Which prognostic score for abdominal sepsis? Analysis of final results of PIPAS (Physiological Indicators for Prognosis in Abdominal Sepsis) study in a single center

Stefano Raimondo,[1] Massimo Sartelli,[2] Federico Coccolini,[1] Paola Fugazzola,[1] Raffaele Bova,[1] Matteo Tomasoni,[1] Fausto Catena,[3] Luca Ansaloni[1]

[1]General, Emergency and Trauma Surgery Department, Bufalini Hospital, Cesena (FC); [2]General Surgery Department, Macerata Hospital, Macerata; [3]Emergency and Trauma Surgery Department, Maggiore Hospital, Parma, Italy

Abstract

Intra-abdominal infections (cIAIs) constitute an important cause of morbidity and mortality. Numerous risk factors may influence prognosis of cIAIs. This study aims to evaluate which parameters and scores may better predict prognostic outcomes in cIAIs.

This is a single-center prospective observational study. Data from sixty-five patients were collected during a four-month period. Univariate and multivariate analysis for physiological parameters and ROC curves for SIRS, qSOFA and WISS scores were calculated in relation to mortality, intensive care unit (ICU) admission and surgical complications.

Blood oxygen saturation level (SpO_2), heart and respiratory rate, systolic blood pressure (SBP), level of consciousness, INR, C-reactive protein (CRP), white blood cells, source control and health care-acquired infections affect prognosis in cIAIs according to univariate analysis.

On multivariate analysis level of consciousness, SpO_2, CRP, diffuse peritonitis, INR and SBP significantly influenced prognosis in cIAIs.

AUROC for WISS score were 0.89 for mortality, 0.86 for major complications, 0.76 for ICU admission.

In our study many risk factors adversely affect prognostic outcomes in cIAIs; PIPAS study probably may provide even better results on that. Moreover, WISS score reached remarkable performance in predicting mortality and major surgical complications in abdominal sepsis; qSOFA did not achieve satisfactory results in none of analyzed outcomes.

Correspondence: Stefano Raimondo, General, Emergency and Trauma Surgery Department, Bufalini Hospital, Viale Giovanni Ghirotti, 286, 47521 Cesena (FC), Italy.
Tel.: +39.0547.394335 - Fax: +39.0547.352563.
E-mail: stefanoraimondo1987@gmail.com

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Introduction

Sepsis is currently defined as life-threatening organ dysfunction caused by a dysregulated host response to infection.[1]

Intra-abdominal infections (IAIs) represent a wide variety of lesions that can involve single organs of abdominal cavity with or without any kind of peritonitis (primary, secondary, tertiary).

If this process evolves in a microscopic or macroscopic perforation, or even in a bacterial translocation, this will lead to localized or diffuse grade of peritonitis: this clinical condition is defined complicated intra-abdominal infection (cIAI).

IAIs are, after pulmonary focus, regarded as the second most common origin of sepsis[2] and constitute an important cause of morbidity and mortality.

Management of cIAIs frequently requires a multidisciplinary approach and treatment has to be started as soon as possible to avoid the aggravation of clinical process.

Early risk stratification is paramount in order to establish which patients are at high risk of treatment failure and mortality, and in consequence to optimize an appropriate and fast treatment plan.

The most known scores for diagnosis and risk stratification in sepsis are SIRS (Systemic Inflammatory Response Syndrome) criteria,[3] SOFA (Sequential [sepsis-related] Organ Failure Assessment) score[4] and the recent quick SOFA (qSOFA).[1]

Much criticism has risen about the use of these scores in clinical practice; moreover, these scores concern sepsis in general, regardless of the source of infection. In surgical departments could be more useful to handle a specific tool for IAIs and intra-abdominal sepsis; in this field prompt detention of sepsis is mandatory, because of the necessity of early and adequate (surgical or radiological) source control.[5,6]

About that, the World Society of Emergency Surgery (WSES) published an observational study[6] in which clinical data (age, origin of abdominal infection, delay in source control, co-morbidities, suspected kind of infection, and degree of sepsis according to

sepsis-1 definitions) were enrolled from 4533 patients of 132 medical institutions worldwide on a 4-month period. Overall mortality rate was 9.2%. Mortality related with sepsis severity was only 1.2% of infection without sepsis, 4.4% with sepsis, 27.8% with severe sepsis and 67.8% with septic shock. Early detection and timely therapeutic intervention improved the prognosis and overall clinical outcome of patients. They assigned different scoring to any of significative clinical data obtained to multivariate analysis, and created a new risk-assessment score, named *WISS* in this work, with reference to the study that designed it.

