Comparison of APACHE II, P-POSSUM and SAPS II scoring systems in patients underwent planned laparotomies due to secondary peritonitis

Koray Das, Mehmet Ozdogan, Faruk Karateke, Abdurrahman Selcuk Uzun, Selim Sozen, Sabri Ozdas

Numune Training and Research Hospital, Department of General Surgery, Adana, Turkey

Comparison of APACHE II, P-POSSUM and SAPS II scoring systems in patients underwent planned laparotomies due to secondary peritonitis

BACKGROUND: The first aim of this study was to discuss the factors affecting mortality rate in patients with severe intra-abdominal sepsis treated with planned relaparotomy. The second aim was to compare APACHE II, P-POSSUM and SAPS II scoring systems to allow identification of high-risk patients.

MATERIAL AND METHODS: A series of 34 patients who had intra-abdominal sepsis and treated with planned relaparotomy between January 2009 and January 2012 were included the study. The source of the peritonitis, type and number of surgical procedures, number of planned relaparatomies, microbiology surveillance, total intensive care unit (ICU) and hospital stay duration, number of intubated days, morbidity and mortality were analyzed. APACHE II, SAPS II, P-POSSUM scores and estimated mortality ranges at admission were compared.

RESULTS: The mean age was 46 (16-76 years) and 73.5% (n=25) were male. A total of 119 operations and 50 surgical procedures were performed. The overall mortality rate was 20.6% (n=7). Complications developed in %53 (n=18) of the patients. Mortality was higher in upper GIS leaks (6/20 versus 1/14 patients). Areas under the curve calculated by ROC curve analysis for APACHE II, SAPS II and P-POSSUM were 0.958, 0.955 and 0.931, respectively. The highest values for sensitivity (100%) and specificity (85.2%) together were reached in APACHE II, when cut off value for it was set to 20.5. The SAPS II and P-POSSUM physiology scores were correlated with overall hospital stay (p=0.022 r=0.438 and p=0.001 r=0.609 respectively), but this correlation was not found for APACHE II score (p=0.085 r=0.337). However, all three scoring systems provided clear estimation of ICU stay duration.

CONCLUSION: We suggest that, in secondary peritonitis patients reserved for planned relaparotomy, APACHE II is more reliable for prediction of mortality and P-POSSUM scoring system is more reliable for prediction of overall hospital stay duration.

KEY WORD: APACHE II, P-POSSUM, Peritonitis, SAPS II

Introduction

Secondary peritonitis related intra-abdominal sepsis is a difficult problem for the surgeons. Although there are numerous surgical strategies, antibiotic treatments and intensive care unit facilities, mortality rate of this disease has not decreased below 30% 1. The management includes peritoneal debridement and lavage, resections, ostomies, or drainage tubes for source control if necessary 2,3. At the initial operation, severity of the peritonitis brings most surgeons to a decision point; to left the abdomen open, or to close the abdomen for planned or on-demand relaparotomy. There are studies in the literature indicating that repetitive relaparotomy strategy is more commonly used than open abdomen
in recent years. However, it is still controversial whether to perform a planned or an on-demand laparotomy. Several scoring systems are being used for assessing the severity of disease and predicting mortality in critically ill patients. On the other hand, there is no reliable data regarding which scoring system is preferable for the prediction of mortality for these patients.

The first aim of this study was to discuss the factors affecting mortality in patients with severe intra-abdominal sepsis treated with planned relaparotomy. The secondary aim was to compare APACHE II, P-POSSUM and SAPS II scoring systems to allow identification of high-risk patients.

**Material and Methods**

This retrospective study was performed in the Surgery Clinic of Numune Training and Research Hospital after ethics committee approval. A series of 34 patients who had intra-abdominal sepsis and treated with planned relaparotomy between January 2009 and January 2012 were included in the study. The exclusion criteria were having primary peritonitis, and peritonitis related to mesenteric vascular occlusions, abdominal traumas, acute pancreatitis and case files with incomplete data. Data including the source of the peritonitis, type and number of surgical procedures, number of planned relaparotomies, microbiology surveillance, total intensive care unit (ICU) and hospital stay duration, number of intubated days, morbidity, mortality and data necessary for APACHE II, P-POSSUM and SAPS II scoring systems were used.

