sciendo

J Biomed Clin Res Volume 16 Number 2, 2023

DOI:10.2478/jbcr-2023-0021

Original Article

SURGICAL SEPSIS OF HEPATOBILIARY ORIGIN: COMPLICATIONS AND PROGNOSIS

Polina G. Marinova

Department of Surgical Diseases,
Faculty of Medicine
Medical University Pleven, Bulgaria

Summary

Hepatobiliary sepsis and biliary septic shock are defined as a group of purulent-inflammatory diseases of the biliary tract which, in their progression, lead to sepsis in case of delayed diagnosis and treatment. The study aimed to analyse all the cases of hepatobiliary sepsis treated at the Clinic of Surgery, Dr G. Stranski University Hospital – Pleven, from 2016 to 2020 and create a reliable prognostic score for surveillance for patients with hepatobiliary sepsis. Retrospectively, we analysed the records of 697 patients (81%) with a hepatobiliary tract infection, including 79 (11.3%) diagnosed with hepatobiliary sepsis and six fatal cases (1.3%). We evaluated all statistically significant factors that affected mortality: immune deficiency comorbidity ($p<0.005$), pathogenesis-related to trauma and ascending biliary tract infection ($p<0.005$), positive hemoculture ($p<0.001$), length of hospital stay, the need of treatment in intensive care unit and all septic complications. We designed four different prognostic indices based on calculated individual SOFA scores and factors that significantly affected mortality in the high SOFA score patients: immune deficiency, pathogenesis-related risks of sepsis or positive blood culture. The newly designed indices for the outcome are original and have 80% sensitivity and 87% specificity, compared with a simple SOFA score.

Keywords: hepatobiliary sepsis, SOFA score

Introduction

Hepatobiliary sepsis is a set of life-threatening inflammatory diseases involving the liver parenchyma, intra- and extrahepatic bile ducts and the gallbladder, whose progression leads to multi-organ dysfunction with hemodynamic instability. This condition requires urgent diagnosis and timely performed source control of the infection. Severe biliary infections complicated by sepsis account for 8-20% of community-acquired bacteremia in adult patients. The infections of hepatobiliary tree

Corresponding Author:
Polina Georgieva Marinova
Department of Surgical Diseases,
Faculty of Medicine,
Medical University – Pleven, Bulgaria
e-mail: polina_g.marinova@abv.bg

Received: December 16, 2022
Revision received: August 10, 2023
Accepted: November 09, 2023

lead to positive blood cultures in 12.5% of community-acquired biliary tract infections, and hospital-acquired hepatobiliary sepsis accounts for 4.1% of all cases of bacteremia. Septic shock occurs in 10-30% of patients with biliary tract infection [1]. The main risk factor for developing hepatobiliary sepsis is bactobilia - microorganisms in the bile [2]. They are found in 72% of patients with acute cholangitis, in 4% of those with chronic cholangitis, and in half of the cases with biliary obstruction. Bacteria in the bile are found in 90% of patients with choledocholithiasis complicated by mechanical jaundice [3].

The study aimed to analyse all cases of hepatobiliary sepsis (HBS) treated at the Clinic of Surgery, Dr G. Stranski University Hospital - Pleven for the period 2016-2020 and the main complications of HBS that lead to death, determine the statistically significant factors that affect lethality due to HBS and create and validate a prognostic index, based on SOFA score that may predict the treatment outcome in patients with HBS.

Materials and Methods

We performed a retrospective analysis of all cases with HBS diagnosed and treated in the Clinic of Surgery from 2016 to 2020. We searched the hospital Gamma Code Master® database to find all the cases with final diagnoses, as coded by the international diseases code system (ICD), 10th revision, as acute cholecystitis K 80.0, acute cholangitis K 83.0, liver abscess K 75 and acute peritonitis of biliary origin K 65.0. We investigated the case histories, operative protocols, treatment profiles at the intensive care unit (ICU), laboratory tests and microbiological results from hemocultures. The study group of 79 patients was formed based on clinical manifestations and laboratory and microbiological improved sepsis. We assessed the degree of multiple organ damage in all the patients with HBS and the vital signs and laboratory test results of inflammation registered on the 24th and 48th hour following hospital admission. We calculate the SOFA score of each patient with HBS.

The investigation was approved by the Medical University Ethical Commission and is part of a University Scientific project.