Numerous studies in literature have shown the influence of risk factors in prognosis of IAIs: advanced age, expired nutritional conditions, immunosuppression, severe cardiovascular comorbidity, prolonged hospitalization, delay and inadequate source control, organ failure, septic shock, nosocomial infections.[5,7-11]

Starting from these concepts, a new worldwide prospective observational study will be published soon; this study, called PIPAS, Physiological Indicators for Prognosis in Abdominal Sepsis, aims to evaluate which parameters can be used to predict in-hospital mortality in patients with acute peritonitis.

To get this, many criteria in each patient, varying from physical parameters to examination to past medical history, from information about diagnosis (laboratory and radiological findings) to therapeutic strategies, have been collected.

A total of 3137 from 94 worldwide surgical departments were enrolled during a four-month period between February and May of this year. Once obtained and arranged, these clinical data will be tested on univariate and multivariate analysis and then, as a secondary aim, performed a new predictive simple early physiological score for abdominal sepsis (PIPAS protocol is reported in the Appendix).

Our work follows the design of principal study; the primary aim of this work was to evaluate which parameters significantly influence prognostic outcomes in cIAIs, in particular in-hospital mortality, intensive care unit (ICU) admission and surgical complications. The Secondary end-point was to compare three sepsis score (qSOFA, SIRS and WISS) and to evaluate the global performance in predicting outcomes.

Materials and Methods

Data collection and inclusion criteria

This is a single-center prospective observational study.

Surgical Department of Cesena (Emilia Romagna, Italy) is one of 94 centers involved in PIPAS study.

We prospectively selected all consecutive patients admitted to our unit with diagnosis of cIAI during a four-month period from February 1, 2018 to May 31, 2018. Diagnosis of IAI was based on clinical, laboratory and/or radiological findings.

Patients were monitored until discharge or transfer to another ward.

The following data were collected: i) age and sex; ii) past medical History: immunodeficiency (virus related (HIV), chronic steroids or immunosuppressive assumption, chemotherapy, lymphatic disease), malignancy, diabetes, severe chronic obstructive pulmonary disease, severe cardiovascular disease, chronic kidney disease; iii) physiological parameters at admission: heart rate (bpm), respiratory rate (breaths/min), blood systolic pressure (mmHg), body temperature (°C), level of consciousness (measured with Alert/Verbal/Pain/Unresponsive (AVPU) scale), pain scale, blood oxygen saturation level (SpO_2 %) in air; iv) clinical findings: source of infection, physical examination of the abdomen, peritonitis diffusion (localized peritonitis/abscess or diffuse peritonitis); v) laboratory findings: white blood cells, platelets, International Normalized Ratio (INR), C-reactive Protein (CRP), lactates (if measured in emergency ward); vi) radiological tool for diagnosis: X-ray, Ultrasounds, CT; vii) setting of acquisition (community-acquired or health care-acquired infection); viii) therapeutic outcomes: delay in source control, adequate source control, therapeutic strategy (laparoscopic or open surgery, radiological drainage, antibiotics), surgical strategy (open abdomen, planned or on demand laparotomy), eventual re-intervention and his timing (in hours); ix) prognostic outcomes: in-hospital mortality, post-operative complications (according to Clavien-Dindo classification),[12] admission in ICU, length of hospital stay.

Statistical analysis

Single parameters were analyzed with univariate and multivariate analysis, focusing on in-hospital mortality, ICU admission and surgical complications as outcomes.

Statistical analysis was performed with T test for continuous variables with normal distribution and with the Mann-Whitney test for non-normal distribution variables. Parametric variables were compared with chi square test. Significant p value was considered lower than 0.05.