**Assessing Disease Severity**

APACHE II, SAPS II, P-POSSUM scores and estimated mortality ranges at admission were calculated by using the calculator in http://www.sfar.org for each patient.

**Planned Relaparotomy**

Relaparotomies were performed every 36 to 48 hours after the initial laparotomy to inspect, drain, lavage, and perform other necessary abdominal interventions for residual peritonitis or foci. The sequence of planned relaparotomies was terminated when a macroscopically clean abdomen was found at relaparotomy.

**Statistical Analysis**

SPSS 18.0 package program was used in statistical analysis. Categorized and numeric data was summarized with number and percentages, and mean and standard deviation (median and minimum and maximum where necessary), respectively. Chi square test was used for mortality comparison of categorical data. For mortality comparison of numeric data, in independent groups, in the state of hypothesis admission, T test and in the state of hypothesis rejection, Mann Whitney U test was used. Logistic regression was used for multidimensional modeling of factors affecting mortality. Receiver Operator Characteristic (ROC) curve analysis was used for classification success and cut off points for mortality assessment scores. Cox regression analysis was used for factors affecting on mortality. Correlation between hospitalization duration and numeric data was analyzed using Spearman correlation coefficient. Univariate general linear models were used for identification of parameters affecting hospitalization duration. Statistical significance level was set as alpha = .05 for all tests.

**Results**

A total of 38 patients underwent planned relaparotomy for secondary peritonitis between 2009 and 2012 were analyzed. Due to missing data 4 case files were excluded.

In 34 patients, the mean age was 46 (16-76 years) and 73.5 % (n=25) were male. A total of 119 operations and 50 surgical procedures were performed, the median number of operations and surgical procedures were 3 (2-15) and 1 (1-6) respectively. Upper gastrointestinal system (GIS) and lower GIS related secondary peritonitis ratio was 59% (n=20) and 41% (n=14), respectively. The overall mortality rate was 20.6% (n=7). Complications developed in %53 (n=18) of the patients with pneumonia and acute renal failure as the most common complications detected (n=7, n=6 respectively).

The overall median ICU stay was 4 days (1-82 days) and the median hospital stay was 21 days (1-150 days). It was found that, patients with upper GIS tract related sources had significantly longer ICU and overall hospital stays (Table I). Additionally, the length of ICU stay was associated with duration of mechanical ventilation (p=0.002 r=0.754) and number of relaparotomies.

<table>
<thead>
<tr>
<th>Source of peritonitis</th>
<th>Lower GIS</th>
<th>Upper GIS</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±SD</td>
<td>Mean±SD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Med (Min-Max)</td>
<td>Med (Min-Max)</td>
<td></td>
</tr>
<tr>
<td>Overall hospital stay</td>
<td>23.77±9.44</td>
<td>43.36±34.57</td>
<td>0.029</td>
</tr>
<tr>
<td></td>
<td>22 (15-48)</td>
<td>35 (17-150)</td>
<td></td>
</tr>
<tr>
<td>ICU stay</td>
<td>3±1.87</td>
<td>14.71±20.7</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>2 (1-7)</td>
<td>9 (2-82)</td>
<td></td>
</tr>
</tbody>
</table>
K. Das, et. al.

(p=0.030 r=0.426). The overall hospital stay period was associated with duration of ventilation (p=0.010 r=0.659).

Successful source control was achieved in 90% of patients (n=30). However, three patients (3/7) in whom the source control was achieved successfully, died of pneumonia, as a complication. In other four patients (4/7) who died, multiple organ failure (MOF) due to septic shock was the cause.

The mean age was 42 years (16-71 years) in survivors and 62 years (21-76 years) in non-survivors. It was found that the impact of “age” on survival is significant.

Table II - Demographics and clinical outcomes.

