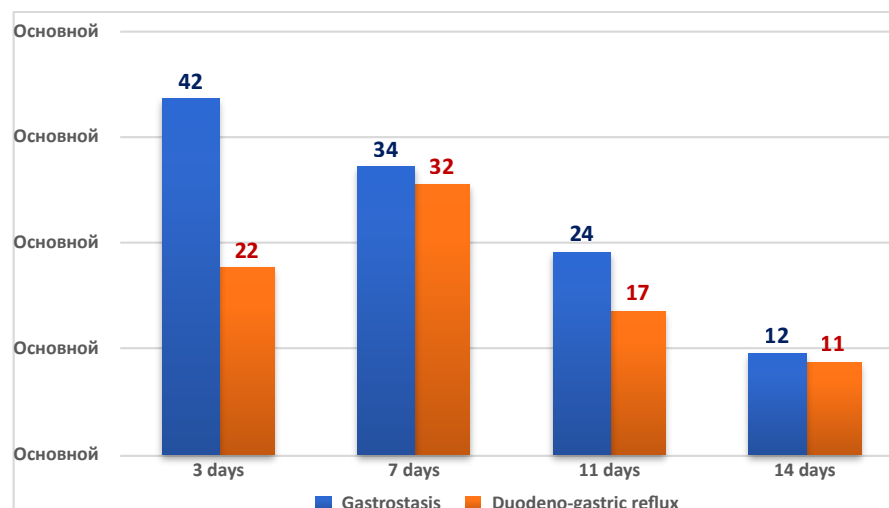


FIGURE 9. Dynamics of Gastric and Intestinal Motility Complications in Burn Disease (N = 45)

Admission time and late start of intensive care after 12 hours

One of the main factors in the development of acute gastroduodenal complications was the late arrival of patients to the burn department with, accordingly, a late start to intensive care treatment.

In patients with delayed hospitalization at a specialized medical institution and late start of intensive care therapy more than 12 hours later, 57.8% developed acute gastroduodenal complications, whereas, in patients without these factors, only 42.2% developed acute gastroduodenal complications (Table 1). Thus, a delay in hospitalization at a specialized medical institution and late start of intensive care resulted in 15.6% more patients developing complications of burn disease in the form of acute gastroduodenal complications.

Total burn area of $\geq 40\%$

We found that total area of burn injury of 40% or more affected the likelihood of developing an acute gastroduodenal complication. In patients with total burn area of $\geq 40\%$, 71.1% developed acute gastroduodenal complications; in those whose total burn area did not exceed 40%, only 28.9% developed acute gastroduodenal complications (Table 2).

Consequently, we found that the criterion of total burn injury area of 40% or more greatly determined the degree of risk of developing acute gastroduodenal complications in patients with extensive burns at 2.5 times more often.

Deep burn area of 10% or more

In patients with deep burns exceeding 10%, 62.2% developed acute gastroduodenal complications. In contrast, in those whose total area of deep burn did not exceed 10%, 24.4% less patients developed acute gastroduodenal complications (Table 3).

TABLE 1. Distribution of Patients With Burn Injury and Acute Gastroduodenal Complications: Postponement of Admission to Burn Department and Start of Intensive Care

	TIME OF ADMISSION AND START OF INTENSIVE CARE	
	<12 HOURS	≥ 12 HOURS
Patients with acute gastroduodenal complications (n = 45), No. (%)	19 (42.2%)	26 (57.8%)
Patients without acute gastroduodenal complications (n = 40), No. (%)	17 (42.5%)	23 (57.5%)

TABLE 2. Distribution of Patients With Burn Injury and Acute Gastroduodenal Complications: Total Burn Area

	TOTAL BODY SURFACE BURN AREA	
	<40%	$\geq 40\%$
Patients with acute gastroduodenal complications (n = 45), No. (%)	13 (28.9%)	32 (71.1%)
Patients without acute gastroduodenal complications (n = 40), No. (%)	18 (45%)	22 (55%)

TABLE 3. Distribution of Patients With Burn Injury and Acute Gastroduodenal Complications: Area of Deep Burn Lesion

	AREA OF DEEP BURN OF $\geq 10\%$ OF BODY SURFACE	
	WITHOUT	WITH
Patients with acute gastroduodenal complications (n = 45), No. (%)	17 (37.8%)	28 (62.2%)
Patients without acute gastroduodenal complications (n = 40), No. (%)	21 (52.5%)	19 (47.5%)

Thus, when we analyzed the incidence of complications at week 2 after burn injury, we found that the criterion of deep burns of 10% or more resulted in 1.5 times more likelihood of acute gastroduodenal complication development in patients with severe burns.

Lesion severity index

In our analysis of severity index of the lesion, we found that patients whose severity index was more than 130 units developed acute gastroduodenal complications 9 times more often than patients with a severity index of less than 70 units (62.2% vs 6.7%, respectively; Table 4).