Then, the accuracy of the three analyzed sepsis scores was compared performing Receiver Operating Characteristic (ROC) curve. SPSS was used for statistical analysis.

Results

Patient data

Sixty-five patients were enrolled in the study, 24 (36.9%) were females, 41 (63.1%) were males. Mean age was 58.3 years (SD±21.7 years). Average length of stay was 11.2 days (SD ±8.8 days).

The most frequent source of peritonitis was acute cholecystitis, in 25 cases (38,4%), followed by acute appendicitis in 12 (18.5%) cases, 8 (12.3%) large bowel perforations or necrosis, 6 (9.2%) small bowel perforations or necrosis, 4 (6.2%) anastomotic leaks, 4 (6.2%) acute diverticulitis, 3 (4.6%) gastro-duodenal perforations, 3 (4.6%) other conditions (pancreatitis and mesenteric abscess) (Table 1).

19 patients (29.2%) had diffuse peritonitis, while 46 (70.8%) had localized peritonitis or peritoneal abscess.

Considering the setting of acquisition, 5 (7.7%) patients were affected by hospital-acquired infections, while 60 (92.3%) had community-acquired IAIs.

Table 1. Source of infection in 65 patients with complicated IAIs.

Source of infection	Number (%)
Cholecystitis	25 (38.4%)
Appendicitis	12 (18.5%)
Large bowel perforation or necrosis	8 (12.3%)
Small bowel perforation or necrosis	6 (9.2%)
Anastomotic leak	4 (6.2%)
Acute diverticulitis (excluded Hinchey III or IV)	4 (6.2%)
Gastro-duodenal perforation	3 (4.6%)
Other conditions	3 (4.6%)
Total	65 (100%)

Treatment

Delay (>24 hours) on target treatment compared to the onset of symptoms (not from the first medical examination in emergency room) occurred in 60% of patients

Source of infection was entrusted to surgery in 54 (83.1%) cases. We chose a laparoscopic approach in 30 cases with conversion rate of 6.7%, and open surgery in 24 cases. Among the latter, eight patients required open abdomen (12.3% of all treatments, 14.8% of surgical treatments); of which, 4 presented an ongoing peritonitis on second-look findings, while only 1 patient was revised for ongoing peritonitis after laparotomy closure (the other 2 patients with ongoing peritonitis were not treated over more, because of the occurrence of other systemic complications).

Total re-operation rate was 13.8%, including also patients treated with open abdomen.

Seven patients (10.8%) were treated with percutaneous drainage and in all but one adequate source control was obtained. In only 4 (6.2%) patients a conservative treatment (with antibiotics) was administered.

Source control was not achieved in 8/61 (13.1%) patients undergone interventional procedures.

Complications

The overall mortality rate in our study was 10.8% (7 patients). This is in line with other epidemiological studies in a larger scale.[5,6]

13 patients (20%) needed hospitalization in ICU. Average ICU stay was 13.5 days (SD±11.1).

Post-operative complications were observed in 23.1% patients (15 patients). Somebody suffered from more than one complication. In particular, 7 patients (10.7%) experimented ongoing peritonitis, 5 patients (7.7%) presented wound infection, 2 (3.1%) post-operative bleeding, 2 (3.1%) post-operative abdominal abscess and 1 (1.5%) evisceration.

According to Clavien-Dindo classification, grade I or II complications were recorded in 5 patients (7.7%), while 10 patients (15.4%) had grade IV or V complications. Table 2 summarizes patient's characteristics and outcomes.

Table 2. Patient characteristics and outcomes.

Age	58.3±21.7 years
Male	41 (63.1%)
Female	24 (36.9%)
Mortality	7 (10.8%)
Post-operative complications	15 (23.1%)
Ongoing peritonitis	7 (10.7%)
Wound infection	5 (7.7%)
Post-operative bleeding	2 (3.1%)
Post-operative abdominal abscess	2 (3.1%)
Evisceration	1 (1.5%)
Clavien-Dindo grade I or II	5 (7.7%)
Clavien-Dindo grade IV or V	10 (15.4%)
Length of stay	11.2±8.8 days
ICU-admission	13 (20%)
ICU length of stay	13.5±11.1 days
Surgical treatment	54 (83.1%)
Percutaneous drainage	7 (10.8%)
Conservative treatment	4 (6.2%)