We used IBM-SPSS 21 version statistical programme for Microsoft Windows and performed univariate and multivariate regressive logistic analyses. A $p<0.005$ value was considered significant. We extracted records of all fatal cases among septic patients and performed univariate analyses, cross-tabulations and Chi-square tests of different factors that may significantly affect the lethal outcome: risk pathogenesis of sepsis, hospital stay duration, the need for treatment in ICU, presentation of comorbid conditions with immunosuppressive effect, the type of sepsis-related organ complications in the abdominal cavity, systemic manifestation of multi-organ insufficiency, results of calculated total SOFA score. All possible complications in the septic patients were registered, and fatal cases in the group with the highest SOFA score total were analysed. We created prognostic indices that combined the individual total SOFA score result plus a 4-fold magnitude of the risk factor, which was identified as having high statistical significance for correlating lethal outcomes in a high-risk group of HBS patients. We created mathematical models of four different indices. We receiver–operating characteristic curve (ROC) to analysed the sensitivity and specificity of each of tested indices and we compared them with pure SOFA total score as an independent prognostic score for septic patients outcome.

Results

For the period 2016-2020, a total of 5 915 patients underwent operative treatment at the First Surgical Clinic, Division of Biliary, Liver and Pancreatic Surgery of D-r G. Stranski University Hospital, Pleven. Of them, 860 have hepatobiliary tract diseases (14.5%). With benign origin there were 730 patients (84.9%), and malignant diseases had another 130 patients (15.1%). A total of 697 patients (81%) had an infection of hepatobiliary tract. Patients with clinically and laboratory diagnosed HBS are 79 of all cases with biliary tract infections (11.3%). The patients enrolled in our research were divided in three main groups due to etiology of severe hepatobiliary infections. Group 1 – 61(77.2%) patients with gallbladder infections with destruction of gallbladder wall because of

destructive gangrenous cholecystitis; Group 2 – 14 (16.6%) patients with ascending obstructive biliary tract infection with acute cholangitis; Group 3 – 4 (6.2%) patients with pyogenic liver abscess. The source of infection of hepatobiliary tract of all cases with sepsis was a risk pathogenic factor for progression of the inflammatory process and translocation of bacteria to the blood stream. Risk pathogenesis and origin of hepatobiliary infection rapidly progressing to HBS in our patients is shown on Figure 1.

Septic manifestations and clinical evidence for HBS were due to the presence of a purulent focus in the biliary system or liver parenchyma that cause translocation of microorganisms to the systemic circulation. In our study, all of the patients with improved diagnosis for HBS had clinical and laboratory manifestations of at least two of criteria for systemic inflammatory response syndrome SIRS (temperature more than 38ºC, tachycardia >90 bpm, tachypnea, leukocytosis more than 12.10^9), and 43 of them (54.4%) had positive blood cultures. The comorbidity status was checked and all the patients with HBS had concomitant disease, that compromise the immune system and predispose to progression of biliary infection to sepsis (Figure 2).

The total number of more significant complications that we observed in patients with HBS are 62 (Table 1).

Among the patients with a certain morbidity, those with one to three simultaneous complications of sepsis predominate. Even if there is no registered lethal outcome in the groups of patients with one and two complications, the occurrence of each single complication extends the total stay of patients in the hospital; the stay in intensive care unit (ICU) is prolonged twice and the result is statistically significant. ($p< 0.05$). For each new complication of hepatobiliary sepsis, the financial cost of treatment increased from 150 to 210%. One or two complications don't affect significantly the final prognosis, due to the body's ability to compensate them and maintain homeostasis. One or two complications are better

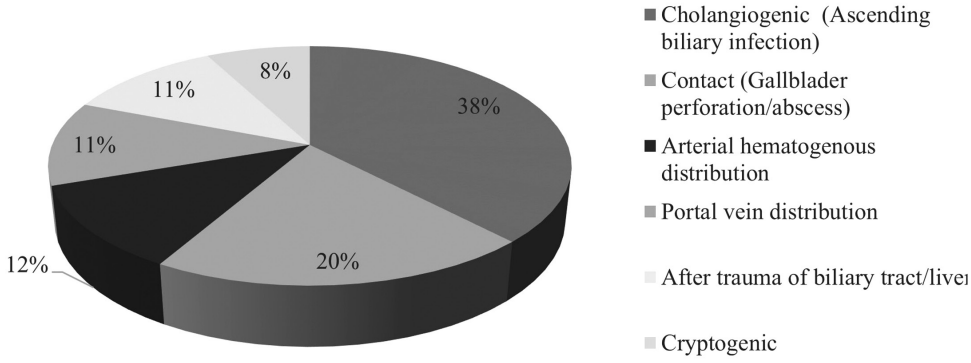

Figure 1. Pathogenesis of hepatobiliary sepsis

Table 1. Number of complications and mortality from hepatobiliary sepsis (HBS)

