

## SYSTOLIC BLOOD PRESSURE IS A VALID MARKER OF IN-HOSPITAL SURVIVAL IN ACUTE CARDIOGENIC PULMONARY EDEMA - ANALYSIS OF 1.397 PATIENTS

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Bearing in mind the prevalence and dramatic clinical picture of acute cardiogenic pulmonary edema (ACPE), as well as impermissibly great early and late mortality, the goal of this paper was to examine if blood pressure (BP) is a predictor of in-hospital outcomes in ACPE. The analysis includes 1.397 patients with ACPE, treated at the Department for Cardiovascular Diseases, Clinical center, Niš, from 1993-2005. According to systolic blood pressure (SBP) on admission, patients were divided into three groups: low SBP (L; <100mmHg), normal SBP (N; 100-139 mmHg) and high BP (H; ≥140mmHg). In-hospital mortality was significantly higher in the subgroup of L vs N (62.75% vs 15.79%,  $p<0.001$ ), as well as in the subgroup N vs H (15.79% compared to 7.26%;  $p<0.0001$ ).

Serum creatinine concentration was significantly higher in the subgroup of L vs N; the level of Na<sup>+</sup>, the thickness of the interventricular septum in diastole and the prevalence of preserved LV contractile function were higher in the subgroup H compared to N; the concentration of K<sup>+</sup> in serum was higher in subgroup L vs H and AF was more represented in the L subset as compared with the N subset.

Therefore, the systolic BP is an important predictor of in-hospital survival, not only in AMI, but in acute cardiogenic pulmonary edema, too. In the study including the largest homogeneous group of patients with acute cardiogenic pulmonary edema without AMI (1.397 persons), we found that patients with hypotension (systolic BP<100 mmHg) died in hospital about 9 times more often (62.75% vs 7.26%) than patients with elevated systolic BP on admission. *Acta Medica Medianae* 2015;54(3):45-50.

**Key words:** acute cardiogenic pulmonary edema, blood pressure, sodium, potassium, prognosis

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ty, compromised quality of life, numerous comorbidities, high treatment cost (1-4). General prevalence of HF in Europe is 1-2% and significantly higher among those older than 60 years: over 10% for men and 8% for women. Acute HF has high annual mortality: 20-30% (5, 6).

Acute cardiogenic pulmonary edema (ACPE) is the most difficult type of retrograde failure of the left heart and represents 16.2% of acute HF; the direct triggers are: hypertensive crisis, arrhythmia (including atrial fibrillation (AF), acute myocardial infarction (AMI) myocardial ischemia without necrosis of cardiomyocytes, valvulopathy, infection (particularly of the lungs), anemia, inadequate medication, etc. (5, 7-14). Depending on concrete etiopathogenetic factors, therapy should be tailored to each individual patient (6, 9). As the heart impact is an important component of blood pressure (BP), especially of the systolic BP, insufficient left ventricle (LV), in general, is not able to raise BP. Therefore, BP is low in complicated forms of chronic and even acute HF.

### Introduction

Heart failure (HF) is a very important medical, and therefore a social problem for many reasons: high and growing prevalence, high mortality

## Aims

The aim of this work was to examine if the BP is an indicator of in-hospital mortality in ACPE.

## Patients and methods

The analysis covers 1397 patients having ACPE, with rates >50% at lung fields at auscultation, as well as with oxygen saturation <95%, who were hospitalized at the Department for Cardiovascular Diseases, Clinical Center Niš, from 1993-2005. There were 50.90% men with the average age of 69.98±9.45 years (23-94 years). AMI was the exclusion criterion, but shock was not. According to the systolic BP (SBP) at the time of hospitalization, patients were divided in three subgroups:

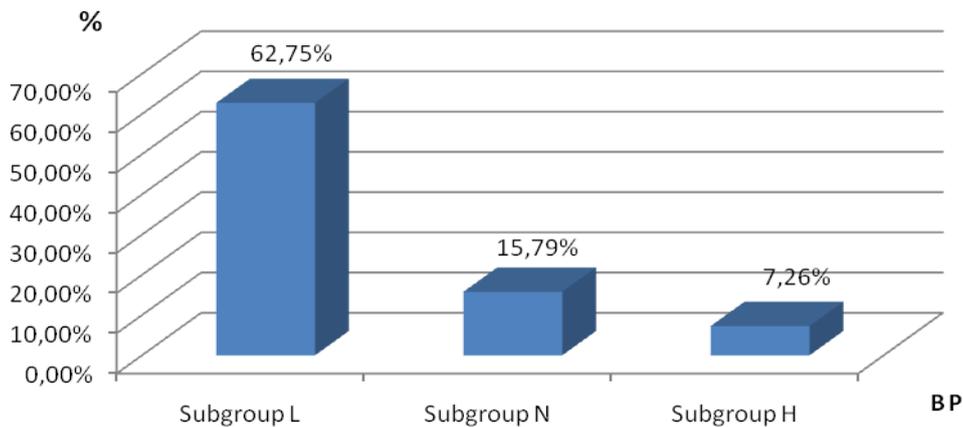
with low SBP (L; <100 mmHg), normal SBP (N; 100-139 mmHg), and high SBP (H; >140 mmHg) (1, 15).

Global LV contractile function is considered preserved if the LV ejection fraction (EF) was ≥45%, according to numerous publications, but without definitive evidence (5, 16). Statistical analysis were performed using commercial software (SPSS, Chicago, Illinois, version 19). A p value <0.05 was considered statistically significant.

## Results

More females were in the subgroup H compared with the subgroup N: 54.8% vs 44.6%;  $p < 0.01$ . In-hospital mortality was significantly higher in the subgroup L vs N (62.75% vs 15.79%,  $p < 0.001$ ), as well as in the subgroup N vs H (15.79%

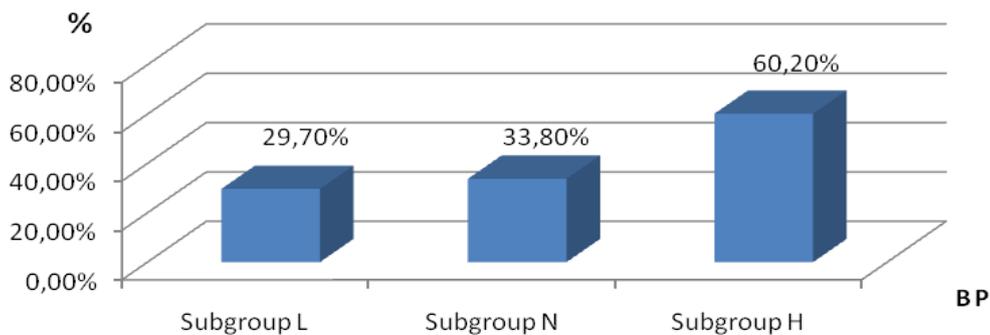
**Graph 1: In-hospital mortality of patients with acute cardiogenic pulmonary edema**



**Figure 1: In-hospital mortality of patients with acute cardiogenic pulmonary edema**

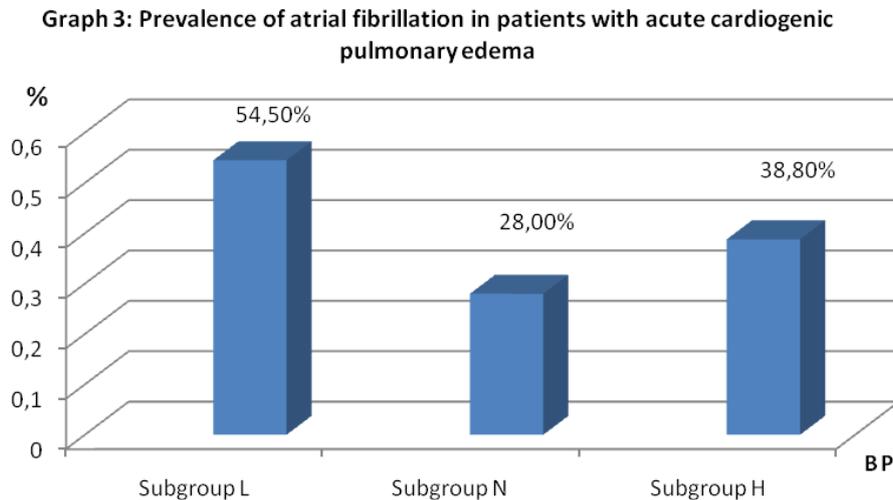
\*subgroup L: with low BP (L<100mmHg), subgroup N: with normal BP (N=100-139mmHg) and subgroup H: with high BP (H≥140mmHg); L vs N  $p < 0.000001$ ; N vs H  $p = 0.00018$ .