Outcomes

Univariate analysis comparing single variables in surviving and dead patients showed highly significant differences in the following parameters: blood oxygen saturation level (P<0.001) and C-reactive Protein (P=0.026) for continuous variables; blood oxygen saturation level ≤95% (P=0.002), White Blood Cells lower than 4000/mm^3 (P=0.029), CRP >200 mg/L (P=0.044), level of consciousness different from *alert* (P=0.003), inadequate source control (P<0.001) and setting of acquisition (if health-care acquired, P<0.001) for categoric variables (Tables 3 and 4).

Then, we combined statistically significant parameters on univariate analysis to evaluate independent variables associated with in-hospital mortality, according to the logistic regression method: only level of consciousness different from Alert demonstrated statistical significance on multivariate analysis (P=0.018) (Table 5).

In the same way, univariate and multivariate analysis were calculated for ICU admission and for complications.

Univariate analysis in relation to ICU admission demonstrated statistically significant values for the following variables (Tables 3 and 4): heart rate (P<0.001), blood oxygen saturation level (P<0.001), C-reactive protein (P<0.001), INR (P=0.047), AVPU scale different from *alert* (P=0.023), severe pain (P=0.042), abnormal (under 9 or over 19 breaths/min) respiratory rate (P=0.038), inadequate source control (P=0.016), diffuse peritonitis (P<0.001) and setting of acquisition (if health-care acquired, P=0.005).

Relating all these parameters on multivariate analysis, C-reactive protein (P=0.011) and diffuse peritonitis (P=0.045) resulted statistically significant (Table 5).

Univariate analysis in relation to overall surgical complication rate demonstrated statistically significant values in the following variables (P values are reported in Tables 3 and 4): heart rate, blood oxygen saturation level, systolic blood pressure, C-reactive Protein, INR, AVPU scale different from *alert*, abnormal (under 9 or over 19 breaths/min) respiratory rate, inadequate source control, diffuse peritonitis and setting of acquisition (if health-care acquired).

Relating all these parameters on multivariate analysis, blood oxygen saturation level (P=0.017), C-reactive protein (P=0.015), diffuse peritonitis (P=0.037), INR (P=0.017) and systolic blood pressure (P=0.017) were significantly related with surgical complications (Table 5).

For each patient, once calculated WISS score, qSOFA and SIRS criteria, we also compared each other on univariate analysis: WISS score >5 was the only significantly related to mortality, if considered that six of the seven dead patients had WISS >5, against only 1/7 with qSOFA >2 and 4/7 with SIRS >2.

Focusing on mortality, WISS score had sensitivity of 85.7% and specificity of 75.9% (that increased till 91.4% if considered a cut off ≥8), qSOFA had sensitivity of 14.3% and specificity of 98.3%, SIRS had sensitivity of 57.1% and specificity of 70.7%.

Mortality rate proportionally increased with grading of WISS score, similarly to what seen in the original study:[6] it was only 2.9% if WISS was under or equal to 3, reached 28.6% if WISS was 7 or 8, 50% between 9 and 12, until 66.7% if WISS >12.

The global performance of the tests is expressed by ROC curves (Figure 1). WISS score resulted the best score in predicting mortality (AUROC=0.89), major surgical complications (Clavien-Dindo ≥3) (AUROC=0.86) and overall surgical complications (AUROC=0.75); SIRS criteria were slightly better than WISS score in predicting ICU admission (AUROC 0.78 *vs* 0.76); in our study qSOFA has never achieved good performance values (Table 6).

Discussion

The management of complicated intra-abdominal infections is a major concern in surgical departments.

When sepsis comes from abdominal cavity, a particularly severe evolution of illness may result, due to the peculiarity of anatomy, microorganisms involved and physiology of the abdominal cavity and its contents.[13,14] Moreover, unlike other sources of infection, abdominal sepsis necessitates a multi-pronged approach, intended as source control, resuscitation and medical treatment. In this contest early detention of sepsis is mandatory.