	Number of patients with HBS n=(%)	Average hospital stay, days	The average stay in ICU*, days	In lethal cases, the number	Lethal cases, %
No complications	44(55.6%)	13.8	1.46	0	0
With 1 complication	9(11.4%)	18.1	2.22	0	0
With 2 complications	9(11.4%)	23.1	4.04	0	0
With 3 complications	8(10.1%)	25.3	4.5	1	12.5
With 4 complications	6(7.6%)	24.8	7.3	2	33.3
More than 4 complications	3(3.8%)	21.6	19.3 **p<0.05**	3	100 **(p< 0.05)**
Total	**79**	**19.9**	**3.98**	**6**	**7.6**

**ICU- intensive care unite*

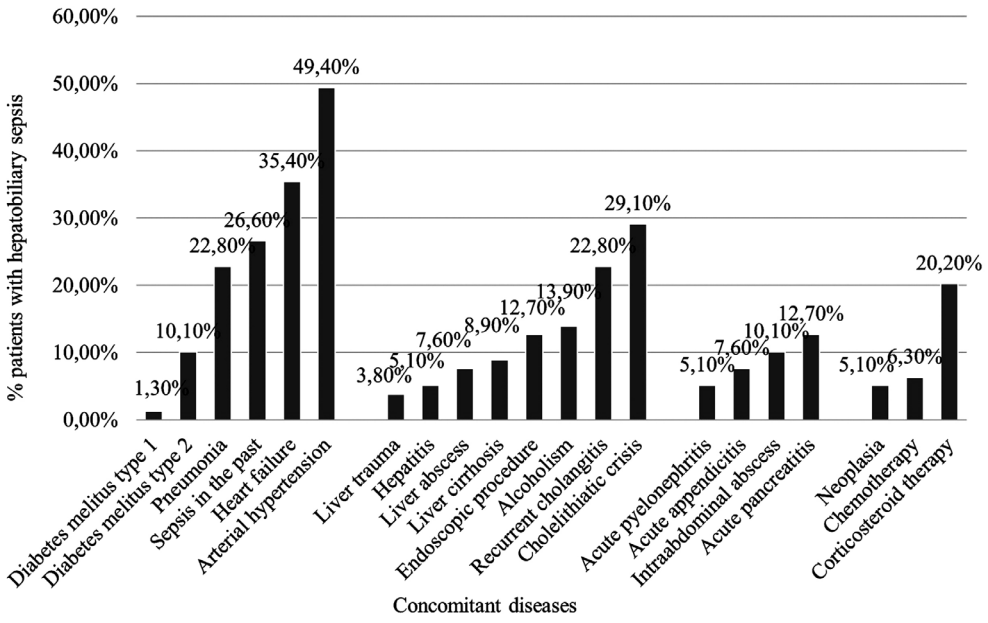

Figure 2. Comorbidity of patients with hepatobiliary sepsis

Table 2. Most common complications in patients with hepatobiliary sepsis

N	Complications	Number of patients	Average hospital stay, days	The average stay in ICU*, days	In lethal cases, the number	Lethal cases, %
	Extra-abdominal					
1.	Acute circulatory insufficiency, shock	25	21.9	7.2	5	19.2
2.	Pleural effusion	13	27.8	6.6	2	15.4
3.	Acute renal failure	9	19.2	13.2	4	44.4
4.	Stress ulcus	9	26.8	2.8	1	11.1
5.	Acute respiratory distress syndrome	8	21,2	14.5	2	25.0
6.	Pneumonia	6	29.3	12.4	2	33.3
7.	Hepatorenal syndrome	1	1	1	1	100
	Abdominal					
1.	Subdiaphragmatic abscess	1	26.4	5.1	0	0
2.	Abdominal sepsis	3	50	16	2	66.6
	Total number	**64**		**6**		

**ICU- intensive care unite*

tolerated by younger patients (up to 60 years), in whom recovery is faster and is accompanied by a shorter hospital bed stay (average 15.6 days), while for elderly group patients over 60, they recover at a slower trend due to pre-existing comorbid conditions, which decompensate in the background of HBS. The average hospital stay of these patients was 21.4 days ($p<0.001$). The lethal cases in the group of patients with three recorded complications affect the elderly population (>80 years), and the rest of the fatal cases are patients in the younger age group 45-55 years. In that group we registered 4 and more than 4 complications of sepsis, presented together. Every third complication make the patient's prognosis worse for 1% to 12.5% of all cases with HBS, every fourth complication is a life threatening condition and every fifth complication practically leaves no chance of life for any patient. For patients from this last group, the main treatment was obligatory in ICU. This group of patients with HBS and septic shock is

with the greatest social importance, because they consume the most health and financial resources, and the final result most often is negative. We divided the complications of HBS that we observed in our septic patients into two main groups: extra-abdominal and intra-abdominal complications (Table 2).

