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Predictors of Mortality in Complicated Intra-abdominal Infections: A Comparative Study between International Scores

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ABSTRACT

Background: Due to the known poor prognosis of complicated intra-abdominal infections (cIAIs), a clinically usable predictive model of cIAI outcomes may be used to identify the high-risk patients and encourage appropriate management.

Objectives: The aim of the current work was to evaluate and compare Mannheim Peritonitis Index (MPI) and Sepsis Severity Score (SSS) validity in predicting the cIAIs related mortality based on score parameters.

Patients and Methods: This observational prospective study included a total of 143 patients with acute abdomen caused by intra-abdominal sepsis, attending at Department of General Surgery, Zagazig University Hospitals. during the period from December 2018 to December 2019. The enrolled patients were evaluated by two different scores (SSS and MPI) without any interference in management decisions or a plan and comparing each score.

Results: For SSS and MPI, respectively, the optimal cut-off points discovered from the curve were 9.5 and 24.5. Both scores according to the ROC curve demonstrated an excellent mortality prediction, with the area under the curve being outstanding for both scores (AUC > 0.7). The MPI total accuracy (67.13%) was lower than that of SSS (75%), but MPI produced true positives indicating higher sensitivity than SSS, which produced more specificity (true negative). Between MPI and SSS, there was a fair degree of agreement (kappa agreement = 0.603) and a statistically significant moderately positive correlation (r=o.562).

Conclusion: It could be concluded that MPI score is more sensitive than WSES-SSS in the prediction of mortality, however, WSES-SSS is more specific for the prediction of intra-abdominal sepsis related mortality.

Keywords: Intra-abdominal infections, Sepsis, MPI score.

INTRODUCTION

Intra-abdominal infections that are complicated (cIAIs) are associated with a poor prognosis and represent an important cause of morbidity. The infectious process in cIAIs spreads outside of the organs and results in either localized or generalized peritonitis (abdominal sepsis) [1, 2].

To provide adequate care while making the greatest use of available resources and give an affordable prognostic evaluation, a cIAIs related outcome model of prediction may be therapeutically valuable. This could even lead to a decrease in the death rate [3].

The Mannheim Peritonitis Index (MPI) was created in a retrospective assessment of peritonitis patients treated in two surgical departments in Germany in the 1980s, and it was subsequently confirmed in a multi-institutional study. The MPI, also known as "empirically deduced first risk score," was created with the aim of classifying the cIAIs severity and identifying patients who needed quick and aggressive treatment using data that could be easily gathered during clinical examination and surgical exploration [4].

The World Society of Emergency Surgery (WSES) developed the Sepsis Severity Index (SSS), which is regarded as a novel useful clinical severity measure for patients with cIAIs. Even during surgery, it is specific for cIAIs and simple to compute. It can be important to adjust the intensity of the treatment course, especially for individuals at higher risk [5].

As the monitoring scores are essential to identify the risky patients to promote aggressive management, this requires validity and investigations of such scores. Accordingly, this comparative study aimed to assess the two-scoring systems validity in mortality prediction of cIAIs based on parameters for scoring.

The aim of the work was to evaluate and compare Mannheim Peritonitis Index (MPI) and Sepsis Severity Score (SSS) validity in predicting the cIAIs related mortality based on score parameters.

PATIENTS AND METHODS

This observational prospective study included a total of 143 patients with acute abdomen caused by intra-abdominal sepsis, attending at Department of General Surgery, Zagazig University Hospitals. during the period from December 2018 to December 2019.

Exclusion criteria:

Patients under 18 years, pregnant women, and patients presented to the ER without having any clear signs of sepsis.

Enrolled patients were evaluated by two different scores (WSES-SSS and MPI) based on a collection of the data about their parameters without any interference in management decisions or a plan and comparing each score.

The chosen patients had extensive history taking, which included personal information, current illness history, and information about previous medical history. This information was obtained from the patients

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themselves or from family members if they had altered mental status. General and local examinations as well as laboratory investigations were conducted on all patients.