The aim of PIPAS study is to find simple and fast physiological parameters related to poor clinical outcomes; this could provide at least two advantages: i) to reduce time interval between diagnosis and risk stratification of sepsis and initiation of therapy; ii) to select patients who could benefit from particular life-saving treatments, like open abdomen or damage control surgery.

Our study, despite limitations resulting from small dataset, proved statistically significant relationship between some physiological parameters and increased risk of in-hospital mortality, ICU admission and post-operative complications. Anyway, results from ongoing PIPAS study probably will be even more remarkable, considering the larger size of the sample; finally, a new score could be made up from these results, easy and cheap enough to be used worldwide, sufficiently accurate to obtain better outcomes in diagnostic earliness and in improving prognosis.

Indeed, the scores currently available have been criticized in the recent literature for many reasons.

SOFA score was born in 1996 from the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine to objectively describe the degree of organ dysfunction over time[4] and then adopted by new definitions as the suggested diagnostic tool of sepsis.

SOFA has been criticized by many because of his difficult application outside ICU; it has neither easy nor fast values to obtain, especially PaO2, that requires an invasive arterial blood gas measurement, or bilirubin or creatinine that are not immediately reported by laboratories.

For this reason, the SCCM/ESICM task force proposed in 2016 a new simplified bedside tool, the quick-SOFA,[1] to facilitate easier detection of patients potentially at risk of dying from sepsis or who may need ICU admission; this practical score is composed of three physiological parameters: systolic blood pressure, respiratory rate and neurologic state.

Anyway, in our study qSOFA did not reach satisfactory global performance, in none of analyzed outcomes. This result could be explained with the following hypotheses:

i) It is not selective for abdominal sepsis but for sepsis in general. IAIs do not necessarily evolve in sepsis and have particular clinical expressions and clinical evolution; so, it would be more useful a targeted severity score of IAIs, rather than a generic score of overt sepsis. On that, in our study mortality rate proportionally raises with increasing of WISS score, similar to original WISS study.[6]
ii) It is poorly sensitive: this could lead to underrate degree of illness, neglecting patients who should instead be treated as soon as possible; this corresponds to higher number of delayed diag-

Table 3. Univariate analysis of statistically significant continuous variables for each single analyzed outcome.

Continuous variable	Mean±SDMedian (range)	Mean±SDMedian (range)	P value
	Dead	Survivor	
SpO_2 (%)	90.86±4.60 91.0 (85.0-98.0)	97.07±2.90 98.0 (87.0-100.0)	<0.001
CRP (mg/L)	177.20±107.09 206.3 (46.90-314.60)	88.44±100.54 39.5 (0.3-315.0)	0.026
	Non-ICU admission	ICU admission	
SpO_2 (%)	97.46±2.39 98.0 (90.0-100.0)	92.15±4.69 91.0 (85.0-99.0)	<0.001
CRP (mg/L)	68.65±86.46 27.95 (0.30-315.0)	215.5±86.12 31.7 (46.9-314.6)	<0.001
Heart rate (bpm)	81.85±17.93 77.5 (60.0-130.0)	105.85±20.48 100.0 (78.0-150.0)	<0.001
INR	1.21±0.28 1.14 (0.93-2.64)	1.28±0.17 1.19 (1.06-1.54)	0.047
	Uncomplicated patients	Complicated patients	
SpO_2 (%)	97.22±2.61 98.0 (90.0-100.0)	93.67±5.12 95.0 (85.0-100.0)	0.016
CRP (mg/L)	71.13±93.32 23.6 (0.3-315.0)	187.55±89.05 179.8 (46.9-314.6)	<0.001
Heart rate (bpm)	83.38±18.71 79.0 (60.0-130.0)	97.53±23.83 95.0 (67.0-150.0)	0.044
INR	1.17±0.2 1.13 (0.9-1.9)	1.39±0.3 81.3 (1.1-2.6)	0.002
SBP (mmHg)	131.3±21.83 130.0 (90.0-180.0)	117.2±13.06 120.0 (100.0-143.0)	0.019

SpO_2, blood oxygen saturation level; CRP, C-reactive protein; INR, international normalized ratio; SBP, systolic blood pressure.

nosis (increase in false negative). For this reason, qSOFA should not be considered a screening tool for early sepsis. In other worlds, there is a risk to recognize patients when they have already organ dysfunction, starting treatment too late.