For the assessment of complications because of organ damages in the background of sepsis, we used one of the emergency systems, regularly used in intensive care units – SOFA system (Septic Organ Failure Assessment) – a score for assessing organ failure in septic patients. We assessed the risk profile of patients with a high probability of developing hepatobiliary sepsis based on the calculation of the total SOFA score for each patient with hepatobiliary infection in the time of admission. This score system is suitable for early and fast evaluation of patients with clinical evidence for sepsis and may predict the progression to severe sepsis and septic shock in critically ill patients (Table 3).

The score values range from 1 to 24 points. A low score has a favorable prognosis, and an increase in the score till 24 points indicates deterioration and an unfavorable outcome. Manifestations of sepsis depend on the duration of prehospital stage of the disease, the immune reactivity of patients, the timing and adequacy of biliary tract decompression and drainage, infection source control and the virulence of the microorganisms isolated in the bloodstream culture. According total SOFA score result, we divided the patients in four groups (Figure 3).

Table 3. SOFA Score elements

Affected system	Criteria	Score
Respiratory system	PaO_2/FiO_2	
	< 400	1
	< 300	2
	< 200 and mechanical ventilation	3
	< 100 and mechanical ventilation	4
Central nervous system	Glasgow Coma Scale	
	13 – 14	1
	10 – 12	2
	6 – 9	3
	< 6	4
Cardiovascular system	Mean arterial pressure /MAP/ - hypotension or requirement of vasopressors	
	MAP < 70 mm Hg/	1
	dop ≤ 5 or dob /any dose/	2
	dop > 5 or epi≤ 0.1 or nor ≤ 0.1	3
	dop > 15 or epi > 0.1 or nor > 0.1	4
	/dop – Dopamine; dob – Dobutamine; epi – Epinephrine; nor - Noradrenaline/	
	Dosage in μmg/kg/min	
Liver function	Bilirubin mg/dl /μmol/l/	
	1.2 – 1.9 /> 20-32/	1
	2.0 – 5.9 /33-101/	2
	6.0 – 11.9 /102 – 204/	3
	>12.0 />204/	4
Coagulation	Platelets x 10^3/μl	
	< 150	1
	< 100	2
	< 50	3
	< 20	4
Renal function	Creatinin mg/dl /or urinary output/	
	1.2 – 1.9 /110-170/	1
	2.0 – 3.4 /171-299/	2
	3.5 – 4.9 /300-400/	3
	> 5.0 />400/	4

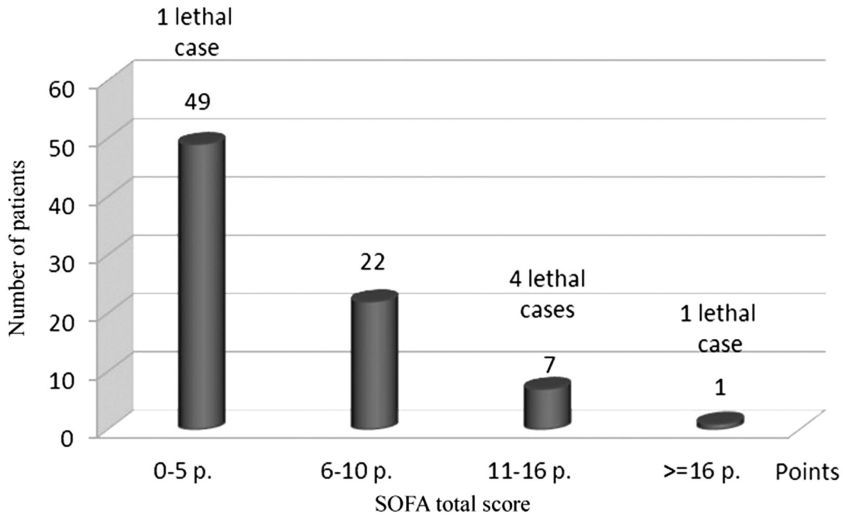

Figure 3. Groups of patients with hepatobiliary sepsis and final SOFA score result