<table>
<thead>
<tr>
<th></th>
<th>Survivor</th>
<th>Nonsurvivor</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>43.22±14.82</td>
<td>59.43±17.75</td>
<td>0.019</td>
</tr>
<tr>
<td></td>
<td>42 (16-71)</td>
<td>62 (21-76)</td>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td>19 (%70.37)</td>
<td>6 (%85.71)</td>
<td>0.644</td>
</tr>
<tr>
<td></td>
<td>8 (%29.63)</td>
<td>1 (%14.29)</td>
<td></td>
</tr>
<tr>
<td><strong>Overall hospital stay</strong></td>
<td>33.93±27.17</td>
<td>7.86±5.81</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>25 (15-150)</td>
<td>8 (1-15)</td>
<td></td>
</tr>
<tr>
<td><strong>Length of ICU stay</strong></td>
<td>9.07±15.85</td>
<td>5.14±4.67</td>
<td>0.803</td>
</tr>
<tr>
<td></td>
<td>4 (1-82)</td>
<td>4 (1-15)</td>
<td></td>
</tr>
<tr>
<td><strong>Mechanical ventilation duration</strong></td>
<td>4.29±6.87</td>
<td>3.14±6.3</td>
<td>0.255</td>
</tr>
<tr>
<td></td>
<td>1 (0-25)</td>
<td>2 (1-3)</td>
<td></td>
</tr>
<tr>
<td><strong>Number of relaparatomies</strong></td>
<td>2.77±4.44</td>
<td>1.57±0.53</td>
<td>0.030</td>
</tr>
<tr>
<td></td>
<td>2 (2-14)</td>
<td>2 (1-2)</td>
<td></td>
</tr>
<tr>
<td><strong>Number of surgical procedures</strong></td>
<td>1.52±1.31</td>
<td>1.29±0.49</td>
<td>0.803</td>
</tr>
<tr>
<td></td>
<td>1 (1-6)</td>
<td>1 (1-2)</td>
<td></td>
</tr>
<tr>
<td><strong>Source of peritonitis</strong></td>
<td>13 (%48.15)</td>
<td>1 (%14.29)</td>
<td>0.198</td>
</tr>
<tr>
<td><strong>Lower GIS</strong></td>
<td>14 (%51.85)</td>
<td>6 (%85.71)</td>
<td></td>
</tr>
<tr>
<td><strong>Upper GIS</strong></td>
<td>13 (%48.15)</td>
<td>1 (%14.29)</td>
<td></td>
</tr>
<tr>
<td><strong>Number of additional diseases</strong></td>
<td>4.5±0.53</td>
<td>1.8±1.33</td>
<td>0.999</td>
</tr>
<tr>
<td></td>
<td>5 (1-6)</td>
<td>1 (1-4)</td>
<td></td>
</tr>
</tbody>
</table>

Table III - Scores in patients at the admission.