The major concern raised in literature about efficiency of SIRS criteria lies in their lack of specificity, despite of their good sensitivity. This leads to excessive over-treatment, as many patients with simple infection would be treated as septic and in the same way

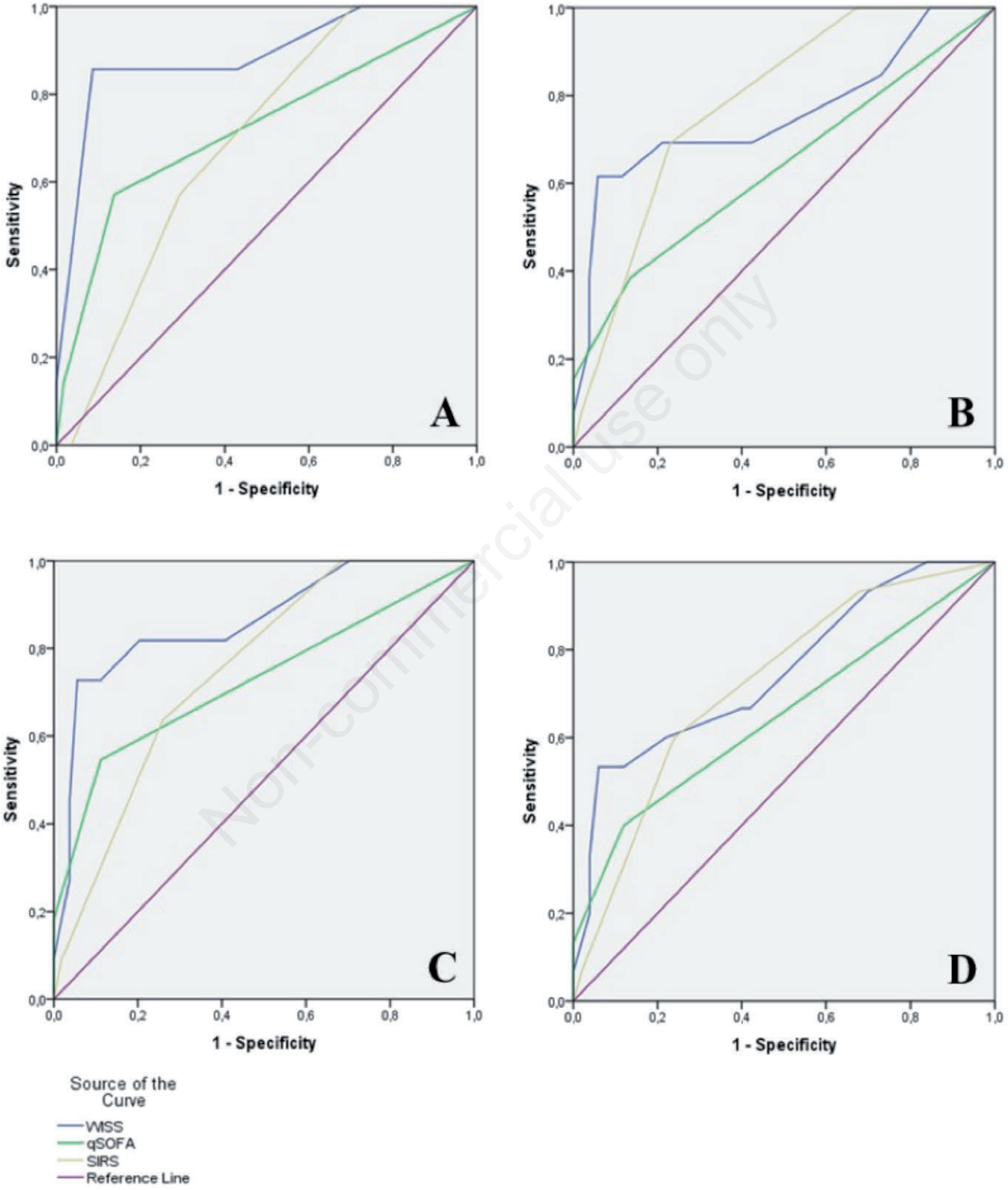

Figure 1. ROC curves of analyzed sepsis scores for each single outcome: A) mortality; B) ICU-admission; C) major surgical complications; D) overall surgical complications.