There were 49 patients (62.0%) with multi-organ failure in a mild degree (0-5 points), 22 patients (27.8%) have a moderate functional deficit (6-10 points). Patients with severe (11-15 points) and very severe (over 16 points) multiple organ failure are 10.1% of all patients, and the mortality among them is the highest - 62.5% of all patients with a total SOFA score of more than 11 points. A total score up to 9 points predicts a fatal outcome for 33% of our patients, and more than 11 points – put the patients in the high-risk for septic complications group, where SOFA score can be used as a predictor of final patient outcome.

Mortality and prognosis of patients with hepatobiliary sepsis

In our study over 79 cases with HBS, we had only 6 lethal cases and an overall mortality was 7.6%. On the basis of the calculated SOFA score in the assessment of multiple organ damage by sepsis, we predicted mortality in patients with HBS treated according to the recommendations of Tokyo guideline 2018 and Surviving Sepsis Campaign 2021. For SOFA score total, the predictive value of the indicator was as follows: 0-5 points – expected mortality up to 10%; 6-10 points – 11-25% expected mortality, 11-15 points – 26-55% expected mortality; ≥16 points – 56-100% expected mortality. Our study results and the analysis risk factors, significantly associated with in-hospital mortality from HBS showed that those significantly associated with lethal outcome were, as follows: underlying malignant disease ($p=0.001$), indications for emergent biliary tract surgery ($p=0.001$), and delay in diagnosis more than 14 days ($p=0.001$). All of these variables were independent risk factors associated with HBS mortality and had a significant effect on the unfavorable final outcome. Among all six lethal cases in our research, we found that 5 of them had a high SOFA score total more than 10 points. In these septic patients, high SOFA score corresponds only with three factors, that are statistically significant for fatal outcome in that high risky group: immune deficiency ($p < 0.005$), type of pathogenesis of the septic condition and pathway of generalisation of infection- by trauma or by ascendent progression of inflammation in biliary tree ($p<0.005$); positive blood culture ($p<0.001$). As a consequence of that result, we created a mathematical models of new indices that link the result of the patient's SOFA score with one of the following groups of factors related to the development and progression of HBS: the patient's immune deficiency status; risk pathogenesis of HBS; and positive for microorganism blood culture. Then, we evaluated which of these indices had the greatest predictive value for the lethal outcome due to HBS.

Index 1 is based on the magnitude of immune deficiency

In this group we evaluate all conditions that predispose to systemic immune deficiency in

patients with HBS, and these are: 1 – history data for a malignant neoplasm; 2 – systemic therapy with corticosteroids during previous hospitalisation; 3 – Diabetes mellitus 1 type; 4 – hematological disease, that require systemic suppressive therapy; 5 – chronic alcoholism; 6 – liver metastases of a neoplasm; 7 – systemic immunosuppressive therapy with corticosteroids or cytostatic carried out to date.

Index 2 is based on the magnitude of magnitude risk pathogenesis of HBS (liver trauma or contact abscess formation).

From the analysis of the strength of the relationship between the risk pathogenesis of hepatobiliary sepsis and the final outcome of treatment (alive and dead), we found that a greater causal relationship of mortality occurs when hepatobiliary sepsis occurred only after liver trauma or perforation of the gallbladder adjacent to the liver, which are 5.71 fold more frequent among the lethal group compared to the control group of surviving patients. ($p<0.005$) (Figure 4).

We registered that the lethal cases occurred in patients only with presence of contact abscess or liver trauma and never registered lethal outcome among the patients with another risky for sepsis pathogenesis.

Index 3 is based on the magnitude of positive blood culture

When calculating each one of the indices, we evaluated the presence of any of the studied variables ("immune deficiency", "risky pathogenesis" and "positive blood culture" with 1, and its absence with 0).

Index 1=SOFA SCORE TOTAL + 4 * immunodeficiency (1 – yes; 0 – no).

Index 1 may have maximal value of 24+4=28 points.

Index 2=SOFA SCORE TOTAL + 4 * risk-pathogenesis (1 – yes; 0 – no).

Index 2 may have maximal value of 24+4= 28 points.

Index 3=SOFA SCORE TOTAL + 4*positive-blood culture (1 – yes; 0 – no).

Index 3 may have maximal value of 24+4=28 points.