All patients were evaluated by WSES-SSS[5] and MPI[4] to assess the severity of sepsis, considering the occurrence of tissue perfusion or dysfunction of involved organs as a result of sepsis induction including acute lung injury, hypotension <90/60, urine output (UOP) <0.5 mL/Kg/h for longer than 2 h despite appropriate fluid resuscitation, platelet count <100.000 ($x10^9$ /l), INR >1.5, creatinine >2.0 mg/dl and bilirubin >2 mg/dl, all as signs of severe sepsis. A Septic shock is a severe form of sepsis characterized by refractory hypotension (BP<90/60) despite adequate resuscitation of fluid.

Ethical consent:

An approval of the study was obtained from Mansoura University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical Analysis

The computer was fed with data, and IBM SPSS software version 22.0 was used to analyse it. The qualitative data were presented using numbers and percentages. The mean and standard deviation for parametric data were used to describe the data after the Kolmogorov-Smirnov test was employed to ensure that quantitative data were normal. To assess the significance of the collected data, the (0.05) level was chosen. There were three tests used: the ANOVA, the Student t-test, and the Chi-Square test. The Pearson product-moment correlation is used to estimate the magnitude and direction of a linear relationship between two continuously distributed variables with normal distribution. To evaluate the diagnostic efficacy of the analyzed scores, Receiver Operating Characteristic (ROC) curve analysis was employed. Binary stepwise to predict the independent variables of a binary outcome, logistic regression analysis was applied. Cross-tabulation for categorical variables with Kappa was used to determine the kappa agreement degree (Slight agreement is between 0.01 and 0.20, fair agreement is between 0.21 and 0.40, moderate agreement is between 0.60 and 0.80, and perfect agreement is between 0.81 and 0.99).

RESULTS

The mean age of the studied cases is 55.6 ±13.65, and males were predominant (60.1%). Sepsis was the most common clinical presentation 69.2%. The perforated appendix was the most cause of IAIS 47.5% followed by perforated duodenal ulcer 24.5%. Most of the cases were operated on before 24 hours of admission. Cases with immunosuppression represented 27.9%, 19.6% of the studied cases have malignancy, and 30.1% have organ failure. The purulent exudate was predominant (50.3%) followed by fecal exudate (24.5%). The mean ± SD of preoperative days of clinical presentations at home was 6.45 ± 1.02. The mean of systolic (SBP) and diastolic (DBP) blood were 73.5, and 44 respectively. The mean of serum creatinine was 2.88 and the mean of platelets was 88.24. Figure (1) shows that the mortality rate among studied cases was 16.1%.

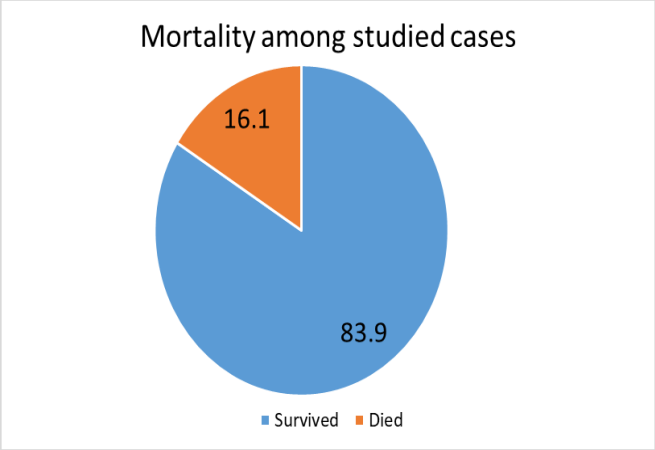

Figure (1): Mortality rate among studied cases.

Organ failure is a good indicator with a highly statistically significant risk factor for mortality (p=0.001). In addition to, old age, the presence of septic shock, malignancy, fecal exudate, lower mean SBP and DBP, lower platelets count, higher serum creatinine, and higher serum bilirubin are also statistically significant risk factors. On the other hand, other factors including, sex, time of intervention, immunosuppression, urinary output (UOP), Po2, and Pco2 are not considered significant risk factors for mortality. Table (1).