Table 4. Univariate analysis of statistically significant categoric variables for each single analyzed outcome.

Categoric variable		Survivors (%)	Dead (%)	Total	P value
SpO_2 (%)	>95	45 (97.8)	1 (2.2)	46	0.002
	≤95	13 (68.4)	6 (31.6)	19	
Level of consciousness	Alert	57 (93.4)	4 (6.6)	61	0.003
	V/P/U	1 (25.0)	3 (75.0)	4	
CRP (mg/L)	<5	16 (100)	0 (0)	16	NS
	5-100	20 (90.9)	2 (9.1)	22	NS
	101-200	11 (91.6)	1 (8.3)	12	NS
	>200	11 (73.3)	4 (26.7)	15	0.044
Source control	NO	6 (50)	6 (50)	12	<0.001
	YES	52 (98.1)	1 (1.9)	53	
Setting of acquisition	CA-IAIs	57 (95.0)	3 (5.0)	60	<0.001
	HA-IAIs	1 (20.0)	4 (80)	5	
White blood cells (cells/mm3)	<4000	1 (33.3)	2 (66.7)	3	0.029NSNS
	4000-12,000	24 (92.3)	2 (7.7)	26	
	>12,000	33 (91.7)	3 (8.3)	36	
		Non ICU (%)	**ICU (%)**	**Total**	
SpO_2 (%)	>95	42 (91.3)	4 (8.7)	19	0.001
	≤95	10 (52.6)	9 (47.4)	46	
Level of consciousness	Alert	51 (83.6)	10 (16.4)	61	0.023
	V/P/U	1 (25.0)	3 (75.0)	4	
CRP (mg/L)	>200	6 (40.0)	9 (60.0)	15	0.001
	≤200	46 (92.0)	4 (8.0)	50	
Source control	NO	7 (53.8)	6 (46.2)	13	0.016
	YES	45 (86.5)	7 (13.5)	52	
Setting of acquisition	CA-IAIs	51 (85.0)	9 (15.0)	60	0.005
	HA-IAIs	1 (20.0)	4 (80.0)	5	
Heart rate (bpm)	>90	12 (54.5)	10 (45.5)	22	0.001
	≤90	40 (93.0)	3 (7.0)	43	
Pain scale	Severe	12 (63.2)	7 (36.8)	19	0.042
	Mod/mild/no p.	40 (87.0)	6 (13.0)	46	
Respiratory rate (breaths/min)	Normal (9-19)	52 (82.5)	11 (17.5)	63	0.038
	Abnormal	0 (0)	2 (100)	2	
Peritonitis	Localized	43 (93.5)	3 (6.5)	46	<0.001
	Diffuse	9 (47.4)	10 (52.6)	19	
		Uncomplicated (%)	**Complicated (%)**	**Total**	
SpO_2 (%)	>90	50 (80.6)	12 (19.4)	62	0.01
	≤90	0 (0.0)	3 (100.0)	3	
Level of consciousness	Alert	50 (82.0)	11 (18.0)	61	0.002
	V/P/U	0 (0.0)	4 (100.0)	4	
CRP (mg/L)	>200	8 (53.3)	7 (46.7)	15	0.031
	≤200	42 (84.0)	8 (16.0)	50	
Source control	NO	6 (46.2)	7 (53.8)	13	0.007
	YES	44 (84.6)	8 (15.4)	52	
Setting of acquisition	CA-IAIs	49 (81.7)	11 (18.3)	60	0.009
	HA-IAIs	1 (20.0)	4 (80.0)	5	
Heart rate (bpm)	>90	13 (59.1)	9 (40.9)	22	0.027
	≤90	37 (86.0)	6 (14.0)	43	
Respiratory rate (breaths/min)	Normal (9-19)	50 (79.4)	13 (20.6)	53	0.05
	Abnormal	0 (0)	2 (100)	2	
Peritonitis	Localized,	40 (87.0)	6 (13.0)	46	0.007
	Diffuse	10 (52.6)	9 (47.4)	19	
SBP (mmHg)	>120	30 (88.2)	4 (11.8)	34	0.038
	≤120	20 (64.5)	11 (35.5)	31	
INR	<1.2	13 (56.5)	10 (43.5)	23	0.006
	≥1.2	37 (88.1)	5 (11.9)	42	