TABLE 4. Distribution of Patients With Burn Injury and Acute Gastroduodenal Complications: Severity Index of the Lesion

	SEVERITY INDEX OF THE LESION, SCORE		
	≤70	71 to 130	≥130
Patients with acute gastroduodenal complications (n = 45), No. (%)	3 (6.7%)	14 (31.1%)	28 (62.2%)
Patients without acute gastroduodenal complications (n = 40), No. (%)	25 (62.5%)	10 (25%)	5 (12.5%)

Thermal inhalational damage in the respiratory tract

According to our results, we found that the presence of thermal inhalational damage to the respiratory tract was important in predicting the development of acute gastroduodenal complications in patients with severe burns (Table 5). This criterion was closely associated with another prognostic criterion (the use of mechanical artificial lung ventilation for >48 h).

TABLE 5. Distribution of Patients With Burn Injury and Acute Gastroduodenal Complications: Presence of Thermal Inhalation Damage to Respiratory Tract

	SEVERITY OF THERMAL INHALATION DAMAGE TO RESPIRATORY TRACT, DEGREE		
	I	II	III
Patients with acute gastroduodenal complications (n = 45), No. (%)	2 (4.4%)	13 (28.9%)	30 (66.7%)
Patients without acute gastroduodenal complications (n = 40), No. (%)	29 (72.5%)	6 (15%)	5 (12.5%)

Duration of mechanical ventilation of more than 48 hours

Among patients with severe burns who required artificial lung ventilation within the first 3 days for more than 48 hours, the development of acute gastroduodenal complications was almost 3 times more often than in those who did not require artificial lung ventilation for more than 48 hours.

History of peptic ulcer disease

When we analyzed data on frequency of concomitant pathological conditions and history of peptic ulcer disease of more than 5 years, we found that acute gastroduodenal complications developed 1.2 times more often than in patients with an uncomplicated history (64.4% vs 35.6%, respectively; Table 6).

TABLE 6. Distribution of Patients With Burn Injury and Acute Gastroduodenal Complications: Presence of Concomitant Disease

	PRESENCE OF CONCOMITANT DISEASE	
	WITHOUT	WITH
Patients with acute gastroduodenal complications (n = 45), No. (%)	16 (35.6%)	29 (64.4%)
Patients without acute gastroduodenal complications (n = 40), No. (%)	31 (77.5%)	9 (22.5%)

Analysis of parameters

For all of these parameters that could lead to the likelihood of development of acute gastroduodenal complications in patients with severe burns, we calculated the ratio index of frequency of its occurrence in patients with complicated (main group) and uncomplicated (control group) burn disease. In addition, the forecast weight factor was also calculated. For the convenience of calculations, fractional values of logarithms were replaced by equivalent, increased by a factor of 10, whole numbers of conventional units. These results are shown in Table 7.

Scale for predicting the development of acute gastroduodenal complications in severely burned patients

On the basis of the parameters that we analyzed, a scale for predicting the development of acute gastroduodenal complications in patients with severe burns was created. We determined an adequate value or range of values for each selected parameter, which was guided by the calculated forecast weight coefficients. All coefficients for these 7 indicators were summed up, with the total corresponding to the forecast index, which were then divided into

TABLE 7. Clinical and Laboratory Parameters in Development of Acute Gastroduodenal Complications in Patients With Severe Burn on Day 3 After Burn Injury

Parameter	LEVEL (FREQUENCY) OF OBSERVATION OF THE PARAMETER		RATIO INDEX	FORECAST WEIGHT FACTOR
	WITH ACUTE GASTRODUODENAL COMPLICATIONS (n = 45)	WITHOUT ACUTE GASTRODUODENAL COMPLICATIONS (n = 40)		
Postponement of admission and start of intensive care of ≥12 h				
No	19 (42.2)	23 (57.5)	0.805	-2.2
Yes	26 (57.8)	17 (42.5)	1.227	2.0
Total burn area of ≥40%				
No	13 (28.9)	18 (45)	0.539	-6.2
Yes	32 (71.1)	22 (55)	1.417	3.5
Deep burn area of ≥10%				
No	17 (37.8)	21 (52.5)	0.645	-4.4
Yes	28 (62.2)	19 (47.5)	1.623	4.8
Severity index of lesion, score				
≤70	3 (6.7)	25 (62.5)	0.195	-16.3
71 to 130	14 (31.1)	10 (25)	0.731	-3.1
≥130	28 (62.2)	5 (12.5)	4.667	15.4
Thermal inhalation lesion of respiratory tract, degree				
I	2 (4.4)	29 (72.5)	0.090	-24.0
II	13 (28.9)	6 (15)	3.400	12.2
III	30 (66.7)	5 (12.5)	10.587	23.6
Artificial lung ventilation for >48 h				
No	11 (24.4)	30 (75)	0.245	-14.1
Yes	34 (75.6)	10 (25)	5.717	17.4
Concomitant disease (peptic ulcer history of >5 y)				
No	16 (35.6)	31 (77.5)	0.451	-8.0
Yes	29 (64.4)	9 (22.5)	5.310	16.7

3 ranges: -15 conventional units or less, from -15 to +15 conventional units, and +15 conventional units or more. Values of the forecast index were calculated with the confidence interval from -15 to +15 conventional units.

