Predictive value of POSSUM score in surgery of acute abdomen in cirrhotic patients

Banu P, Popa F, Constantin VD, Balalau C
“Carol Davila” University of Medicine and Pharmacy, Bucharest, General Surgery Department, “Sf. Pantelimon” Hospital, Bucharest

Correspondence to: Banu Petrisor, MD,
General Surgery Department, “Sf. Pantelimon” Emergency Hospital, 340 – 342 Pantelimon Road, District 2, Bucharest
Phone: 004 0788363814, E-mail: ptrbanu@gmail.com

Received: June 7th, 2013 – Accepted: September 30th, 2013

Abstract
Introduction: As liver cirrhosis has an increasing incidence in the general population and the life expectancy for these patients has increased, surgery procedures practiced for acute abdomen in such category of patients are more frequent.
Aim: To evaluate the predictive value of POSSUM score in cirrhotic patients undergoing abdominal surgery in emergency cases.
Material and method: A prospective study based on 115 consecutive patients with liver cirrhosis hospitalized and operated in the first 24 hours from admission for acute abdomen. The patients’ stratification was done by using Child Pugh score for liver cirrhosis. POSSUM score was calculated for each patient and postoperative outcomes were compared with prediction based on this score. Statistical data analysis was made by using the chi-square test and a p value of less than 0.05 was considered to be statistically significant.
Results: There were 33 patients in stage Child A of cirrhosis, 54 in stage Child B and 28 in stage Child C. For Child A group, the POSSUM score had a satisfactory prediction in terms of morbidity and mortality. In advanced stages of liver cirrhosis, Child B and C, mortality had high rate and the observed outcomes were outside the area of POSSUM score prediction.
Conclusions: POSSUM score offers a satisfactory prediction for morbidity and mortality in emergency abdominal surgery for patients in compensated stages of liver cirrhosis. In advanced stages of cirrhosis high levels of mortality cannot be predicted by using POSSUM score.

Keywords: audit, liver cirrhosis, acute abdomen

Introduction
Liver cirrhosis has an increasing incidence in the general population. It is estimated that, in Europe, there are 170,000 annual deaths due to this cause with major differences between regions. Thus, in the south-east cirrhosis mortality rate is 10-20 times higher than the rest of the continent.

Romania is situated on the second place with figures of 64 males and 26.7 females considering the death rate per 100,000 population. The main causes of the disease are represented by chronic alcohol consumption, infections with hepatitis viruses B and C, and obesity related metabolic syndromes.

In these circumstances, abdominal surgery in patients with liver cirrhosis has an increasing frequency. Liver cirrhosis is a chronic and slowly progressive disease characterized by a replacement of normal liver tissue with scars. Liver function is progressively altered leading to hepatic failure.

The effects of cirrhosis are not limited to liver function, but also affect other organs and systems. The renal, cardiac and respiratory functions are also adversely affected. These, along with coagulation disorders and immune deficiency create premises of a high-risk surgical ground.

Surgery for “acute abdomen” in such patients has a high mortality rate and requires special measures of resuscitation.

Copeland and al. proposed, in 1991, The Physiologic and Operative Score for enUmeration of Mortality and Morbidity (POSSUM) as a scoring system for the surgical audit. Considering both pre- and intra-operative commonly measured parameters, this score is easy to use and has a wide application for general surgery in emergency and elective procedures.

The aim of the present study is to evaluate the accuracy of POSSUM score in predicting outcomes after emergency abdominal surgery in patients with liver cirrhosis.

Material and method
Our study is based on a prospective analysis between January 2008 and December 2012 on 115 consecutive patients with liver cirrhosis hospitalized and
operated for acute surgical abdomen in Surgery Clinic of “Sf. Pantelimon” Hospital in Bucharest. The criteria for the patients' inclusion in the group were the following:
- Liver cirrhosis as a background disease
- The presence of an abdominal surgical problem whose solution was imposed in the first 24 from admission as an emergency solution.

