folia medica

Folia Medica 65(1):73-79
DOI: 10.3897/folmed.65.e76709

Original Article

Can We Predict Death Using Scoring Systems in Patients with Local Peritonitis? A Retrospective Study

Evgeni N. Dimitrov[1], Georgi A. Minkov[1], Emil T. Enchev[1], Krasimira S. Halacheva[2], Yovcho P. Yovtchev[1]

[1] *Department of Surgical Diseases, Prof. Dr. Stoyan Kirkovich University Hospital, Stara Zagora, Bulgaria*

[2] *Laboratory of Clinical Immunology, Prof. Dr. Stoyan Kirkovich University Hospital, Stara Zagora, Bulgaria*

Corresponding author: Evgeni Dimitrov, Department of Surgical Diseases, Prof. Dr. Stoyan Kirkovich University Hospital, 2 Stoletov St., Stara Zagora, Bulgaria; Email: evgeni_d1984@yahoo.com; Tel.: +359 887 609 943

Received: 18 Oct 2021 ♦ **Accepted:** 2 Dec 2021 ♦ **Published:** 28 Feb 2023

Citation: Dimitrov EN, Minkov GA, Enchev ET, Halacheva KS, Yovtchev YP. Can we predict death using scoring systems in patients with local peritonitis ? A retrospective study. Folia Med (Plovdiv) 2023;65(1):73-79. doi: 10.3897/folmed.65.e76709.

Abstract

Introduction: Prognostic scores in patients with local peritonitis (LP) have not yet been studied exhaustively.

Aim: We, therefore, aimed in this study to evaluate the ability of several scoring systems to predict death in LP.

Materials and methods: A retrospective analysis including 68 patients with LP was conducted at Prof. Dr. Stoyan Kirkovich University Hospital in Stara Zagora from January 2017 to August 2021. Clinical and laboratory data needed for calculating the scoring systems were collected at admission or postoperatively. We compared the prognostic performance of WSES SSS, MPI, SIRS, and qSOFA using area under the receiver operation characteristics (AUROC) curves and bivariate correlation analysis.

Results: The observed mortality rate was 8.8%. Among all scores, MPI showed the best prognostic performance (AUROC=0.805, 95% CI 0.660–0.950). A threshold MPI >25 points permitted prediction of adverse outcome with a sensitivity of 66.7% and a specificity of 80.6%. The only significant correlation was found between outcome and MPI (p=0.012, r=0.302).

Conclusions: The MPI has the ability to prognosticate mortality in patients with LP unlike WSES SSS, qSOFA and SIRS.

Keywords

mortality, MPI, outcome, qSOFA, SIRS, WSES SSS

INTRODUCTION

Acute peritonitis (AP) is a major factor for non-traumatic mortality[1] and one of the most common causes of acute abdomen.[2] AP is a result of a complicated intra-abdominal infection[3] and is still associated with high morbidity, mortality, and healthcare costs worldwide[4]. Based on the spread of infection, it is classified as local or diffuse.[5] Local peritonitis (LP) may manifest as peritoneal inflammation encapsulated by fibrous tissue containing leucocytes, bacteria, debris, and exudate (abscess), or as a non-encapsulated process involving no more than one intraperitoneal area.[3]

Globally, mortality rate of AP varies between 10% and 30%.[1,6,7] This data refers mainly to patients with diffuse peritonitis, while no exhaustive study on the death rate of LP has yet been conducted. Unfortunately, nowadays it is also unclear which might be the prognostic factors of unfavorable outcome in LP. Various prognostic scoring systems have been developed over the years; unfortunately, none of them is widely accepted in everyday practice. No study

so far (to the best of our knowledge) has been conducted investigating mortality prediction scores in LP exclusively. Therefore, we set out to explore the prognostic performance of four of the easiest for calculation scoring systems: two peritonitis-specific scores – the Mannheim Peritonitis Index (MPI) and World Society of Emergency Surgery Sepsis Severity Score (WSES SSS), and two disease-independent ones – systemic inflammatory response syndrome (SIRS) and quick sequential organ failure assessment (qSOFA) score in patients with LP.

