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# The impact of serum albumin and serum protein levels on POSSUM score of patients with proximal femur fractures

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ABSTRACT

*Background:* POSSUM was developed to predict risk-adjusted mortality and morbidity rates for surgical procedures. We evaluated the impact of serum albumin and serum protein levels on POSSUM scores.
*Methods:* Medical files of 2269 patients operated for proximal femur fractures were reviewed. Preoperative serum albumin levels were available for 387 patients (mean 35.1 g/l, range 22–49) and serum protein levels for 279 patients (mean 61.6 g/l, range 40–86).
*Results:* Serum albumin and protein levels were inversely associated with mortality in multivariate models (albumin, OR = 0.89, $p = 0.009$; protein, OR = 0.92, $p = 0.009$) and in composite outcome models as well (albumin, OR = 0.955, $p = 0.219$, protein, OR = 0.94, $p = 0.014$). The area under the curve (AUC) for POSSUM prediction of mortality ($n = 1770$) was 0.632 (95% CI: 0.580–0.684, $p < 0.001$). The AUC for a model including serum protein levels was 0.742 (95% CI: 0.649–0.834, $p < 0.001$). Hospitalisation time was longer for patients with lower serum proteins levels ($p = 0.045$), with an inverse correlation (Pearson correlation −0.164, $p = 0.011$).
*Conclusions:* Lower preoperative serum albumin and serum protein levels were associated with increased risk for mortality, increased hospitalisation time and poorer outcomes in patients operated for proximal femoral fractures. Including those values to POSSUM scores would increase their predictive power.



## Introduction

The POSSUM (Physiologic and Operative Severity Score for the enUmeration of Mortality and morbidity) score was developed to predict risk-adjusted mortality and morbidity rates for surgical procedures, and found to be an efficient indicator [1]. These 12-variable factors, 4-grade physiologic and 6 operative-factor score were developed for the general spectrum of vascular, gastrointestinal, hepatobiliary, urological and miscellaneous surgeries. Various modifications of the original form were made to provide better prediction for different groups of patients, i.e., P-POSSUM (Portsmouth) [2], V-POSSUM (vascular) [3], and CR-POSSUM (colorectal) [4]. Mohamed et al. [5] developed an orthopaedic version using a modified operation classification. The orthopaedic POSSUM score (OPS) showed a close correlation between the overall observed rates for mortality and morbidity and the predictions derived from the POSSUM logistic regression equations. The OPS for patients with proximal femur fracture, an exclusive risk group, was further evaluated to predict mortality and morbidity [6–8].

Two parameters have not been included in POSSUM score, serum albumin and serum protein. Serum albumin is the main protein of the plasma, and its main function is to regulate the colloidal osmotic pressure of blood. In their meta-analysis, Goldwasser and Feldman [9] found that serum albumin concentration is inversely related to mortality risk in a graded manner over its entire range. It is well known that lower levels of serum albumin can predict mortality risk in proximal femur fracture patients [10,11]. Preoperative low serum albumin was associated with increased mortality and postoperative medical complications [12,13].

The aim of this study was to compare the impact of including serum albumin and serum protein levels when determining the physiological OPS for establishing the mortality and morbidity risks of patients with proximal femur fractures.

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## Patients and methods

### Study population

After obtaining the approval of our institutional review board, we retrospectively reviewed our organizational electronic database to retrieve the medical records of all patients who sustained a proximal femur fracture, intracapsular fractures (femoral neck fractures) and extracapsular fractures (inter- and sub-trochanteric fractures), and were admitted to our medical centre between January 2008 and December 2011. The physiologic and operative POSSUM score was assessed for 1770 out of 2269 patients from the electronic database, 816 intracapsular and 1453 extracapsular fractures. The preoperative serum albumin and serum protein levels were available for only 387 and 279 patients, respectively, since they are not routinely assessed, but their post hoc power analysis was above 95%.

### Definition of variables

The values for serum albumin and serum protein levels included in the current analysis were only those of the first samples after hospital arrival prior to surgery. "Physiologic" POSSUM parameters for urea nitrogen, natrium (Na), potassium (K), haemoglobin (Hg), and white blood cells (WBC) were defined as the last value prior to surgery. The definition of the parameter "cardiac signs" was based on the patient's list of diagnoses and medications at hospital admission. We defined "composite outcome" as the occurrence of any of the following: peri-operative, in-hospital or 30-day post-hospital discharge mortality, additional surgery during hospitalisation, 7-day hospital readmission, transfer to intensive care, peri-hospitalisation deep vein thrombosis, myocardial infarction, pulmonary or systemic embolism and prolonged hospitalisation.