**Graph 2: Prevalence of preserved left ventricular global contractile function in patients with acute cardiogenic pulmonary edema**



**Figure 2: Prevalence of preserved left ventricular global contractile function in patients with acute cardiogenic pulmonary edema**

\*subgroup L: with low BP (L<100mmHg), subgroup N: with normal BP (N=100-139mmHg) and subgroup H: with high BP (H≥140mmHg); H vs N  $p = 0.0002$



**Figure 3:** Prevalence of atrial fibrillation in patients with acute cardiogenic pulmonary edema

\*subgroup L: with low BP ( $L < 100 \text{ mmHg}$ ), subgroup N: with normal BP ( $N = 100\text{-}139 \text{ mmHg}$ ) and subgroup H: with high BP ( $H \geq 140 \text{ mmHg}$ ); L vs N  $p = 0.0004$

compared to 7.26%;  $p < 0.001$ ) (Figure 1).

Serum creatinine concentration was significantly higher in the subgroup L than in the subgroup N ( $150.1 \pm 75.6$  vs  $118.2 \pm 52.0$  mmol/L;  $p < 0.05$ ). Blood sodium level was higher in the subgroup H as compared to N ( $140.1 \pm 3.6$  vs  $139.0 \pm 4.3$  mmol/L,  $p < 0.05$ ). Serum potassium level was higher in the subgroup H vs L ( $4.87 \pm 0.58$  vs  $4.46 \pm 0.70$  mmol/L;  $p < 0.05$ ). The prevalence of preserved global LV contractile function was higher in the subgroup H compared to subgroup N (60.2% vs 33.8%;  $p < 0.001$ ) (Figure 2).

Interventricular septum thickness in the diastole (measured by echocardiography) was higher in the subgroup H than N ( $12.4 \pm 2.4$  vs  $11.4 \pm 2.8$  mm,  $p < 0.05$ ). AF was more prevalent in the subgroup L vs N (54.5% compared to 28.0%;  $p < 0.001$ ) (Figure 3).

There were no statistically significant differences among subgroups in other tested parameters, such as age, prevalence of diabetes mellitus, serum glucose levels and LV diastolic diameter.

## Discussion

Our finding that more females were in the subgroup H compared to subgroup N was due to the fact that arterial hypertension is a very common cause of HF in older women and is often characterized by preserved LV global systolic function (3, 17).

The probability of surviving hospitalization was directly proportional to the value of SBP on admission, with large, nine-fold gradient between those with high and low BP (Figure 1). It is known that SBP is essential for the prognosis of acute HF, as well as AMI (1, 18). Pulmonary edema is a form of acute HF and the most severe type of retrograde LV failure. In this study we have confirmed

that systolic BP was a valid prognostic parameter in ACEP. The confirmation is reliable, given the large number of examined patients. Therefore, in ACEP patients without AMI, SBP as an extremely simple and universally available marker was able to stratify patients according to the risk of death. The explanation is obvious: high BP in ACEP is both the cause and a consequence of the severity of the disease and consequent stress and involves mainly good inotropic and chronotropic response to excessive myocardial sympathetic and catecholamine stimulation. In a large registry, almost half of the hospitalized patients with HF had BP  $> 140/90$  mmHg (3).

In addition to prognostication, this recognition of the importance of higher SBP as a marker of in-hospital survival has therapeutic implications (19-21). It is necessary to take a lot of care not to reduce the BP excessively. Noninvasive ventilation with positive pressure may be useful (22, 23). It helps to preserve lung function and provides condition for better BP control, by liberalization infusion of fluids in part. SBP was a significantly better marker of in-hospital survival compared with DBP in our patients with ACEP. It is unusual that we have shown just the opposite for long-term survival (24). A meaningful explanation is that there is prognostic information both in SBP (which is largely related to the LV global contractility and more important in the acute phase of pulmonary edema) and in DBP (which is in relation to peripheral vascular resistance, and thus the organ perfusion pressure, including vital ones, which is important for the long-term prognosis of ACEP patients).