The Mannheim Peritonitis Index (MPI), developed by Wacha and Linder[8] in 1983, seems to be one of the oldest and most practical score for patients with secondary peritonitis[8,9]. The World Society of Emergency Surgery Sepsis Severity Score (WSES SSS) was designed by the aforementioned surgical society in 2014 as a prognostic scoring system specific for cIAIs.[1] In 1991, the Systemic Inflammatory Response Syndrome (SIRS) was first introduced as criteria of defining sepsis and predicting in-hospital death.[10] In 2016, a working group created the current definitions of Sepsis-3 and removed the term SIRS from the definition of sepsis.[11] The same group introduced the quick sequential organ failure assessment (qSOFA) score as a prognostic score that could immediately determine which patients with suspected infection are likely to need intensive care or die in the hospital.[11]

AIM

Thus, in our study we aimed to find out if MPI, WSES SSS, SIRS, and qSOFA could prognosticate a fatal outcome in patients with LP.

MATERIALS AND METHODS

Study design

We retrospectively studied the medical records of 171 adult patients diagnosed with acute peritonitis admitted to the Department of Surgical Diseases (DSD) at Prof. Dr. Stoyan Kirkovich University Hospital in Stara Zagora between January 2017 and August 2021. Missing data on some clinical parameters was established in 23 patients, 2 patients died preoperatively, and 1 was under 18 years old. Of the remaining 145 patients, 77 patients presented with diffuse peritonitis. Finally, 68 patients with LP who underwent definitive surgery were included in the study.

Data collection

Demographic and clinical information, as well as final outcomes were determined from patients' medical records during hospitalization.

Scoring systems

SIRS was defined by meeting at least two of the following criteria: a pulse higher than 90 beats per minute, a respiratory rate higher than 20 per minute, a body temperature lower than 36°C or higher than 38°C, and a leucocyte count lower than 4×10^9/L or higher than 12×10^9/L.[10] The qSOFA score was obtained according to three parameters (one point for each parameter): low systolic blood pressure (≤100 mmHg), high respiratory rate (≥22/min), and altered mentation (Glasgow Coma Scale <15 points).[11] Two or more qSOFA points were associated with a higher risk of unfavorable outcome.[11] Both scores were calculated at admission to DSD. WSES SSS and MPI were calculated after surgery according to six[12] **(Table 1)** and eight[8] **(Table 2)** criteria, respectively.

Statistical analysis

For statistical analysis, we used SPSS 19.0 (IBM, Chicago, Illinois, USA). The ability of scoring systems to predict mortality was determined by Receiver Operating Characteristic (ROC) Curve analysis. The association between scoring systems and final outcome was assessed using bivariate correlation analysis and Spearman (r_s) or Pearson (r) correlation coefficient. Qualitative variables were presented as frequency (%) and analyzed by Pearson χ^2 test or Fisher exact test, and quantitative variables were presented as mean (SD) or median (IQR) and compared with Student's t-test or Mann-Whitney U test. *P* values less than 0.05 were reported as statistically significant.

Table 1. WSES Sepsis Severity Score (0–18 score)

Risk factor	Points
Age > 70 years	2
Immunosuppression	3
Setting of acquisition	
Healthcare-associated infection	2
Clinical condition at admission	
Severe sepsis	3
Septic shock	5
Origin of cIAIs	
Colonic non-diverticular perforation peritonitis	2
Diverticular diffuse peritonitis	2
Postoperative diffuse peritonitis	2
Small bowel perforation peritonitis	3
Delay in source control	
Delayed initial intervention > 24 hours	3

RESULTS

Patients characteristics

Of all 68 patients, six (8.8%) died. They were significantly older than those who survived (77.50±7.71 vs. 56.23±18.57, p=0.007). All non-survivors were over the age of 65 (p=0.003). Death rate among patients with arterial hypertension (p=0.01) was significantly higher. Significant differences between survivors and non-survivors were also found according to site of peritonitis (p=0.032). In contrast, type of exudate (p=0.323), sex (p=1.000), preoperative duration of peritonitis >24 hours (p=0.687) and presence of malignancy (p=0.438), diabetes (p=1.000), or chronic renal failure (p=0.17) did not differ significantly between the two groups **(Table 3)**.