Combined index = SOFA SCORE TOTAL + 4* immunodeficiency (1 – yes; 0 – no). + 4* risk-pathogenesis (1-yes; 0 no). This index is a complex mathematical equation and the maximal score may reach 24+4+4=32 points. It consists of three values, highly related to sepsis severity and lethality – SOFA score, 4-fold of any immunodeficiency presentation, and 4-fold of risk pathogenic factor (trauma or contact abscess) presentation. We examined the predictive ability of the constructed indices with ROC curves (response–operator curves)

Figure 4. Lethality and risk pathogenesis of hepatobiliary sepsis.

Table 4. Statistical characteristics of the proposed indices

Report death		Index1	Index 2	Index 3	Combined Index 4
Alive with sepsis	Mean	6.5926	5.6049	4.9032	7.6296
	N	81	81	62	81
	SD	3.54181	3.49885	3.04991	3.96372
Death with sepsis		14.3333	15.0000	12.8000	17.0000

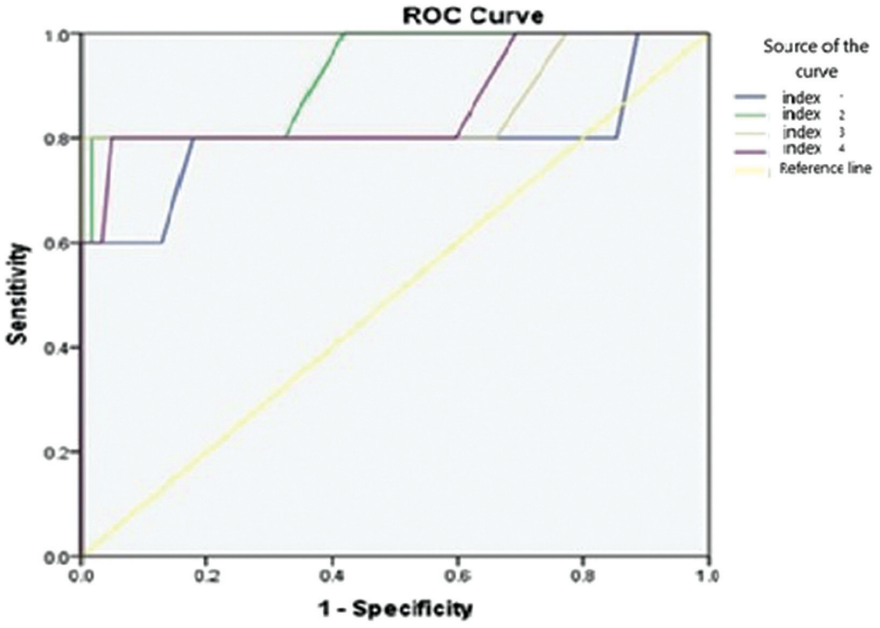

Figure 5. Sensitivity and specificity of the tested indices

and evaluated the statistical significance of each index, as well as the critical point with the best sensitivity and specificity. The data demonstrate a statistically significant difference between the mean values of so calculate indices in survivors and those who died with hepatobiliary sepsis. For example, index1 in survivors is on average 6.59, and in those who died it is 14.33, etc., with $p < 0.001$. (Table 4).

With the largest area under the curve (ROC value) =0.92, the index combining SOFA and „sepsis risk pathogenesis" – „Index 2" seems a better characteristic than the SOFA score alone. The evaluation of the „critical point" showed that with an index >9.5 points has sensitivity 80% and a specificity 87% (1-0.129=87.1%). The result shows that the greatest burden for the development of HBS is the pathogenesis of sepsis, in which the trauma and destruction of the gallbladder wall and the cholangiogenic spread of the infection from the biliary tract have great importance (Figure 5).

Discussion

In our study of 79 cases with HBS, we had only 6 lethal cases and overall mortality was 7.6%. This is relatively low compared to data in the literature [1]. From 2018 till now, strategies and consensuses for the treatment of intra-abdominal, hepatobiliary sepsis, and septic shock have undergone significant changes and updates, according to the new definitions and understandings of sepsis [2, 3]. Detailed therapeutic strategies with internationally recognised experience based on clinical studies and meta-analyses are presented as a part of the global surviving sepsis campaign strategy [4, 5]. The manifestations of sepsis are directly dependent on the following factors: duration of the disease and time hospitalisation, the immune reactivity of the macroorganism, timely performed procedure of decompression of biliary tract, and evacuation of pus collection from abscess focus [6]. According to the patient

profile, the main factor the severity of HBS is, accompanying comorbidity, as well as the virulence of microorganisms circulating in the bloodstream [7].