In order to assess the determinant factors of postoperative morbidity and mortality in these patients we considered the following:
- Evolutive stage of the liver disease
- Physiological status of the patient at the moment of operation
- Type and magnitude of the surgical procedure

For the staging of the liver cirrhosis we choose Child – Pugh classification. This classification is an useful instrument in emergency conditions because of its small number of parameters which can be rapidly evaluated – serum albumin level, total bilirubin, prothrombin time INR, the presence and grade of ascites and grade of encephalopathy [8].

This score has proven its usefulness in many studies involving patients with liver cirrhosis, whether it was the rupture of esophageal varices, hepatocellular carcinoma, Budd-Chiari syndrome or portal subclinical encephalopathy [9-12].

In a study conducted over a period of 12 years Mansour used Child – Pugh score as a prognosis factor for non hepatic abdominal surgery [13].

Despite the criticism that brings into question that the score is based upon components empirically chosen or that its variables are not independent predictors, studies show that the data obtained with this score have statistical significance [14].

In light of the above, Child-Pugh score remains an instrument which is easy to use in the evaluation of the prognosis of the patient with liver cirrhosis and its predictive value is at least comparable to some elaborated scores such as MELD [15], elements which have imposed their use in our study.

The physiological status of patients and magnitude of surgery procedure were evaluated based on the POSSUM score.

This score quantifies twelve significant and independent physiological variables which evaluate the physiological status of the patient at the time of surgery. The patient's respiratory and cardiac function are assessed by using information that can be obtained quickly and easily by clinical and laboratory common methods - the presence and degree of dyspnea and its degree of severity, chest X-ray appearance, presence of arrhythmias on the electrocardiogram, blood pressure, pulse, the presence of angina or an underlying heart disease requiring inotropic therapy or anticoagulant. In addition to these are the laboratory tests such as hemoglobin, WBC count, blood urea nitrogen, sodium and potassium. Moreover, the patient's age and Glasgow score are also considered. The values obtained for the physiological score calculated at the time of intervention can have values between 12 and 88 (Table 1).

| Table 1. POSSUM physiological score according to Copeland and al. |
|---------------------------------------------------------------|
| **Age (years)** | ≤60 | 61 - 70 | ≥71 | ≥8 |
| **Cardiac signs** | No failure | Diuretic, digoxin, antianginal or hypertensive therapy | Peripheral edema; warfarin therapy | Raised jugular venous pressure |
| **Respiratory history** | No dyspnea | Dyspnea on exertion | Borderline cardiomegaly | Cardiomegaly |
| **Blood pressure (systolic)** | 110-130 | 131 - 170 | ≥171 | ≥89 |
| **Pulse (beats/min)** | 50-80 | 81 – 100 | 101 – 120 | ≥121 |
| **Glasgow coma score** | 15 | 12 – 14 | 9 – 11 | ≤8 |
| **Hemoglobin (g/100ml)** | 13 – 16 | 11.5 – 12.9 | 10 – 11.4 | ≤9.9 |
| **White cell count (x10^9/l)** | 4 – 10 | 10.1 – 20 | ≥20.1 | ≤3 |
| **Serum urea (mmol/l)** | ≤7.5 | 7.6 – 10 | 10.1 – 15 | ≥15 |
| **Serum sodium (mmol/l)** | ≥136 | 131 – 135 | 126 – 130 | ≤125 |
| **Serum potassium (mmol/l)** | 3.5 – 5 | 3.2 – 3.4 | 2.9 – 3.1 | ≤2.8 |
| **Electrocardiogram** | Normal | Atrial fibrillation | Any other abnormal rhythm | Of 25 ectopics/min Q waves or ST/T wave changes |

Surgical trauma is evaluated based on six factors of the severity of procedure. This is classified into four categories taking into account the extent of surgery, emergency or elective nature of the operation, amount of
blood lost during surgery, duration, peritoneal contamination and the presence / extension of a neoplasm (Table 2).

Once the score is known, it is possible to estimate the risk of morbidity (R2) and mortality (R1) by using two equations. For morbidity the equation is the following:

\[
\log \left( \frac{R2}{1-R2} \right) = -5.91 + (0.16 \times \text{physiological score}) + (0.19 \times \text{severity score of the surgical procedure})
\]

For mortality the equation is the following:

\[
\log \left( \frac{R1}{1-R1} \right) = -7.04 + (0.13 \times \text{physiological score}) + (0.16 \times \text{severity score of the surgical procedure}).
\]

The physiological score was assessed at the time of surgery and the operative score at the moment of the patient’s discharge.

