Risk Stratification in Emergency Surgical Patients

Is the APACHE II Score a Reliable Marker of Physiological Impairment?

Thomas Koperna, MD, PhD; Dagmar Semmler, MD; Friedrich Marian, MD

Hypotheses: The APACHE II (Acute Physiology and Chronic Health Evaluation II) score used as an intensive care unit (ICU) admission score in emergency surgical patients is not independent of the effects of treatment and might lead to considerable bias in the comparability of defined groups of patients and in the evaluation of treatment policies. Postoperative monitoring with the APACHE II score is clinically irrelevant.

Design: Inception cohort study.

Setting: Secondary referral center.

Patients: Eighty-five consecutive emergency surgical patients admitted to the surgical ICU in 1999. The APACHE II score was calculated before surgery; after admission to the ICU; and on postoperative days 3, 7, and 10.

Main Outcome Measures: APACHE II scores and predicted and observed mortality rates.

Results: The mean ± SD APACHE II score of 24.2 ± 8.3 at admission to the ICU was approximately 36% greater than the initial APACHE II score of 17.8 ± 7.7, a difference that was highly statistically significant (P < .001). The overall mortality of 32% favorably corresponds with the predicted mortality of 34% according to the initial APACHE II score. However, the predicted mortality of 50% according to the APACHE II score at admission to the ICU was significantly different from the observed mortality rate (P = .02). In 40 long-term patients (≥10 days in the ICU), the difference between the APACHE II scores of survivors and patients who died was statistically significant on day 10 (P = .04).

Conclusions: For risk stratification in emergency surgical patients, it is essential to measure the APACHE II score before surgical treatment. Longitudinal APACHE II scoring reveals continuous improvement of the score in surviving patients but has no therapeutic relevance in the individual patient.


Many authors1-11 have proposed using the APACHE II (Acute Physiology and Chronic Health Evaluation II) score to compare the severity of disease in patients with intra-abdominal infection to make results of surgical treatment comparable in terms of severity of illness.

The APACHE II score contains not only physiological variables but also age points and chronic health evaluation points for the measurement of comorbid diseases. Nevertheless physiological variables have the utmost importance in the APACHE II score. On the other hand, the APACHE II score offers no opportunity to evaluate interventions, although interventions might significantly alter many of the physiological variables.

Because the APACHE II score was designed as an intensive care unit (ICU) admission score, many studies with surgical patients use it in that way regardless of the requirement that the score has to be independent of treatment. Although the APACHE II score is an admission score, longitudinal APACHE II scoring is also reported.

There is general agreement that mortality is mainly related to an overwhelming cytokine-mediated inflammatory response, which may lead to multiple organ dysfunction syndrome. On the other hand, the inability of elderly and frail patients to immunologically react against infection may contribute to an anergic state, which can also be recorded by the APACHE II score.5,6,11-16

Our aim was to elucidate the matter of timing in the calculation of the APACHE II score in emergency surgical patients and the clinical relevance of ICU admission and longitudinal APACHE II scores.
The APACHE II score at the beginning of treatment was 17.8±7.7 (range, 5-43), which was statistically significantly different from the APACHE II score of 24.2±8.3 (range, 10-42) calculated at admission to the ICU (P<.001). Only 10 of 85 patients had an initial APACHE II score greater than or equal to the score measured at admission to the ICU. Overall, the APACHE II score measured at ICU admission was about 36% greater than the initially calculated score, which showed a similar difference for each disease (Table 1).

For APACHE II scores measured before and after surgical treatment and on postoperative days 3, 7, and 10, multiple logistic regression analysis revealed statistically significant relations to patient survival (P=.003-.0001). Age also significantly affects outcome (P=.03). Overall, the APACHE II scores on days 7 and 10 showed a significant decrease compared with the score calculated before surgical treatment (P=.008 and P=.01, respectively), whereas the APACHE II score on day 3 was not different from the initial score (P=.32) (Table 2). In patients who died, there was no improvement in the APACHE II score.