A major disadvantage of the SOFA scoring system is the evaluation of some vital signs only through certain laboratory tests to assess organ dysfunction. That makes the scale inapplicable outside of emergency and hospital settings. Therefore, a variant of the SOFA score-quick SOFA [qSOFA] has been proposed to rapidly detect patients with suspected infection at risk of developing sepsis based on clinical symptoms alone, without the need for laboratory verification. This rapid version appears to be a better predictor of in-hospital mortality due to sepsis than SOFA-scale scores. Q SOFA has a value from 0 to 3, with 1 point marking the presence of the following registered changes: Respiratory rate ≥22/min; the presence of changes in the mental status (Glasgow coma scale < 15 points) – 1 point; hypotension, systolic pressure ≤100 mmHg, – 1 point. A cumulative score of more than 2 points is associated with a risk of either prolonged hospital stay in the intensive care unit or is a predictor of impending death secondary to sepsis. Increasing SOFA by more than one point leads to increasing the risk of death in the ICU by 1.35 times [8]. Q Sofa is less sensitive than SOFA, but the combination of variables in q SOFA, S OFA, and ΔSOFA may be helpful for the evaluation of the prognosis of septic patients. The high total score in each of these systems is an objective approach to predicting the severity of multi-organ dysfunction in sepsis background and the final lethal outcome [9]. Based on three main criteria q SOFA is more prognostic scale and not so diagnostic tool for septic patients. It may predict real outcomes such as a high risk of in-hospital or prolonged stay in the ICU for septic patients. The mortality rate of patients increased steadily from 16% to 20% and reached 46% in patients with sepsis, severe sepsis, and septic shock respectively [10, 11]. After trauma, the development of sepsis is related to the presence of adjacent comorbidities, SOFA score results in admission, and injury severity score results [12]. The acute increase in SOFA score with at least 2 points, especially in patients with liver cirrhosis, leads to a significant increase in in-hospital mortality [13]. Logistic Organ Dysfunction Score (LODS) is another scoring system that objectively provides an assessment of organ dysfunction – it identified dysfunction of 6 organ systems – renal, pulmonary, neurologic, hematologic, liver, and cardiovascular and determines 3 different levels of functional damage. Among ICU patients the predictive validity of in-hospital mortality for LODS score is 75% sensitivity, for q SOFA is 66%, and SOFA 74%, respectively [14, 15]. Among septic patients in ICU, the potential to predict in–hospital mortality of SOFA score was not significantly different than LODS, but it is statistically greater than q SOFA and SIRS criteria for inflammatory process. The mean and highest scores of SOFA, calculated in the first few days after admission to the ICU may predict the outcome and any increase in the total score within the first 48 hours predicts a mortality rate of 50% [16, 17]. The measured initial, mean and the highest SOFA score in patients in the ICU and at the emergency department, admitted with sepsis, correlates with mortality rates. The data confirms the prognostic value of SOFA score variations and its significance is higher, when it is evaluated together with elevated serum lactate concentration in the first 24 hours in ICU admission and the patient age is above 65 years. [18-21].

Conclusion

The low mortality rate in our research of patients with hepatobiliary sepsis, treated according to the contemporary recommendations shows that it can be used as a reliable guide in predicting the outcome in patients with HBS. The proposed prognostic indexes are original, first designed, described, and presented by our research and we have not met another prognostic scale for treatment outcome of HBS till that moment in the literature, that combined SOFA score and described in our research clinical variables, that have high significance for sepsis outcome. These indices may help clinicians in predicting mortality among severe septic patients.

Acknowledgements

With thanks to Assoc. Prof. Pencho Tonchev, MD, PhD, for the statistical analysis and support.