Table (1): Mortality risk factors among cases studied

	Total number n=143	**Survived n=120 (83.9%)**	**Died n=23 (16.1%)**	**P value**
Age/years (Mean ± SD)	55.60±13.56	53.13±12.86	68.52±9.21	p<0.001*
Sex				
Male	86 (60.1)	74 (61.7)	12 (52.2)	p=0.39
Female	57 (39.9)	46 (38.3)	11 (47.8)	
Clinical manifestations				
Septic shock	13 (9.1)	0 (0)	13 (56.5)	p<0.001*
Severe sepsis	31 (21.7)	21 (17.5)	10 (43.5)	
Sepsis	99 (69.2)	99 (82.5)	0 (0.0)	
Setting of acquisition				
Perorated appendix	68 (47.5)	63 (52.5)	5 (21.7)	p<0.001*
Perforated duodenal ulcer	35 (24.5)	31 (25.8)	4 (17.4)	
Perforated GB	6 (4.2)	4 (3.3)	2 (8.7)	
Mesenteric vascular occlusion	9 (6.3)	3 (2.5)	6 (26.1)	
Non-diverticular colonic perforation	16 (11.2)	14 (11.7)	2 (8.7)	
Diffuse Diverticular peritonitis	9 (6.3)	5 (4.2)	4 (17.4)	
Time of intervention				p=0.15
<24 h	125 (87.4)	107 (89.2)	18 (87.4)	
>24 h	18 (12.6)	13 (10.8)	5 (21.7)	
Immuno-suppression				
-ve	103 (72.0)	87 (72.5)	16 (69.6)	p=0.77
+ve	40 (28.0)	33 (27.5)	7 (40.4)	
organ failure				
-ve	100 (69.9)	91 (75.8)	9 (39.1)	p=0.001*
+ve	43(30.1))	29 (24.2)	14 (60.9)	
Malignancy				
-ve	115(80.4)	103 (85.8)	12 (52.2)	p<0.001*
+ve	28(19.6)	17 (14.2)	11 (47.8)	
Exudate				p=0.77
Turbid	28 (19.6)	24 (20.0)	4 (17.4)	p=0.10
Purulent	72 (50.3)	64 (53.3)	8 (34.8)	P=0.41
Intestinal	3 (2.1)	2 (1.7)	1 (4.3)	p=0.02*
Fecal	35 (24.5)	25 (20.8)	10 (43.5)	P=1.0
Cloudy	4 (2.8)	4 (3.3)	0 (0.0)	P=1.0
Bile	1 (0.7)	1 (0.8)	0 (0.0)	
Pre-operative duration /days	6.45 ± 1.02	6.18 ± 1.31	7.87 ± 1.30	p=0.013*
Systolic blood pressure (mmHg)	73.50 ± 9.13	74.68 ± 8.67	61.82 ± 4.05	p<0.001*
Diastolic blood pressure (mmHg)	44.0 ± 8.24	45.23 ± 7.53	31.82 ± 4.05	p<0.001*
Serum creatinine (mg/dl)	2.88 ± 0.43	2.76 ± 0.41	3.51 ± 0.75	p=0.001*
UOP (mL/Kg/h)	17.68 ± 4.12	17.79 ± 4.03	10 ± 0.0	p=0.38
Platelet ($x10^9$ /l)	88.24 ± 1.19	89.71 ± 11.83	80.57 ± 8.91	p=0.001*
Bilirubin (mg/dl)	2.49 ± 0.32	2.42 ± 0.43	2.89 ± 0.41	p=0.009*
PO2	45.53 ± 5.60	45.59 ± 6.06	45.21 ± 1.86	p=0.77
PCO2	57.16 ± 4.64	56.96 ± 4.58	58.22 ± 4.92	p=0.24

The regression model found that the only two factors that may accurately predict mortality in 95% of instances are organ failure and hypotension. Other significant risk factors can't be proven as predictors of mortality including age, immunosuppression, malignancy, platelets, and serum creatinine level. Table (2).

Table (2): Predictors of death among studied cases.

Predictors	B	p	odds ratio	95.0% C.I. odds ratio	
				Lower	Upper
Age/years	.041	.468	1.042	.933	1.164
Setting of acquisition					
Perorated appendix	0.48	0.49	1.626	0.41	6.48
Perforated duodenal ulcer	1.84	0.06	6.300	0.91	43.24
Perforated GB	3.23	0.1	25.200	0.9	132.31
Mesnentric vascular occlusion	0.59	0.51	1.800	0.32	10.25
Colonic non diverticular perforation	2.31	0.3	10.080	0.87	49.89
Organ failure (+VE)	2.79	<0.001*	16.31	3.65	22.79
Malignancy(+VE)	1.251	.403	3.493	.186	65.604
Pre -operative duration/days	.403	.054	1.496	.993	2.253
SBP	-.251	.035*	.778	.616	.983
DBP	.231	.029*	1.794	1.645	1.977
Creatinine	.016	.982	1.016	.263	3.929
PLT	-.067	.335	.935	.817	1.071
Constant=21.539 Overall % predicted =95%					