<table>
<thead>
<tr>
<th></th>
<th>Survivor</th>
<th>Nonsurvivor</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>APACHE II score</strong></td>
<td>15.56±4.93</td>
<td>25.71±3.82</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>16 (6-26)</td>
<td>26 (21-33)</td>
<td></td>
</tr>
<tr>
<td><strong>SAPS II score</strong></td>
<td>34.85±10.78</td>
<td>59.57±10.92</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>37 (15-51)</td>
<td>61 (45-73)</td>
<td></td>
</tr>
<tr>
<td><strong>P-POSSUM physiology score</strong></td>
<td>29±7.02</td>
<td>44.86±8.19</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>27 (22-52)</td>
<td>47 (35-56)</td>
<td></td>
</tr>
<tr>
<td><strong>P-POSSUM Operative severity score</strong></td>
<td>20.56±3.85</td>
<td>23.86±5.24</td>
<td>0.069</td>
</tr>
<tr>
<td></td>
<td>21 (13-30)</td>
<td>24 (17-33)</td>
<td></td>
</tr>
</tbody>
</table>
These two strategies were similar 10,11 Meta-analysis stud-
hand, there are studies showing that the outcomes of
is lower than planned relaparatomies8,9. On the other
ment of persistent infection is called as “laparatomy on
strategy that waiting for relaparotomy until the develop-
Discussion
Therapy
In severe peritonitis there is a diffuse inflammatory
response caused by the extending infection 6. Surgical
debridement and drainage is the aim in the initial oper-
ation in order to decrease the bacterial and toxic load.
However it is generally not completely effective because of
the anatomical structure of the abdominal cavity.
Because of the formation of locular pockets of pus, approx-
imately 60-40% of patients require re-exploration 7. The
strategy that waiting for relaparotomy until the develop-
ment of persistent infection is called as “laparatomy on
demand”. Wittmann et al. and Grunau et al. reported
that the mortality rate following “wait and see” strategy
is lower than planned relaparatomies8,9. On the other
hand, there are studies showing that the outcomes of
these two strategies were similar 10,11 Meta-analysis stud-
ies comparing these methods describe these inconclusive
evidences with heterogeneity, non-randomized allocation,
and small size of the studies 12. Our study included only
a planned relaparotomy group, thus we didn’t compare
with patients undergone laparotomy on demand. However,
overall mortality rate in our study was lower than the results reported in the literature (20.6% versus
21-77% mortality) 8,12. Patients in our study had severe peritonitis with high
APACHE II, SAPS II and P-POSSUM scores. All of
the patients were followed in ICU for at least one day
(1-82 days, median 4 days). The same broad-spectrum
antibiotic regimen was administered at the admission to
all patients and changed after the culture results were
required. A group of patients underwent extensive multi-
ple operations. We know that peritoneal washing suppresses
the peritoneal defense mechanisms and likewise a surgical
trauma is immunosuppressive 13. Infection may find a new
chance to persist 7. Because of these facts, we additional-
ly continued the antibiotic therapy for 7 days after the
final closure. A prospective study showed that if the source
was associated with end or lateral duodenal leak, source
control was more problematic 7. In our study, we found
similar results to that; source control was more difficult in
upper gastrointestinal system related sources than ones relat-
ed with other locations. In upper gastrointestinal leaks,
collected fluid volume may exceed the tube drainage or
intraabdominal defense mechanisms’ containment capacity.
We found that patients with upper gastrointestinal system
leak had longer ICU and hospital stay than ones with peri-	onitis related with other areas. Although the mortality was
higher in upper gastrointestinal system leaks (6/20 versus
1/14 patients), we did not find any significant differences
between mortality rates due to the limited number of
patients. Some authors reported that, type of illness, success of
source control, occurrence of complications are the main
independent determinants of mortality 7,10. In our cases
successful source control was achieved in 90% of patients
(n=30) and 27 of them have survived. In whom the source
control was achieved successfully, died of pneumonia, as a
complication. In other four patients (4/7) who died, MOF
due to septic shock was the cause. Koperna et al. showed that patients over 70 years of age
are at high risk for developing persistent intraabdominal