We suggest that, if the prognosis index is greater than or equal to +15 conventional units, the development of acute gastroduodenal complications can be expected with a high probability (more than 85%). If the prognosis index is less than or equal to -15 conventional units, then complications in the form of acute gastroduodenal complications will not develop with the same probability. When the prognosis index is calculated as -15 to +15 conventional units, the prognosis is uncertain, with probability of developing acute gastroduodenal complications of 50%.

CONCLUSIONS

Among gastroduodenal complications in patients with burn injuries, the most frequent complications are inflammatory, erosive, and ulcerative lesions and gastric and intestinal motility disorders (motor-evacuation disorders). The degree of their severity varies depending on the duration of the burn and the provided intensive therapy.

We found that our choice of prognostic criteria could predict the likelihood for development of acute gastroduodenal complications in patients with severe burns. Based on studies of the clinical picture and our analysis of the course of burn disease and results of treatment in patients with severe burn injury, we could create a scale for the prognosis of the development of acute gastroduodenal

complications. We suggest that its high reliability could predict the development of acute gastroduodenal complications, allowing timely preventive measures.

REFERENCES

1. Akhmedov AI, Fayazov AD, Babajanov AS, et al. The possibility of predicting the development of acute gastroduodenal complications in severely burned patients. XXII International Correspondence Scientific Specialized Conference. International Scientific Review of the Problems of Natural Sciences and Medicine, Boston, Massachusetts; 2021. https://scientific-conference-com.translate.goog/grafik/grafik-2019-pervoe-polugodie.html?_x_tr_sl=ru&_x_tr_tl=en&_x_tr_hl=en&_x_tr_pto=ajax,sc,elem
2. Fayazov AD., Babajanov AS, Akhmedov AI, et al. Risk factors and features of treatment of acute gastroduodenal bleeding in severely burned patients. LXIX International Correspondence Scientific and Practical Conference. European Research: Innovation in Science, Education and Technology, London, United Kingdom; 2021.
3. Yenikomshian H, Reiss M, Nabavian R, Garner WL. Gastric feedings effectively prophylax against upper gastrointestinal hemorrhage in burn patients. *J Burn Care Res.* 2011;32(2):263-268. doi:10.1097/BCR.0b013e31820aaf7
4. Fayazov AD, Akhmedov AI, Babajanov AS, et al. [Improvement of the treatment of severely burned against the background of chronic gastroduodenal ulcers.] *Bull Sci Educ.* 2021;4(107):18-26.
5. Fayazov AD, Babajanov AS, Akhmedov AI, Toirov A, Makhmudov S, Djalolov D. Prevention of gastrointestinal complications in severely burned patients. *Chin J Ind Hyg Occup Dis.* 2021;39(7):86-92. doi:10.5281/zenodo.5236329
6. Romanenkov NS. [Possibilities of modern medical technologies in the prevention and elimination of complications of gastric ulcer and duodenal ulcer in victims of burns.] Abstract of Thesis of Candidate of Medical Sciences. Velikiy Novgorod; 2014.
7. Chichkov OV, Skrebin ON, Gorshenin TL, et al. [Features of the clinic, diagnosis and treatment of patients with bleeding gastroduodenal ulcer, victims of burns.] *J Basic Res Penza.* 2014;10-11:208-211.
8. Bobrovnikov AE, Krutikov M.G. Analysis of erosive and ulcerative lesions of the gastrointestinal tract and bleeding from them in victims with burns. Materials of All-Russian Scientific Practical Conference With International Participation "Thermal Injuries and Their Consequences." Yalta; 2016:43-46.
9. Wagner DO, Verbitsky VG. Comprehensive prevention of gastrointestinal bleeding in victims with thermal shock injury. Materials of All-Russian Scientific Practical Conference With International Participation. Dedication for 70th Anniversary of the First Burn Center in Russia. St. Petersburg, Russia; 2016:19-22.
10. Wagner DO, Krylov KM, Shlyk IV. et al. Comparison of the effectiveness of H2 blockers and proton pump inhibitors in victims with extensive burns. Materials of All-Russian Scientific Practical Conference "Ambulance - 2015." St. Petersburg, Russia; 2015:25-26.