### Statistical methods

The relative effect of serum albumin and serum protein levels when added to the components of the physiological OPS on outcome was compared by multivariate logistic regression models for mortality and composite outcome. The Charlson co-morbidity score, provision of intraoperative transfusions and time from hospital arrival to surgery were also assessed in the models. The predictive values of multivariate models with and without the inclusion of serum albumin and serum protein levels, and the predictive value expressed by the POSSUM score were assessed using the receiver operating characteristic (ROC) curve, comparing the area under the curve (AUC).

## Results

### Population characteristics

A total of 1088 (67.1%) out of 1770 patients were females. The patients' mean age was 80 years (range 19–107, SD 11.87 years, median 83 years). The mean Charlson co-morbidity score was 4.47 (SD 1.78, median 4). Physical health condition classification was evaluated by the American Society of Anesthesiologists (ASA) score, and it was defined as being "mild" (ASA = 1–2) for 42.2%, "moderate" (ASA = 3) for 50.6% and "severe" (ASA = 4–5) for 7.2% of our patients. The mean preoperative serum albumin level was 35.1 g/l (range, 22–49 g/l) and the mean serum protein level was 61.6 g/l (range, 40–86 g/l). Serum protein levels were decreased in the extracapsular group 60.56 (g/l) in comparison to the intracapsular group 62.85 g/l ($p = 0.008$), but there was no significant difference in the POSSUM score between the groups 23.04 and 23.06, respectively ($p = 0.941$).

### Multivariate models for mortality and composite outcome

Preoperative serum albumin and protein levels were inversely associated with mortality in the multivariate models (albumin g/L OR = 0.89, $p = 0.009$; protein g/L OR = 0.92, $p = 0.009$) and with composite outcome (albumin OR = 0.955, $p = 0.219$, protein OR = 0.94, $p = 0.014$) (Tables 1 and 2). In addition to the effect of serum albumin and protein on POSSUM results, it emerged that intraoperative transfusions, urea nitrogen and leukocytes may also affect the final predictive score to some degree.

### Comparing the predictive value of models

The predictive value of the POSSUM score ($n = 1770$) for mortality, as expressed by the AUC, was 0.632 (95% CI: 0.580–0.684, $p < 0.001$). AUC was calculated for two multivariate models in order to assess the contribution of the serum protein level data to predicting mortality. A model that included the OPS components, the Charlson score and the time from hospital admission to surgery ($n = 223$) performed similarly to the POSSUM score [AUC = 0.673 (95% CI: 0.587–0.758, $p = 0.001$)], but a model that also included serum protein levels performed better [AUC = 0.742 (95% CI: 0.649–0.758, $p = 0.001$) (Figs. 1 and 2).

**Table 1**
Multivariate model for peri-operative and peri-hospitalisation mortality in 279 patients with recorded serum protein levels.

| | Peri-operative mortality | | Peri-hospitalisation mortality | | Composite Outcome | |
|---|---|---|---|---|---|---|
| | OR | *p*-value | OR | *p*-value | OR | *p*-value |
| Age | 1.008 | 0.733 | 1.018 | 0.413 | 1.004 | 0.821 |
| Cardiac signs and drugs score | 0.820 | 0.309 | 0.939 | 0.713 | 1.057 | 0.704 |
| Systolic blood pressure | 0.992 | 0.245 | 0.992 | 0.189 | 0.995 | 0.294 |
| Heart rate | 1.003 | 0.798 | 1.005 | 0.538 | 0.999 | 0.916 |
| Urea nitrogen (mMol/dL) | 1.056 | 0.181 | 1.048 | 0.209 | **1.066** | **0.046** |
| Sodium | 1.004 | 0.938 | 1.006 | 0.896 | 1.031 | 0.419 |
| Potassium | 0.425 | 0.069 | 0.507 | 0.108 | 0.611 | 0.182 |
| Haemoglobin level | 1.215 | 0.199 | 1.082 | 0.558 | 1.050 | 0.674 |
| White blood cells | 1.100 | 0.091 | 1.097 | 0.064 | **1.116** | **0.013** |
| Intra-op.[a] transfusion | 4.072 | 0.073 | **5.182** | **0.016** | **4.434** | **0.020** |
| POSSUM ECG score | 0.938 | 0.865 | 1.279 | 0.342 | 1.267 | 0.309 |
| Charlson Score | 1.078 | 0.617 | 0.995 | 0.968 | 0.900 | 0.379 |
| Time to surgery (h) | 1.001 | 0.494 | 1.000 | 0.514 | 1.000 | 0.915 |
| Protein (gr/l) | **0.932** | **0.046** | **0.922** | **0.009** | **0.937** | **0.014** |

Bold indicates a significant statistic result.
[a] Intra-op., intra-operative.