infections that causes high mortality 10. The mean age of
non-survivors was 59.5±17.75 and it was found that the
impact of age on survival is statistically significant
(p=0.019). Sex, length of ICU stay, number of rela-
paratomies, number of surgical procedures, and number of
additional diseases were not associated with mortal-
ty. Mortality was higher in upper GIS leaks (6/20 ver-
sus 1/14 patients), but there weren’t any statistically sig-
ificant differences (p=0.198) (Table II).
The average APACHE II, SAPS II and P-POSSUM phys-
iology scores of non-survivors at the administration were
significantly higher than those of survivors’ (Table III). For
estimating mortality in patients, areas under the curve cal-
culated by ROC curve analysis for APACHE II, SAPS II,
and P-POSSUM were 0.958, 0.955 and 0.931, respective-
ly. As cut off point set to 20.5 for APACHE II, sensitivity
(100%) and specificity (85.2%) results gained together in
were the highest values among scoring systems (Table IV).
The SAPS II and P-POSSUM physiology scores were cor-
related with overall hospital stay (p=0.022 r=0.538 and
p=0.001 r=0.609 respectively), but this correlation was
not found for APACHE II score (p=0.085 r=0.337).
APACHE II, SAPS II and P-POSSUM scores. All of
the patients were followed in ICU for at least one day
(1-82 days, median 4 days). The same broad-spectrum
antibiotic regimen was administered at the admission to
all patients and changed after the culture results were
required. A group of patients underwent extensive multi-
ple operations. We know that peritoneal washing suppresses
the peritoneal defense mechanisms and likewise a surgical
trauma is immunosuppressive 13. Infection may find a new
chance to persist 7. Because of these facts, we additional-
ly continued the antibiotic therapy for 7 days after the
final closure. A prospective study showed that if the source
was associated with end or lateral duodenal leak, source
control was more problematic 7. In our study, we found
similar results to that; source control was more difficult in
upper gastrointestinal system related sources than ones relat-
ed with other locations. In upper gastrointestinal leaks,
collected fluid volume may exceed the tube drainage or
intraabdominal defense mechanisms’ containment capacity.
We found that patients with upper gastrointestinal system
leak had longer ICU and hospital stay than ones with peri-
onitis related with other areas. Although the mortality was
higher in upper gastrointestinal system leaks (6/20 versus
1/14 patients), we did not find any significant differences
between mortality rates due to the limited number of
patients. Some authors reported that, type of illness, success of
source control, occurrence of complications are the main
independent determinants of mortality 7,10. In our cases
successful source control was achieved in 90% of patients
(n=30) and 27 of them have survived. In whom the source
control was achieved successfully, died of pneumonia, as a
complication. In other four patients (4/7) who died, MOF
due to septic shock was the cause. Koperna et al. showed that patients over 70 years of age
are at high risk for developing persistent intraabdominal
infections that causes high mortality 10. The mean age of
non-survivors was 59.5±17.75 and it was found that the
impact of age on survival is statistically significant
(p=0.019). Sex, length of ICU stay, number of rela-
paratomies, number of surgical procedures, and number of
additional diseases were not associated with mortal-
ty. Mortality was higher in upper GIS leaks (6/20 ver-
sus 1/14 patients), but there weren’t any statistically sig-
ificant differences (p=0.198) (Table II).
The average APACHE II, SAPS II and P-POSSUM phys-
iology scores of non-survivors at the administration were
significantly higher than those of survivors’ (Table III). For
estimating mortality in patients, areas under the curve cal-
culated by ROC curve analysis for APACHE II, SAPS II,
and P-POSSUM were 0.958, 0.955 and 0.931, respective-
ly. As cut off point set to 20.5 for APACHE II, sensitivity
(100%) and specificity (85.2%) results gained together in
were the highest values among scoring systems (Table IV).
The SAPS II and P-POSSUM physiology scores were cor-
related with overall hospital stay (p=0.022 r=0.538 and
p=0.001 r=0.609 respectively), but this correlation was
not found for APACHE II score (p=0.085 r=0.337).
However, all three scoring systems provided clear esti-
mation of ICU stay duration (Table IV).