* statistically significant

It is not surprising that SSS has a difference of statistical significance between septic shock and sepsis, as well as among septic shock and sepsis of severe incidence with the highest mean score detected in septic shock then severe sepsis, and the least being for sepsis (p<0.001*). MPI also showed the same sequence of statistically significant differences as SSS (p<0.001*). Table (3)

Table (3): Comparison of WSES & MPI between Sepsis, severe sepsis and septic shock.

	Septic shock	Sever sepsis	Sepsis	Test of significance
WSES index	11.31±1.93	8.68±2.07	8.07±2.01	F=12.42 p<0.001*
MPI	29.08±3.86	25.90±6.25	22.45±5.43	F=8.05 p<0.001*

F: One Way ANOVA test * statistically significant

Survivors of cIAIs achieved a score less than 8 according to SSS with a mean score of 8.04 ± 2.18 and less than 22 according to MPI with a mean score of 22.62 ± 6.62, however, non-survivors with mortality achieved a mean score of 10.87 ± 2.01 according to SSS and 30.0±3.76 according to MPI with statistically significant difference between survivors and non-survivors in both scores.

According to the cut-off point determined by the ROC curve, 87% of patients with SSS larger than or equal to 9.5 and 95.7% of cases with MPI more than or equal to 24.5. The curve revealed that the best cut-off points for SSS and MPI were 9.5 and 24.5, respectively. Both scores according to the ROC curve demonstrated an excellent prediction of mortality, with the area under the curve being excellent for both scores (AUC>0.7). The MPI total accuracy was lower than that of SSS, but MPI produced more true positives showing more sensitivity than SSS, which produced more specificity (true negative). Table (4).

Table (4): WSES index and MPI validity in mortality prediction among subjects studied.

	AUC (95% CI)	Cut off point	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	P value
WSES index	0.818 (0.724-0.912)	9.5	87.0	73.3	38.5	96.7	75.5	p<0.001*
MPI	0.816 (0.74-0.88)	24.5	95.7	61.7	32.4	98.7	67.13	p=0.002*

AUC: Area Under curve PPV: Positive predictive value NPV: Negative predictive value