Comparing the obtained results with those estimated by using POSSUM score, we tried an appreciation of the influence upon postoperative outcome of the physiological status and evolution stage of liver cirrhosis in these patients.

Statistical data analysis was based on \(X^2\) (chi-square) test and the p value of less than 0.05 was considered statistically significant.

| Table 2. POSSUM operative severity score |
|-----------------------------------------|
| Operative severity | 1 | 2 | 4 | 8 |
| Multiple procedures | Minor | Moderate | Major | Major+ |
| Total blood loss (ml) | ≤100 | 101 – 500 | 501 – 999 | ≥1000 |
| Peritoneal soilin | None | Minor (serous fluid) | Local pus | Free bowel content, pus or blood |
| Presence of malignancy | None | Primary only | Nodal metastases | Distant metastases |
| Mode of surgery | Elective | Emergency resuscitation of > 2 h possible | Operation < 24 h after admission |

Results

Our group was composed of 115 patients, 45 females (39%) and 70 males (61%) and their ages ranged from 29 to 85 years, with an average of 60.27.

The etiology of liver cirrhosis in patients represented in our group was especially chronic consumption of ethanol and hepatitis virus infections, groups including 102 cases - 60 and 42 patients, respectively. To these 8 cases of cardiac cirrhosis and other 5 in which the etiology could not be documented, being labeled as cryptogenic, were added.

The classification of patients into Child groups depending on the evolutionary stage of liver disease was the following: 33 of them (28.7%) were classified in group Child A, 54 (47%) in Child B stage and 28 (24.3%) in group Child C (Fig. 1).

![Fig. 1 Distribution of patients with regard to Child Pugh score](image1)

The preoperative assessment based on the physiological POSSUM score resulted in dividing the patients into the following groups score: below 15,5 cases; 23 cases with a score between 16 and 18, 28 cases with 19 to 21 points, 32 cases with 22 to 24 points, 18 cases with 25 to 27 points, 7 cases with 28 to 30 points, 2 cases over 30 points (Fig. 2).

![Fig. 2 Distribution of patients with regard to physiological score](image2)

The pathological conditions in our group of 115 patients who required emergent surgery were the following: 22 cases of complicated umbilical hernias, 12 complicated postoperative incision hernias, 8 complicated inguinal hernia, 35 acute cholecystitis, 14 peptic ulcer bleeding, 6 perforated ulcer, 3 penetrating abdominal wounds, 4 acute appendicitis, 2 traumatic ruptures of spleen, 2 choledocholithiasis with cholangitis, 7 bowel obstructions.

Surgery procedures practiced in emergency conditions – in the first 24 hours from admission – on our group of patients were the following: splenectomies – 2 cases, umbilical hernia repair – 22 cases, inguinal hernia repair – 8 cases, incision hernia repair – 12 cases, suture of ulcer perforation – 3 cases, excision of ulcer – 2 cases,
gastric resection – 5 cases, gastrotomy with hemostasis *in situ* for bleeding ulcer – 10 cases, resection of small intestine – 3 cases, appendectomy – 4 cases, right hemicolectomy – one case, transverse colon segmental resection – one case, Hartmann operations – 2 cases, laparoscopic cholecystectomy – 21 cases, open cholecystectomy – 14 cases, laparotomy – 3 cases, cholecotony with Kehr drainage – 2 cases.

Calculating POSSUM operator score for our patients resulted in a classification into the following groups: 31 patients with a POSSUM operator score below 10, 42 patients with a score between 11 and 13; 14 patients had a score of 14 to 16; 26 cases with 17 to 19 points; 2 patients with 20 – 22 points (Fig. 3).