Table 2. Mannheim peritonitis index (0 – 47 score)

Risk factor	Points
Age > 50 years	5
Female	5
Organ failure	7
Malignancy	4
Preoperatively duration of peritonitis > 24 hours	4
Origin of sepsis non colonic	4
Diffuse peritonitis	6
Exudate	
Clear	0
Purulent	6
Fecal	12

Prognostic scores

We had a qSOFA score ≥2 points in 4 patients (5.9%), and 3 of them survived (p=0.315); however, none of these had the maximum score. The prognostic ability of SIRS was found worthless (p=1.000), whereat 66.7% of non-survivors showed no signs of SIRS. Patients with poor outcome had higher MPI score than survivors (25.33±4.97 vs. 17.98±4.79, p=0.012). Sixteen patients had MPI >25 points and 4 of them died (p=0.024). Median WSES SSS was also higher in non-survivors compared to survivors; however, there was no significant difference [6 (4.25-8) vs. 3 (0-6),

Table 3. Patients' characteristics

Variable	Total population	Survivors n=62	Non-survivors n=6	*p* value
Age, years ±SD	58.10±18.85	56.23±18.57	77.50±7.71	0.007
Age >65 years, n (%)	27 (39.7)	21 (33.9)	6 (100)	0.003
Sex, n (%) male/female	40 (58.8)/28 (41.2)	36 (90.0)/26 (92.9)	4 (10.0)/2 (7.1)	1.000
Source, n (%)				0.032
Hepatobiliary system	26 (38.2)	22 (35.5)	4 (66.7)	
Appendix	23 (33.8)	23 (37.1)	0 (0)	
Colon/Rectum	8 (11.8)	8 (12.9)	0 (0)	
Stomach/duodenum	3 (4.4)	1 (1.6)	2 (33.3)	
Gynecological	3 (4.4)	3 (4.8)	0 (0)	
Small bowel	1 (1.5)	1 (1.6)	0 (0)	
Other	4 (5.9)	4 (6.5)	0 (0)	
Exudate, n (%)				0.323
Clear	16 (23.5)	16 (25.8)	0 (0)	
Purulent	52 (76.5)	46 (74.2)	6 (100)	
Feculent	0 (0)	0 (0)	0 (0)	
Duration of peritonitis >24 h, n (%)	38 (55.9)	34 (54.8)	4 (66.7)	0.687
Comorbidity, n (%)				
High blood pressure	33 (48.5)	27 (43.5)	6 (100)	0.01
Malignancy	6 (8.8)	5 (8.1)	1 (16.7)	0.438
Diabetes	9 (13.2)	8 (12.9)	1 (16.7)	1.000
Chronic renal failure	2 (2.9)	1 (1.6)	1 (16.7)	0.17

p=0.054] **(Table 4)**.

Sensitivity, specificity, and AUROCs

Among the 4 scoring systems, MPI showed the best ability to prognosticate a fatal outcome (AUROC=0.805, 95% CI 0.660–0.950). We observed an optimal threshold value >25 points and it permitted mortality prediction with a sensitivity of 66.7% and a specificity of 80.6%. WSES SSS showed a lower prognostic performance (AUROC=0.734, 95% CI=0.562–0.906). For cut-off value WSES SSS >4 points, we identified a sensitivity of 83.3% and a specificity of 62.9%. In contrast, positive SIRS (AUROC=0.483, 95% CI 0.209–0.756) and qSOFA ≥2 points (AUROC=0.571, 95% CI 0.331–0.831) were observed with no prognostic value **(Fig. 1)**, **(Table 5)**.

Correlations

The strongest correlation was found between outcome and MPI (r=0.302). A weaker correlation was observed between outcome and WSES SSS (r_s=0.235); however, the p-value was not significant (p=0.054). We established very weak correlations without significance between outcome and qSOFA score (r_s=0.097, p=0.432), and between outcome and SIRS (r_s=−0.18, p=0.883) **(Table 6)**.