**Discussion**

**Therapy**

In severe peritonitis there is a diffuse inflammatory
response caused by the extending infection 6. Surgical
debridement and drainage is the aim in the initial oper-
ation in order to decrease the bacterial and toxic load.
However it is generally not completely effective because of
the anatomical structure of the abdominal cavity.
Because of the formation of locular pockets of pus, approx-
imately 60-40% of patients require re-exploration 7. The
strategy that waiting for relaparotomy until the develop-
ment of persistent infection is called as “laparotomy on
demand”. Wittmann et al. and Grunau et al. reported
that the mortality rate following “wait and see” strategy
is lower than planned relaparatomies8,9. On the other
hand, there are studies showing that the outcomes of
these two strategies were similar 10,11 Meta-analysis stud-
ies comparing these methods describe these inconclusive
evidences with heterogeneity, non-randomized allocation,
and small size of the studies 12. Our study included only
a planned relaparotomy group, thus we didn’t compare

---

**Table IV - ROC curve analysis for classification success and cut off points for mortality assessment scores.**

<table>
<thead>
<tr>
<th></th>
<th>AUC*</th>
<th>P</th>
<th>Cut off point</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>APACHE II Score</td>
<td>0.958</td>
<td>&lt;0.001</td>
<td>20.5</td>
<td>100</td>
<td>85.2</td>
</tr>
<tr>
<td>SAPS2 Score</td>
<td>0.955</td>
<td>&lt;0.001</td>
<td>44</td>
<td>100</td>
<td>74.1</td>
</tr>
<tr>
<td>P-POSSUM Physiologe Score</td>
<td>0.931</td>
<td>&lt;0.001</td>
<td>34.5</td>
<td>100</td>
<td>81.5</td>
</tr>
<tr>
<td>POSSUM Operative Severity Score</td>
<td>0.683</td>
<td>0.142</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

*AUC: Area Under Curve*
Secondary peritonitis developing in elder people doesn’t respond well to therapy and has high mortality rates. It is suggested that these facts are due to decreased physiological reserves and accompanying diseases. Simultaneous occurrences of hepatic and renal disorders, immune suppression and malignities increase mortality. Mortality remains high in patients with multiple physiological reserves and accompanying diseases. Secondary peritonitis developing in elder people doesn’t respond well to therapy and has high mortality rates. It is suggested that these facts are due to decreased physiological reserves and accompanying diseases. Simultaneous occurrences of hepatic and renal disorders, immune suppression and malignities increase mortality.

The authors thank Ilker Unal (Department of Biostatistics, University of Izmir) for help with statistical analysis.

Riassunto
La prima finalità di questo studio è quello di discutere i fattori che incidono sul tasso di mortalità nei pazienti con grave sepsi intra-addominale trattati con una relaparotomia programmata. La seconda finalità era quella di mettere a confronto il punteggio secondo i sistemi APACHE II, P-POSSUM e SAPS II nel consentire l’identificazione dei pazienti ad alto rischio. Sono stati arruolati nello studio 34 pazienti affetti da sepsi intraaddominale e trattati con una relaparotomia tra il gennaio 2009 e il gennaio 2012. Sono stati messi a confronto la sorgente della peritonite, il tipo e numero delle procedure chirurgiche, il numero delle relaparotomie piane, la sorveglianza microbiologica, la durata totale del ricovero in unità di terapia intensiva (ICU) e in degenza ordinaria, la durata in giorni dell’intubazione, la morbilità e la mortalità. Sono stati confrontati i punteggi APACHE II, SAPS II, P-POSSUM e l’ambito stimato della mortalità al ricovero. Tra i risultati l’età media dei pazienti era di 46 anni (tra 16 e 76) ed il 73.5% (n=25) si trattava di sesso maschile. Erano state eseguite un totale di 119 operazioni e 50 procedure chirurgiche. L’incidenza globale della mortalità è stata del 20,6% (n=7 pazienti); complicanze si sono verificate nel 53% dei casi (n=18 pazienti). La mortalità è stata più elevata in caso di deiscenze del tratto gastrointestinale superiore (6/20 contro 1/14 pazienti). L’area sotto la curva calcolata con l’analisi ROC per APACHE II, SAPS II e P-POSSUM era rispettivamente 0.958, 0.955 e 0.931. Il valore più elevato per sensibilità (100%) e specificità (85.2%) associato sono stati raggiunti in APACHE II. Se il valore di cut off veniva posto a 20,5.

Conclusion
As a result, we suggest that, in secondary peritonitis patients reserved for planned relaparotomy, APACHE II is more reliable for prediction of mortality and P-POSSUM scoring system is more reliable for prediction of overall hospital stay duration. However, for more dependable results, it is a fact that prospective, multi-centered studies with large patient series are required.
Il punteggio fisiologico SAPS II e P-POSSUM era correlato con la durata complessiva della degenza (rispettivamente p=0.022 r=0.438 e p=0.001 r=0.609), ma questa correlazione non è stata riscontrata per il punteggio APACHE II (p=0.085 r=0.337). ad ogni modo tutti e tre i sistemi di punteggio hanno provvisto una chiara stima della durata di permanenza della unità di terapia intensiva (ICU).

Quale conclusione si indica che nei pazienti con peritonite secondaria destinati ad una relaparotomia programmata APACHE II è più affidabile nel prevedere la mortalità mentre il sistema di punteggio P-POSSUM è più affidabile nella previsione della complessiva durata della degenza intra-ospedaliera.

References