The estimated mortality risk in our group based on POSSUM score was the following: less than 5% - 22 patients (19%); risk between 6% and 10% - 37 patients (32%); risk 11% to 15% - 23 patients (20%); 16% to 20% mortality risk – 9 patients (7.8%); 21% to 25% - 10 patients (8.7%); over 25% risk – 14 patients (12%) (Fig. 4).

| DEATHS | CHILD A | CHILD B | CHILD C |
|--------|--------|--------|--------|
| Observed (O) | 4 | 29 | 19 |
| Estimated (E) | 3 | 8 | 4 |

The group of patients in stage Child A of liver cirrhosis had a morbidity of 48.5% (16 cases) and a mortality rate of 9.7% (4 cases).

Based on POSSUM score estimation, morbidity in these patients would have a percentage of 42.54 and a mortality rate of 9.1%, values which are quite similar to those registered by us.

The ratio O / E for patients with liver cirrhosis in stage Child A was 1.1 for morbidity and 1.2 for mortality.

The null hypothesis was that the evolutionary stages of liver cirrhosis had no influence on POSSUM score prediction ability.

The statistical analysis based on $X^2$ test ("goodness of fit") for mortality occurred in patients belonging to Child class A, which resulted in the following value:

$$X^2=(1, n=33) =0.36, p<0.05$$

The critical value for $X^2$ is 3.84, placing the result in the acceptance area.

Regarding the capacity of POSSUM score to estimate morbidity for our patients in stage Child A of liver disease, the statistical analysis based on $X^2$ test resulted in the following value:

$$X^2=(1, n=33)=0.35, p<0.05$$

Consequently, the predictive value of POSSUM scores in patients with liver cirrhosis in stage Child A was satisfactory both in terms of morbidity and mortality.

We found an exponential increase in the mortality rate – 29 deaths from 54 – for patients in Child B stage of liver cirrhosis representing 53.7%.

The estimated rate of mortality based on POSSUM score for this group of patients was of 14% - 8 deaths. Thus, the observed/estimated ratio was 3.8/1 and the value for $X^2=(1, n=54)=64.7, p<0.05$, placing the result in the rejection area.

Of the 25 patients of Child B group who were discharged, 22 had postoperative complications.

Patients in stage Child C of liver disease had the highest death rates – 19 from a total of 28, representing 67.85%.

Compared to a total of 4 deaths expected in this group based on POSSUM score prediction the ratio O/E is 4.75 and the value for $X^2$ in rejection area.

All 9 patients belonging to Child C stage who survived surgery had postoperative complications requiring prolonged hospitalization.

**Discussion**

Surgery for acute abdomen in a patient with liver cirrhosis is an unavoidable risk, but its quantification is particularly significant given that modern medicine is
based on analysis, objectivity and rigorous control of medical care quality.

The outcome of surgery depends not only on the skills of the operator, but is the result of several factors such as the physiological status of the patient, the condition requiring surgery, type of operation, but also the resources for preoperative and postoperative resuscitation which the hospital unit can provide.

Operative risk in a patient with cirrhosis can be approximated in a wide range on the evolutionary stage of the liver disease \[13,16\]. For the final result, the magnitude of the surgery and the patient's condition at the time of intervention are important factors to consider. POSSUM score has a satisfying predictive value quantifying and integrating in its equations both the physiological parameters and the magnitude of the procedure.

Cirrhotic patients undergoing abdominal surgery are at a high risk of hepatic decompensation due to reduced hepatic blood flow during such interventions \[17,18\].

Considering all these elements in a 5-year study on a group of 115 patients hospitalized and operated in emergency for various conditions that can be defined as "acute abdomen" we assessed the grade of influence of the liver disease, physiological status and amplitude of surgical procedure on the postoperative outcome.

The data obtained in our study showed that when there is a functional satisfactory hepatic reserve, as in stage Child A of liver cirrhosis, the patient can tolerate the surgical act satisfactorily. At this stage of liver disease, patients can fit in the same category with the other patients in terms of predictive ability of POSSUM score.

For the advanced stages of cirrhosis the high rates of mortality brought out the results from the prediction area provided by the POSSUM score. It suggests that patients in stages Child B and C of liver cirrhosis, emergency abdominal surgery has a major impact on the homeostasis and the resources for compensation are overloaded. Thus, in advanced stages, the liver disease has a prominent value for prognosis as against the POSSUM score.