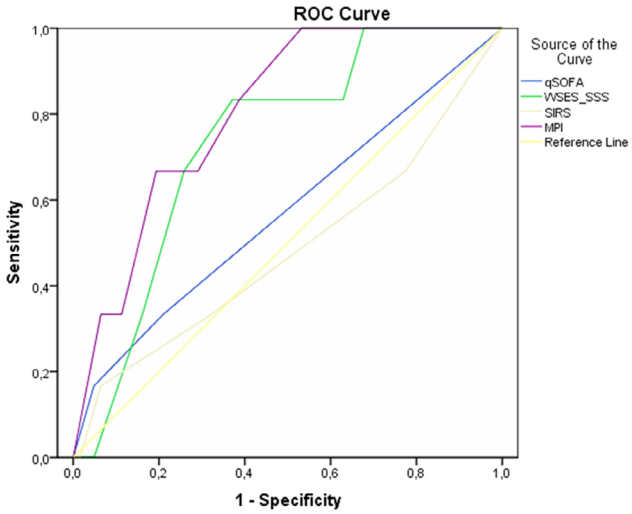

Figure 1. Comparison of ROC curves.

DISCUSSION

Despite the evolution of the diagnostic and management techniques, AP remains a great challenge to emergency surgeons and critical care physicians. It is responsible for nearly 20% of all sepsis cases in Intensive Care Units and is the second most common cause of infectious morbidity and mortality after pneumonia.[4] An early prediction of mortality allows doctors to identify those patients with

Table 4. Scoring systems

Variable	Total population	Survivors n=62	Non-survivors n=6	*p* value
qSOFA, n (%)				0.355
0	53 (77.9)	49 (79)	4 (66.7)	
1	11 (16.2)	10 (16.1)	1 (16.7)	
2	4 (5.9)	3 (4.8)	1 (16.7)	
3	0 (0)	0 (0)	0 (0)	
qSOFA ≥2, n (%)	4 (5.9)	3 (4.8)	1 (16.7)	0.315
SIRS, n (%)				0.521
0	16 (23.5)	14 (22.6)	2 (33.3)	
1	30 (44.1)	28 (45.2)	2 (33.3)	
2	17 (25)	16 (25.8)	1 (16.7)	
3	4 (5.9)	3 (4.8)	1 (16.7)	
4	1 (1.5)	1 (1.6)	0 (0)	
SIRS ≥2, n (%)	22 (32.4)	20 (32.3)	2 (33.3)	1.000
MPI, points ±SD	18.63±6.94	17.98±4.79	25.33±4.97	0.012
MPI >25, n (%)	16 (23.5)	12 (19.4)	4 (66.7)	0.024
WSES SSS, points (IQR)	3 (0-6)	3 (0-6)	6 (4.25-8)	0.054
WSES SSS >4, n (%)	28 (41.2)	23 (37.1)	5 (83.3)	0.074

Table 5. Sensitivity, specificity and AUROCs

Variable	Sensitivity %	Specificity %	AUROC
qSOFA ≥2	16.7	95.2	0.571 (0.331-0.831)
SIRS ≥2	33.3	67.7	0.483 (0.209-0.756)
MPI >25	66.7	80.6	0.805 (0.660-0.950)
WSES SSS >4	83.3	62.9	0.734 (0.562-0.906)

Table 6. Correlations

		MPI	WSES SSS	qSOFA	SIRS
Outcome	Correlation coefficient	r=0.302	r_s=0.235	r_s=0.097	r_s=−0.18
	Significance	p=0.012	p=0.054	p=0.432	p=0.883

AP that are more likely to die during hospitalization and to change the inadequate management strategy so that a fatal outcome may be avoided. In Europe, LP occurs in 63.5% of patients with AP[13], and the international studies report the range between 56.4% and 64%[1,6,12]. Although approximately 2/3 of patients with complicated intra-abdominal infections (cIAIs) have LP, we could not find any study that analyzes prognostic factors or scores in patients with LP exclusively. We chose to assess the predictive ability of four scoring systems which are simple and very easy to calculate. The MPI, introduced by Wacha and Linder[8], represents an independent, objective, and effective score for predicting mortality, which has shown superiority over other scoring systems in AP.[8,9] The WSES SSS, developed in 2014, was already validated in several studies[12,14] and was considered a precise and practical prognostic score for cIAIs. The SIRS was designed to define sepsis and predict mortality.[10] In 2016, the Sepsis-3 redefinition task force removed SIRS from this definition and introduced qSOFA as a rapid score that could almost instantly determine the need for intensive care or the risk of in-hospital death.[11]