Overall mortality was 32% and was highest for patients who underwent surgery for gastrointestinal tract bleeding and lowest for those who underwent surgery for trauma, and the observed mortality rates were considerably lower for peritonitis and bowel obstruction compared with the predicted mortality rates according to the APACHE II score (Table 1). Overall predicted mortality according to the APACHE II score was 34%, which did not significantly differ from the observed mortality rate for any disease and for any range of the APACHE II score (Figure 1). The APACHE II score measured at ICU admission was significantly higher than the initial APACHE II score (Tables 1 and 2). Therefore, overall predicted mortality of 50% differed significantly from observed mortality of 32%, especially in patients with an APACHE II score of 25 or greater (P=.02) (Figure 2).

In 40 patients treated for 10 days or more in the ICU, the APACHE II scores showed no improvement on days 7, 10, or any subsequent postoperative day in patients who died but continuously decreased in survivors. A statistically significant difference was achieved on day 10 (P=.04) (Figure 3).

The duration of surgery, 129.2±111.4 minutes (range, 20-855), varied considerably because of the different diseases and related surgical treatment.

The duration of ICU treatment was 14.7±16.9 days (range, 1-97), and the hospital stay was 27.8±23.3 days (range, 1-164). Eight of the 58 surviving patients needed nursing care at home after discharge from the hospital.

Because the APACHE II score is not specific for intra-abdominal infection, we intended to examine not only patients with secondary peritonitis but also those who underwent various emergency surgical procedures. Another aim was to compare the predicted mortality rate with the observed mortality rate at different points to demonstrate the best timing for the measurement of the APACHE II score.

**RESULTS**

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Clinical assessment for predicting mortality risk in patients admitted to an ICU shows similar sensitivity and specificity compared with various commonly used scores.26,30,31

The original APACHE II system was designed to predict mortality risks for stratification by assessing the patient independent of the effects of treatment, which therefore has to be before surgery. Nevertheless, the APACHE II score was primarily designed to stratify groups of ICU admissions prognostically.17 That is why some authors7,18,20,32-37 calculated the score after admission to the ICU regardless of preceeding surgical treatment. Other investigators2,5,6,9,24,28,38-47 calculated the APACHE II score using laboratory values and physiological data before surgical treatment. Especially in surgical patients, interventions might keep physiological variables stable, while these patients have undergone considerable physiological stress. On the other hand, emergency surgery might increase the postoperative APACHE II score because of the inability to effectively mask the physiological derangement caused by operative stress. These questions were previously addressed, but the difference was not measured before in earlier literature.21 We focused our attention on emergency surgical patients because pretreat-

<table>
<thead>
<tr>
<th>Disease</th>
<th>Patients, No.</th>
<th>Observed Mortality, %</th>
<th>APACHE II Score, Mean ± SD (Predicted Mortality, %)</th>
<th>P †</th>
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<tbody>
<tr>
<td>Peritonitis</td>
<td>34</td>
<td>38</td>
<td>19.9 ± 7.9 (50)</td>
<td>.001</td>
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<td>GI tract bleeding</td>
<td>11</td>
<td>46</td>
<td>21.4 ± 8.7 (38)</td>
<td>.02</td>
</tr>
<tr>
<td>GI tract obstruction</td>
<td>10</td>
<td>30</td>
<td>16.0 ± 5.8 (38)</td>
<td>.002</td>
</tr>
<tr>
<td>Trauma</td>
<td>21</td>
<td>19</td>
<td>16.6 ± 6.4 (15)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Vascular surgery</td>
<td>9</td>
<td>22</td>
<td>10.0 ± 4.0 (10)</td>
<td>.001</td>
</tr>
<tr>
<td>Total</td>
<td>85</td>
<td>32</td>
<td>17.8 ± 7.7 (34)</td>
<td>&lt;.001</td>
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*APACHE II indicates Acute Physiology and Chronic Health Evaluation II; GI, gastrointestinal.
†The significance of the difference is between APACHE1 and APACHE2 (analysis of variance).