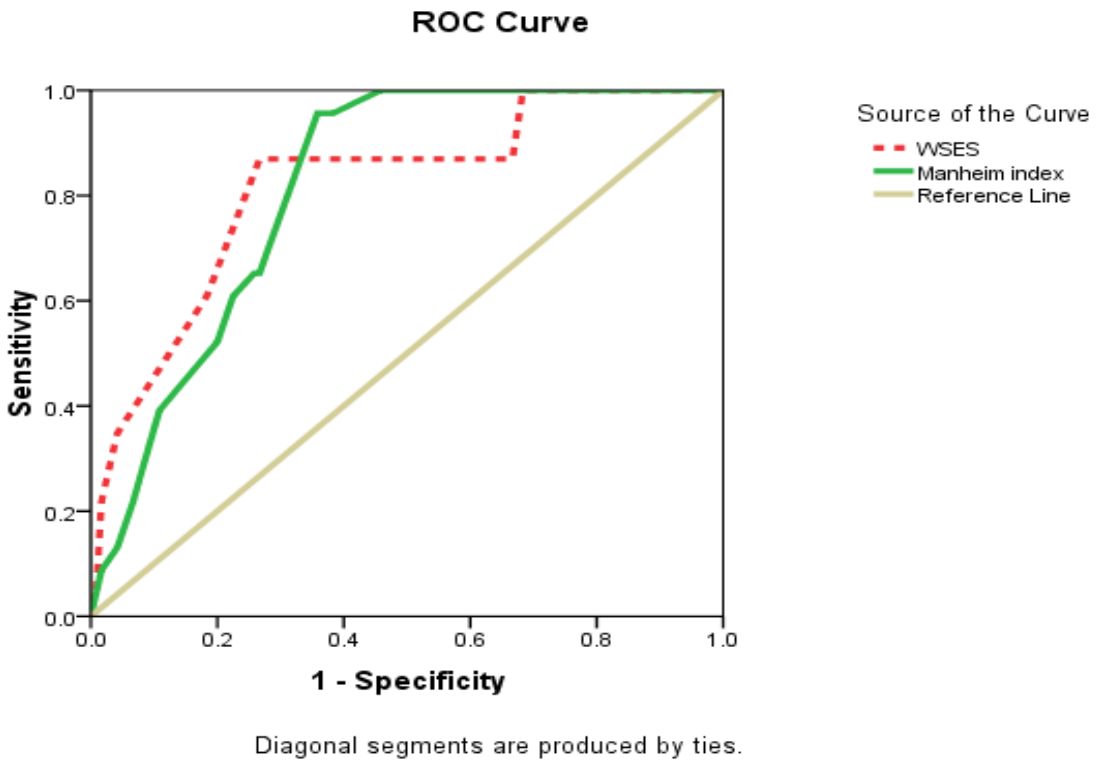

Figure (2): ROC curve for WSES-SSS and MPI in predicting mortality in the patients under study.

Both SSS and MPI are going head efficiently to demonstrate the significant scores on the cut-off points for the prediction of mortality between MPI and SSS, there is a statistically significant moderate positive correlation (r=o.562) and a fair degree of agreement (kappa agreement =0.603). Figure (3).

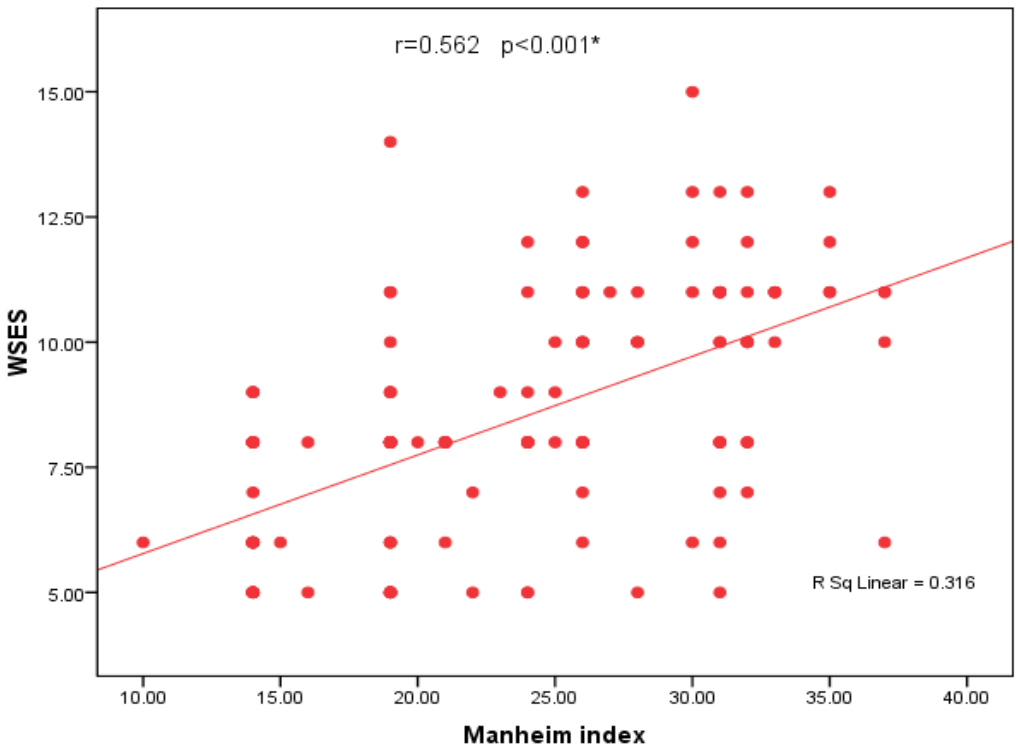

Figure (3): WSES-SSS & MPI correlation among the cases under study is shown in a scatter diagram.

DISCUSSION

High mortality and morbidity risk are characteristics of abdominal sepsis, and this risk rises with sepsis and multiple organ failure (MOF). Early seriousness categorization and stratification of risk enable prediction of prognosis so that the optimal surgical procedure and clinical care support therapy can be adopted[6].