We observed the qSOFA score as not helpful prognostic tool in LP. The ROC Curve Analysis revealed a very low predictive value (AUROC=0.571), whereat only one of non-survivors had qSOFA ≥2 points (16.7%). No significant differences were found between survivors and non-survivors according the qSOFA values (p=0.355). We found no research that studies prognostic performance of this score in LP. However, in patients with cIAIs, Tolonen et al.[15], Jung et al.[16], and Raimondo et al.[17] observed a better predictive value of the qSOFA score: AUROC=0.723, AUROC=0.717, and AUROC=0.722, respectively.

Similar findings were established for the predictive ability of SIRS (AUROC=0.483), and SIRS ≥2 was observed both in 1/3 of survivors and non-survivors (32.3% vs. 33.3%, p=1.00). We found no data about prognostic performance of SIRS in LP in the available literature. Although SIRS was not developed as a prognostic scale but as a tool for defining sepsis, over the years it has been studied as a predictor of death in different clinical settings. In patients with cIAIs, Jung et at.[16] and Raimondo et al.[17] reported higher value of the AUROC Curves with a poor ability to prognosticate mortality: AUROC=0.672 and AUROC=0.692, respectively.

A fair prognostic accuracy was demonstrated in the present study by WSES SSS (AUROC=0.734). Its optimal cut-off value was WSES SSS ≥4 points and it permitted prediction of adverse outcome with a sensitivity of 83.3% and a specificity of 62.9%. No study (to our knowledge) explores the predictive performance of WSES SSS in LP yet. In patients with cIAIs, several authors reported a better accuracy: Godinez-Vidal et al.[14] – AUROC=0.931 with a sensitivity of 76.47%, a specificity of 90.48%, Raimondo et al.[17] – AUROC=0.887, a sensitivity of 85.7% and a specificity of 75.9%, and Tolonen et al.[15] – AUROC=0.809, a sensitivity of 73% and a specificity of 76%. Godinez-Vidal et al.[14] and Raimondo et al.[17] reported the same threshold as ours, while Tolonen et al.[15] found a much higher threshold (≥8). The median WSES SSS in the present study was higher in non-survivors compared to survivors [6 (4.25-8) vs. 3(0-6)], and the difference was very close to significance (p=0.054). We suggest that this could be due to the small number of surveyed patients.

Among the four scores, MPI showed the best ability to prognosticate the fatal outcome in LP (AUROC=0.805) with a sensitivity and a specificity of 66.7% and 80.6%, respectively. Furthermore, the mean score in non-survivors was significantly higher than those in survivors (25.33±4.97 vs. 17.98±4.79, p=0.012). We found no other study that investigated the prognostic value of MPI in LP. Budzyński et al.[9] observed in patients with secondary peritonitis, a predictive accuracy similar to ours (AUROC=0.810). A better prognostic values were reported by Salamone et al.[18] in AP – AUROC=0.89 and Godinez-Vidal et al.[9] in cIAIs – AUROC=0.843, while Tolonen et al.[15] reported a lower value in severe cIAIs – AUROC=0.774. In the original study of Wacha and Linder[8] the determined cut-off value was MPI=26 points with a sensitivity of 84% and a specificity of 79%. We identified the same threshold with a sensitivi-

ty of 66.7% and a specificity of 80.6%. Lower threshold was reported by Godinez-Vidal et al.[14] – MPI ≥18 points with a sensitivity of 82.35% and a specificity of 79.17%, and Salamone et al.[18] – MPI=20 with a sensitivity of 78% and a specificity of 89%. Higher cut-off values were reported in the studies of Tolonen et al.[15] – MPI ≥30 with a sensitivity of 51% and a specificity of 79%, and Budzyński et al.[9] – MPI=32 with a sensitivity of 66.7% and a specificity of 97.9%.