SpO_2, blood oxygen saturation level; CRP, C-reactive protein; SBP, systolic blood pressure; INR, international normalized ratio; V/P/U, verbal/pain/unresponsive; CA-IAIs, community acquired intra-abdominal infections; HA-IAIs, health care-acquired intra-abdominal infections; mod/mild/no p, moderate/mild/no pain.

Table 5. Multivariate analysis of independent variables associated with mortality, ICU admission, overall and major complication rate.

Variables	P value			
	Mortality	ICU admission	Major complications	Overall complications
Health care acquired infection	NS	NS	NS	/
WBC <4000/mm$_3$	NS	/	/	/
AVPU scale different from *A*	0.018	NS	/	/
CRP (continuous variable)	NS	0.011	NS	0.015
SpO_2 (continuous variable)	NS	NS	NS	0.017
Diffuse peritonitis	/	0.045	NS	0.037
INR (continuous variable)	/	NS	NS	0.017
SBP (continuous variable)	/	/	0.029	0.017
Heart rate (continuous variable)	/	/	/	NS

WBC, white blood cells; AVPU, alert/verbal/pain/unresponsive; CRP, C-reactive protein; SpO_2, blood oxygen saturation level; INR, international normalized ratio; SBP, systolic blood pressure.

Table 6. AUROC comparison of analyzed sepsis scores for single outcomes.

Score	AUROC			
	Mortality	Major complications	Overall complications	ICU admission
WISS	0.887	0.862	0.749	0.757
qSOFA	0.722	0.727	0.648	0.635
SIRS	0.692	0.752	0.721	0.783

many patients with a systemic inflammatory illness would be treated with antibiotics, contributing to the increase in antibiotic resistance.

Despite this, SIRS criteria remain one of the most used screening tools for sepsis. In our study, SIRS reached better ROC curves than qSOFA in all but one of analyzed outcomes, and even than WISS score in predicting ICU admission. So, SIRS could be considered a reasonable risk-stratification tool in abdominal infections and abdominal sepsis, as well as a good screening tool.

WISS score can be considered an expansion of SIRS criteria, specific for peritonitis and for abdominal sepsis: a part of the score is calculated on the basis of the degree of sepsis, according to the old sepsis-1 criteria (severe sepsis: 3 points; septic shock: 5 points), in order to better stratify the severity of the illness. The remaining gives importance to the type of infection and to the clinical characteristics of the patients. This model increases accuracy in stratification of patient's risk, in comparison to other *generic* scores for sepsis; it is easy to calculate and may help to decide for intensification and quickness of treatment.

In our study WISS score demonstrated great global performance with excellent ROC in predicting mortality and surgical complications; the area under the ROC curve of WISS score was slightly inferior to AUC of SIRS only in predicting ICU admission, but still superior to the qSOFA one.

We remind that WISS score is not a screening tool, considered that it can be calculated only after etiological diagnosis; thus, it may be considered a risk stratification tool of abdominal sepsis. Instead, qSOFA has the theorical advantage to be a bedside stratification tool, with availability once patients enter in emergency room.

Future perspectives should focus on the development and the validation of a score able on early detection of patients with abdominal sepsis, in particular those with high risk of organ dysfunction and septic shock, even before their onset. This score should help to reach both diagnosis and prognosis as soon as possible, so to move towards one or another treatment approach.

Conclusions

In our study WISS score reached remarkable performance on predicting mortality and major surgical complications in abdominal sepsis. qSOFA did not reach satisfactory results in none of analyzed outcomes.

We are waiting for results from PIPAS study; probably it may provide even better outcomes than our study on identifying which parameters significantly relate with high risk of mortality in abdominal sepsis and complicated intra-abdominal infections.

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