The finding that the serum creatinine and  $K^+$  levels were significantly higher in the L vs N subgroup is probably due to the acute prerenal kidney damage. All the more so because the vast

majority of patients with chronic kidney disease (CKD) have arterial hypertension, and in the absence of acute prerenal kidney damage one would expect a higher not lower BP in those patients with ACEP, who have CKD (25).

The results of this work (that a subgroup of patients with higher SBP on admission has more pronounced thickening of the interventricular septum and that this H subgroup has more patients with preserved LV systolic function) can be easily explained by the higher prevalence of arterial hypertension (3). High BP can trigger ACEP, but once when a patient is in ACEP, deterioration of clinical course toward shock is less likely.

AF is almost twice more prevalent in the subgroup with low BP. There are two rational explanations of this situation:

1. AF reduces cardiac output, and, consequently, the BP.
2. AF and low BP are both the consequences of the reduced LV function.

AF is common in acute heart failure and a marker of bad prognosis during hospital stay and after discharge, despite continuous improving the prognostic trend in acute heart failure (26).

Due to great importance of AF in HF, the new European Society of Cardiology (ESC) Guidelines advice is to search for other possible causes of AF (like hyperthyreosis), triggers (like alcohol abuse), and to evaluate a need for anticoagulant therapy (3).

### Conclusion

Systolic BP is an important predictor of in-hospital survival, not only in acute myocardial infarction, but also in acute cardiogenic pulmonary edema. In the study including the largest homogeneous group of patients with acute cardiogenic pulmonary edema without AMI (1.397 persons), we realized that patients with hypotension on admission (systolic BP <100 mmHg) died in hospital about 9 times more often (62.75% vs 7.26%) than patients with elevated systolic BP on admission.

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## SISTOLNI KRVNI PRITISAK JE VALIDAN MARKER INTRAHOSPITALNOG PREŽIVLJAVANJA U AKUTNOM KARDIOGENOM EDEMU PLUĆA - ANALIZA 1 397 BOLESNIKA

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Imajući u vidu učestalost i dramatičnu kliničku sliku akutnog kardiogenog edema pluća (AKEP), kao i nedopustivo veliki rani i kasni mortalitet, cilj rada bio je da ispita da li je krvni pritisak (KP) prediktor intrahospitalnog ishoda u AKEP. Analiza je obuhvatila 1 397 bolesnika sa AKEP, lečenih u Klinici za kardiovaskularne bolesti Kliničkog centra u Nišu u periodu 1993-2005. Prema sistolnom KP (sKP) pri prijemu, bolesnici su podeljeni u tri podgrupe: sa niskim sKP (L; <100mmHg), normalnim sKP (N; 100-139 mmHg) i visokim sKP (H; ≥140 mmHg). Mortalitet u bolnici je bio znatno veći u podgrupi L vs N (62,75% vs 15,79%, p<0,001), kao i u podgrupi N vs H (15,79% u odnosu na 7,26%; p<0,001).

Koncentracija kreatinina u serumu bila je statistički značajno veća u podgrupi L vs N, nivo Na<sup>+</sup> u serumu, debljina interventrikularnog septuma u dijastoli i zastupljenost očuvane globalne kontraktilne funkcije LK bile su veće u podgrupi H u odnosu na N, koncentracija K<sup>+</sup> u serumu je bila veća u podgrupi L vs H, a atrijska fibrilacija (AF) zastupljena u podgrupi L u poređenju sa podgrupom N.

Dakle, sistolni KP je važan prediktor intrahospitalnog preživljavanja, ne samo u AIM, već i u akutnom kardiogenom edemu pluća. U najvećoj do sada publikovanoj homogenoj grupi bolesnika sa akutnim kardiogenim edemom pluća bez AIM (1 397 osoba) utvrdili smo da su bolesnici sa hipotenzijom (sistolni KP <100 mmHg) umirali u bolnici oko 9 puta češće (62,75% prema 7,26%) od bolesnika sa povišenim sKP pri prijemu. *Acta Medica Medianae 2015; 54(3):45-50.*

**Ključne reči:** akutni kardiogeni plućni edem, krvni pritisak, natrijum, kalijum, prognoza