The observed in-hospital mortality rate in our study was 8.8%. Pupelis et al.[19] reported a little bit higher value than ours – 9.4% in patients with LP. Maseda et al.[20] observed a death rate of 11.1% in critically ill patients with LP. The highest mortality rate was reported by Blot et al.[7] in critically ill patients with LP – 24.2%. Unfortunately, none of these studies showed other data about the predictive performance of scoring systems in LP.

ROC Curve analysis in the present study pointed prognostic superiority of MPI to WSES SSS, qSOFA, and SIRS (AUROC=0.805 vs. 0.734 vs. 0.571 vs. 0.483), whereat it is the only score with good ability to discriminate non-survivors (AUROC of MPI is greater than 0.8). The performed bivariate correlation analysis showed one significant correlation – between outcome and MPI (p=0.012, r=0.302), and the others were weak or very weak with no significance.

This is the first study (to the best of our knowledge) which analyzes prognostic performance of MPI, SIRS, WSES SSS and qSOFA and investigates the correlations between outcome and these scores in patients with LP.

As limitations of our study we can highlight the small number of investigated patients, the single-center experience, and the retrospective design

CONCLUSIONS

In patients with LP due to cIAIs, WSES SSS, SIRS and qSOFA score show no ability to predict the adverse outcome. Although MPI is the oldest among surveyed scores, it shows the best ability to recognize patients at higher risk of death.

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Можем ли мы предсказать смерть с помощью шкалы оценки среди пациентов с локальным перитонитом? Ретроспективное исследование

Евгени Н. Димитров[1], Георги А. Минков[1], Емил Т. Енчев[1], Красимира С. Халачева[2], Йовчо П. Йовчев[1]

[1] *Отделение хирургических болезней, УМБАЛ имени профессора доктора Стояна Кирковича, Стара Загора, Болгария*

[2] *Лаборатория клинической иммунологии, УМБАЛ имени профессора доктора Стояна Кирковича, Стара Загора, Болгария*

Адрес дя корреспонденции: Евгени Н. Димитров, Отделение хирургических болезней, УМБАЛ имени профессора доктора Стояна Кирковича, ул. „Столетов“ 32, Стара Загора, Болгария; Email: evgeni_d1984@yahoo.com; тел.: +359 887 609 943

Дата получения: 18 октября 2021 ♦ **Дата приемки:** 2 дек. 2021 ♦ **Дата публикации:** 28 февраля 2023

Образец цитирования: Dimitrov EN, Minkov GA, Enchev ET, Halacheva KS, Yovtchev YP. Can we predict death using scoring systems in patients with local peritonitis? A retrospective study. Folia Med (Plovdiv) 2023;65(1):73-79. doi: 10.3897/folmed.65.e76709.

Резюме

Введение: Прогностические показатели у больных с локальным перитонитом (ЛП) до сих пор исчерпывающе не изучены. Поэтому мы стремились в этом исследовании оценить возможности применения нескольких шкал оценки для прогнозирования смерти при ЛП.

Материалы и методы: Ретроспективный анализ, включающий 68 пациентов с ЛП, был проведён в Университетской больнице имени профессора доктора Стояна Кирковича в городе Стара Загора с января 2017 г. по август 2021 г. Клинико-лабораторные данные, необходимые для расчёта шкал оценки, были собраны при поступлении или после операции. Мы сравнили прогностическую эффективность WSES SSS, MPI, SIRS и qSOFA, используя площадь под кривыми рабочих характеристик приемника (AUROC) и двумерный корреляционный анализ.

Результаты: Наблюдаемый уровень смертности составил 8.8%. Среди всех показателей MPI показал наилучшие прогностические характеристики (AUROC=0.805, 95% CI 0.660–0.950). Порог MPI >25 баллов позволил прогнозировать неблагоприятный исход с чувствительностью 66.7 % и специфичностью 80.6 %. Единственная достоверная корреляция была обнаружена между исходом и MPI (p=0.012, r=0.302).

Заключение: В отличие от WSES SSS, qSOFA и SIRS, MPI может прогнозировать смертность у пациентов с ЛП.

Ключевые слова

смертность, MPI, исход, qSOFA, SIRS, WSES SSS