The objective of this prospective study, which was carried out at Mansoura University Hospitals, was to assess the two scoring systems' validity for prediction of cIAIs related mortality according to score involved parameters. A total of 143 cases diagnosed with intraabdominal sepsis were involved after the exclusion of 113 cases with a mortality rate of 16.1% which was consistent with **Salamone *et al.*[6]** who reported that the mortality rate due to intraabdominal sepsis ranged between 13 and 43%.

Most recent studies showed age, septic shock, delayed presentation, delay in source control, and organ failure as the most significant risk factors[2, 7-9]. However, predictors of mortality in cIAIs cases were only age, immunosuppression, fecal exudate, organ failure, and hypotension. In this study, we agreed most of the studies in which the most significant risk factors were organ failure, old age, septic shock, malignancy, fecal exudate, and hypotension. Organ failure and hypotension were the only two predictors of mortality in this study.

The recent WSES-SSS is still a modern score and few studies had been achieved for evaluation of this new score. The WSES sepsis score was quite effective in identifying those who would live and those who would not. With a 89.2% sensitivity, 83.5% specificity, and a positive likelihood ratio of 5.4, a 5.5 score was considered the strongest mortality predictor [5]. A direct logistic model of regression used in an Arabian study carried out in the UAE revealed that the WSES-SSS predicts mortality significantly. (p 0.0001) [10]. In the current study's analysis of the WSES SSS, the non-survivor group had noticeably higher scores ($p < 0.001$). It exhibited an 87% sensitivity and a 73.3% specificity. Using a cut-off value of 9.5, its accuracy was 75.5%. Different sample sizes and cut-off values may, however, be the cause of a slight discrepancy in sensitivity and specificity between studies.

MPI is a scoring system that is independent, unbiased, and efficient for predicting mortality and assessing individual risk variables[11]. The MPI score showed the highest sensitivity and specificity as a predictor of mortality according to in study of **Salamone *et al.*[6]** with a score of 20. The authors discovered a sensitivity of 78% and a specificity of 89% at this value. Retrospective data analysis by Mannheim *et al*. revealed the MPI mean score to be 26.6 points (range: 5-47), with 87.3% sensitivity and 41.2% specificity, in 89 cases suffered perforation peritonitis. At a score of 21, the highest accuracy (69.7%) was attained[12].

In a different prospective study, 80 consecutive patients with perforation peritonitis were assessed for the MPI and multiple organ failure scores. The ROC AUC for MPI was 0.972. sensitivity was 100% and specificity was 79% for MPI of 21. With MPI of 29, the sensitivity and specificity were 79% and 96%, respectively[13].

Kusumoto *et al.*[14] evaluated the MPI accuracy in predicting the outcomes associated to patients with peritonitis in a study of 108 participants. According to a study comparing MPI and mortality, patients with a MI score of 26 or less had a 3.8% mortality rate, whereas those with a value greater than 26 had a 41.0% mortality rate.

According to a study by **Qureshi *et al.*[15]** mortality rates for scores under 21, between 21-29, and beyond 30, were respectively 1.9%, 21.9%, and 28.1%. Mortality rate was 4.3% for MI scores below 26, compared to 28.1% for MI values over 26.

Over a two-year period, 101 consecutive patients with widespread peritonitis were included in **Malik *et al.*[11]** prospection study. The MI system mortality was 0 for patients with a score of less than 15, 4% for patients with a score of 16 to 25, and 82.3% for patients with a score of more than 25.

When the MPI was examined in this study, the non-survivor group's results were significantly higher ($p < 0.001$). Its specificity was 61.7% and its sensitivity was 95.7%. With a cut-off value of 24.5, its accuracy was 67.13%.

This study is unique in the matter of comparison between WSES Score and MPI for the prediction of mortality in cIAIs cases, in which MPI yields higher sensitivity (true positive) than WSES score and WSES yields higher specificity (true negative) than MPI.

Up to the publication date of this article, there is no other studies mention the differences between WSES Score and MPI. further studies with larger samples are still needed for better evaluation.

CONCLUSION

It could be concluded that both the WSES-SSS and MPI are good and valid scores for the prediction of mortality in the case of cIAIs. MPI score is more sensitive than WSES-SSS in the prediction of mortality, however, WSES-SSS is more specific for the mortality prediction among those suffered intra-abdominal sepsis. Delayed presentation affects the prognosis of cIAIs cases in our society which need social programs and health education.

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Author contribution: Authors contributed equally in the study.

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