References

1. Melzer M, Toner R, Lacey S, Bettany E, Rait G. Biliary tract infection and bacteremia: presentation, structural abnormalities, causative organisms, and clinical outcomes. Postgrad Med J. 2007; 83(986), 773-6.
2. Evans T. Diagnosis and management of sepsis. Clinical medicine London, England. 2018, 18(2), 146-9.
3. Gomi H, Takada T, Hwang TL, Akazawa K, Mori R, Endo I, et al. Updated comprehensive epidemiology, microbiology, and outcomes among patients with acute cholangitis. Observational Study. 2017; 24(6):310-18.
4. Sartelli M, Coccolini F, Kluger Y, Agastra E, Abu-Zidan FM, Abbas AES, et al. WSES/GAIS/SIS-E/WSIS/AAST global clinical pathways for patients with intra-abdominal infections. World J Emerg Surg. 2021; 16(1):49.
5. Evans L, Rhodes A, Alhazzani W, Antonelli M, Coopersmith CM, French C, et al. Surviving sepsis campaign: international guidelines for the management of sepsis and septic shock 2021. Intensive Care Med. 2021; 47(11):1181-247.
6. Hecker A, Reichert M, Reuß CJ, Schmoch T, Riedel JG, Schneck E, et al. Intra-abdominal sepsis: new definitions and current clinical standards. Langenbecks Arch Surg. 2019;404(3):257-71.
7. Lamontagne F, Harrison DA, Rowan KM. qSOFA for Identifying sepsis among patients with infection. JAMA. 2017; 317(3):267-68.
8. Fuchs P., Czech I., Krzych Ł. The Pros and Cons of the Prediction Game: The Never-ending Debate of Mortality in the Intensive Care Unit. Int. J. Environ. Res. Public Health. 2019;(16):3394.
9. Liu C, Suo S, Luo L, Chen X, Ling C, Cao S. SOFA score in relation to sepsis: clinical implications in diagnosis, treatment, and prognostic assessment. Comput Math Methods Med. 2022; 2022:7870434.
10. Ho VP, Kaafarani H, Rattan R, Namias N, Evans H, Zakrison TL. Sepsis 2019: What surgeons need to know. Surg Infect (Larchmt). 2020;21(3):195-204.
11. Gorcheva Z, Vasileva M. Total Extended Gastrectomy in Advanced Gastric Cancer–Clinical Case. J Biomed Clin Res, 2022;15(2), 182-186.
12. Eguia E, Cobb AN, Baker MS, Joyce C, Gilbert E, Gonzalez R, et al. Risk factors for infection and evaluation of Sepsis-3 in patients with trauma. Am J Surg. 2019; 218(5):851-7.
13. Piano S, Bartoletti M, Tonon M, Baldassarre M, Chies G, Romano A, et al. Assessment of Sepsis-3 criteria and quick SOFA in patients with cirrhosis and bacterial infections. Gut. 2018;67(10):1892-99.
14. Seymour CW, Liu VX, Iwashyna TJ, Brunkhorst FM, Rea TD, Scherag A, et al. Assessment of clinical criteria for sepsis: for the third international consensus definitions for sepsis and septic shock (sepsis-3). JAMA. 2016; 315(8):762-74.
15. Le Gall JR, Klar J, Lemeshow S, Saulnier F, Alberti C, Artigas A, et al. The Logistic Organ Dysfunction System. A new way to assess organ dysfunction in the intensive care unit. ICU scoring group. JAMA.1996; 276(10):802-10.
16. Ferreira FL, Bota DP, Bross A, Mélot C, Vincent JL. Serial evaluation of the SOFA score to predict outcomes in critically ill patients. JAMA. 2001; 286(14):1754-58.
17. Fuchs PA, Czech IJ, Krzych ŁJ. Mortality Prediction Using SOFA Score in Critically Ill Surgical and Non-Surgical Patients: Which Parameter Is the Most Valuable? Medicina (Kaunas). 2020;56(6):273.
18. Innocenti F, Tozzi C, Donnini C, De Villa E, Conti A, Zanobetti M, et al. SOFA score in septic patients: incremental prognostic value over age, comorbidities, and parameters of sepsis severity. Intern Emerg Med. 2018;13(3):405-12.
19. Macdonald SP, Arendts G, Fatovich DM, Brown SG. Comparison of PIRO, SOFA, and MEDS scores for predicting mortality in emergency department patients with severe sepsis and septic shock. Acad Emerg Med. 2014;21(11):1257-63.
20. Quinten VM, van Meurs M, Wolffensperger AE, Ter Maaten JC, Ligtenberg JJM. Sepsis patients in the emergency department: stratification using the clinical impression score, predisposition, infection, response and organ dysfunction score or quick sequential organ failure assessment score? Eur J Emerg Med. 2018;25(5):328-34.
21. Tusgul S, Carron PN, Yersin B, Calandra T, Dami F. Low sensitivity of qSOFA, SIRS criteria and sepsis definition to identify infected patients at risk of complication in the prehospital setting and at the emergency department triage. Scand J Trauma Resusc Emerg Med. 2017;25(1):108.