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Table 2. APACHE II Scores in 85 Patients After Emergency Surgery and 25 Patients Who Died Measured Initially (APACHE1); After Admission to the Intensive Care Unit (APACHE2); and on Postoperative Days 3, 7, and 10 (APACHE3, 7 and 10, Respectively)*

![Figure 1. Observed and predicted mortality rates according to APACHE II (Acute Physiology and Chronic Health Evaluation II) scores calculated before surgery.](image1)

![Figure 2. Observed and predicted mortality rates according to APACHE II (Acute Physiology and Chronic Health Evaluation II) scores calculated after admission to the intensive care unit. There was a significant difference between overall observed and predicted mortality rates and between observed and predicted mortality rates at the APACHE II score of 25 or greater (P = .02).](image2)

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ment stratification for comparison of different groups of patients and prediction of mortality risk is of paramount importance in these patients. Comprising this selected group of patients, we could demonstrate a significant increase in the APACHE II score after surgical therapy.

If the APACHE II score is measured after admission to the ICU a lower mortality rate should be found compared with the predicted mortality rate according to the APACHE II score. \(^\text{18,32,33,35,37}\) Nevertheless, the mortality rate might also be equal to or higher than expected in patients in whom the APACHE II score has been calculated after surgery, which may be explained by a larger proportion of elective surgical patients,\(^\text{10,21,34,37}\) or a larger proportion of patients transferred after initial treatment elsewhere.\(^\text{7}\)

After elective surgery, patients might have a lower APACHE II score at admission to the ICU than before surgical treatment because of preceeding interventions. In many studies, patients are poorly defined and measurement of the APACHE II score differs considerably, making results of treatment difficult or nearly impossible to compare.

Overall, the APACHE II score has been found variously to underestimate or overestimate death, especially in high-risk patients.\(^\text{1,36,37}\) Criticism about the prognostic strength of the APACHE II score also arose when postoperative peritonitis and necrotizing pancreatitis were found to be associated with considerably higher mortality rates than expected,\(^\text{38,45}\) which, however, may be because laboratory values had been corrected, resulting in too low APACHE II scores.\(^\text{37}\) Aggressive surgical treatment in patients with severe intra-abdominal infection may also significantly decrease postoperative mortality, whereas the impossibility of eradicating the source of infection initially significantly increases the postoperative mortality rate.\(^\text{4,7,46-48}\) For a superior prediction of mortality in patients with intra-abdominal sepsis, the combination of the multiple organ dysfunction syndrome score according to Goris et al\(^\text{59}\) or the Mannheimer Peritonitis Index\(^\text{50}\) together with the APACHE II score has been proposed.\(^\text{4,6,34,42}\) For a higher predictive value, the APACHE III score also includes values for preliminary treatment before admission to the ICU.\(^\text{10,51}\)

In trauma patients, the observed mortality rate was significantly higher than the predicted mortality rate.\(^\text{52,53}\) These results suggest that the APACHE II score may not be applicable in these patients. Indeed, in our patients, the observed mortality rate was higher than the expected mortality rate but did not show a significant difference. It was also found that in patients with ruptured abdominal aortic aneurysms, the predicted mortality rate is too low and precise prediction of outcome is impossible.\(^\text{54}\)

According to our results, a continuous decrease in the APACHE II score in long-term patients from day 7 on is associated with a favorable outcome, whereas an increase in the APACHE II score strongly predicts death.\(^\text{21,44}\) However, in the individual patient, clinical significance of longitudinal APACHE II scoring seems to be limited, especially in making decisions regarding relaparotomies.\(^\text{55,6,20,21,43,44}\) Nevertheless, also in the individual patient, a trend toward survival or death may be seen after 7 to 10 days of ICU treatment. In any case, the APACHE II score loses its predictive value for outcome when it is calculated during the ICU stay.\(^\text{7,21}\)

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