Conclusions

Surgery for acute abdomen in patients with liver cirrhosis is a therapeutic challenge and for the surgeon it means taking an inevitably risk. The outcome of the surgical procedure is a resultant of multiple factors and some of them can be quantified and integrated in valuable predictive scores such as POSSUM.

According to our study, POSSUM score offers a satisfactory prediction for morbidity and mortality in emergency abdominal surgery for patients in compensated stages of liver cirrhosis – Child A. For the advanced cirrhosis stages, Child B and C, high levels of mortality cannot be predicted by using POSSUM score and liver disease has a prominent value in prognosis of this category of patients.

References

1. Zatoński WA, Sulikowska U, Mańczuk M, Rehm J, Boffetta P, Lowenfels AB, La Vecchia C. Liver cirrhosis mortality in Europe, with special attention to Central and Eastern Europe, European cancer research. 2010;16(4):193-201. doi: 10.1159/000317248.
2. Blachier M, Leleu H, Peck-Radosavljevic M, Valla DC, Roudot-Thoraval F. The burden of liver disease in Europe – a review of available epidemiological data. Journal of Hepatology. March 2013; 58, 3, 593-608.
3. Porter RS, Kaplan JL. The Merk Manual of Diagnosis and Therapy, 18th edition, 2011, Merk Sharp & Dohme Corp., Whitehouse Station NJ, 203 – 277.
4. Prashant B, Laurent A, Amathieu R, Blachier M, Leleu H, Peck-Radosavljevic M, Valla DC, Roudot-Thoraval F. The burden of liver disease in Europe – a review of available epidemiological data. Journal of Hepatology. March 2013; 58, 3, 593-608.
5. Porter RS, Kaplan JL. The Merk Manual of Diagnosis and Therapy, 18th edition, 2011, Merk Sharp & Dohme Corp., Whitehouse Station NJ, 203 – 277.
6. Jones HJS, de Cossart L. Risk scoring in surgical patients. British Journal of Surgery. 1999;86:149–157.
7. Copeland GPJ, Walters DM. POSSUM: a scoring system for surgical audit. British Journal of Surgery.1991;78:355-360.
8. Jones HJS, de Cossart L. Risk scoring in surgical patients. British Journal of Surgery. 1999;86:149–157.
9. Child CG, Turcotte JG. Surgery and portal hypertension. In: Child CG, editor. The liver and portal hypertension. Philadelphia: W. B. Saunders Co., 1984; 50
10. Merkel C, Bolognesi M, Sacerdotti D, Bombonato G, Bellini B, Bighin R et al. The hemodynamic response to medical treatment of portal hypertension as a predictor of clinical effectiveness in the primary prophylaxis of variceal bleeding in cirrhosis. Hepatology. 2000;32:930–934.
11. Zironi G, Siringo S. Natural history of small untreated hepatocellular carcinoma in cirrhosis: a multivariate analysis of prognostic factors of tumor growth rate and patient survival. Hepatology. 1992;16:132–137.
12. Zeitoun G, Escolano S, Hadengue A, Azar N, El Younsi M, Mallet A et al. Outcome of Budd–Chiari syndrome: a multivariate analysis of factors related to survival including surgical portosystemic shunting. Hepatology. 1999;30:84–89.
13. Mansour A, Watson W, Shayani V, Pickleman J. Abdominal operations in patients with cirrhosis: still a major surgical challenge. Surgery. 1997 Oct;122(4):730–5; discussion 735-6.
14. Christensen E. Prognostic models in chronic liver disease: validity, usefulness and future role. J Hepatol. 1997;26:1414–1424.
15. Durand F, Valla D. Assessment of the prognosis of cirrhosis: Child–Pugh versus MELD. Journal of Hepatology. 2005; 42, S100–S107.
16. Friedman LS. The risk of surgery in patients with liver disease. Hepatology. 1999;29:1617–23.
17. O’Leary JG, Yachiminski PS, Friedman LS. Surgery in the patient with liver disease. Clinics in liver disease. 2009 May;13(2):211-31.
18. Sato K, Kawamura T, Wakusawa R. Hepatic blood flow and function in elderly patients undergoing laparoscopic cholecystectomy. Anesthesia and Analgesia. 2000 May; 90(5):1198-202.