

Right ventricular dysfunction assessment in hemodynamically stable pulmonary embolism patients with bedside echocardiography and cardiac biomarkers



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Introduction

According to recent studies echocardiography and cardiac biomarkers (BNP, NT-proBNP, cTnT) are useful tools in assessment of right ventricular dysfunction (RVD) and they have a high diagnostic and prognostic value in pulmonary embolism (PE) patients, since almost 50% of them have at least one echocardiography sign of the right heart dysfunction. Echocardiography is a diagnostic method of choice in hemodynamically unstable PE patients without possibility of urgent MSCT pulmonary artery angiography.¹ Role of echocardiography in hemodynamically stable PE patients is primarily reserved for additional evaluation of the early mortality risk, since right ventricular dysfunction due to PE predicts increased PE-related mortality in normotensive and hypotensive patients.²

Objectives

The aim of present study was to evaluate the prognostic value of bedside echocardiography and cardiac biomarkers in RVD assessment of hemodynamically stable PE patients associated with early adverse outcome.

Methods

A single-center prospective study of PE patients was conducted at the medical Intensive Care Unit, Sisters of Mercy University Hospital, Zagreb, Croatia in 2010/2011. Acute PE was confirmed with MSCT angiography. The patients were divided into three severity groups: high- (n=33; 31.7%), intermediate- (n=51; 49.1%) and low-risk (n=20; 19.2%) patients. BNP, NT-proBNP, and cTnT were measured at admission, 6, 12, 24 and 72 hours following admission. Echocardiography was performed within 24 hours. The main outcome parameter was in-hospital death.

Results

Out of 104 patients, 19 (18.7%) died, none of whom was in the low-risk group (P<0.001). Mean patients age was 68.7±13.4 years with female predominance (63.5%). The investigated data confirmed the hypothesis that echocardiography and increased levels of NT-proBNP and cTnT successfully detected PE patients with RVD. This was especially evident in the group of hemodynamically stable patients where echocardiography [61 (85.9%) out of 71 patients; (P<0.001)], NT-proBNP (P=0.006), and cTnT (P=0.037) demonstrated a correlation with RVD. Echocardiography sensitivity in RVD assessment was 98.04% with a specificity of 45%. Effectiveness of echocardiography as a RVD diagnostic tool was assessed with odds ratio [OR: 40.09 (95% CI 4.54-1826.84)]. Right ventricular dilatation, free wall motion abnormalities, tricuspid regurgitation, pulmonary hypertension and paradoxical movements of the interventricular septum were correlated with RVD (P<0.001 for all), Table 1.

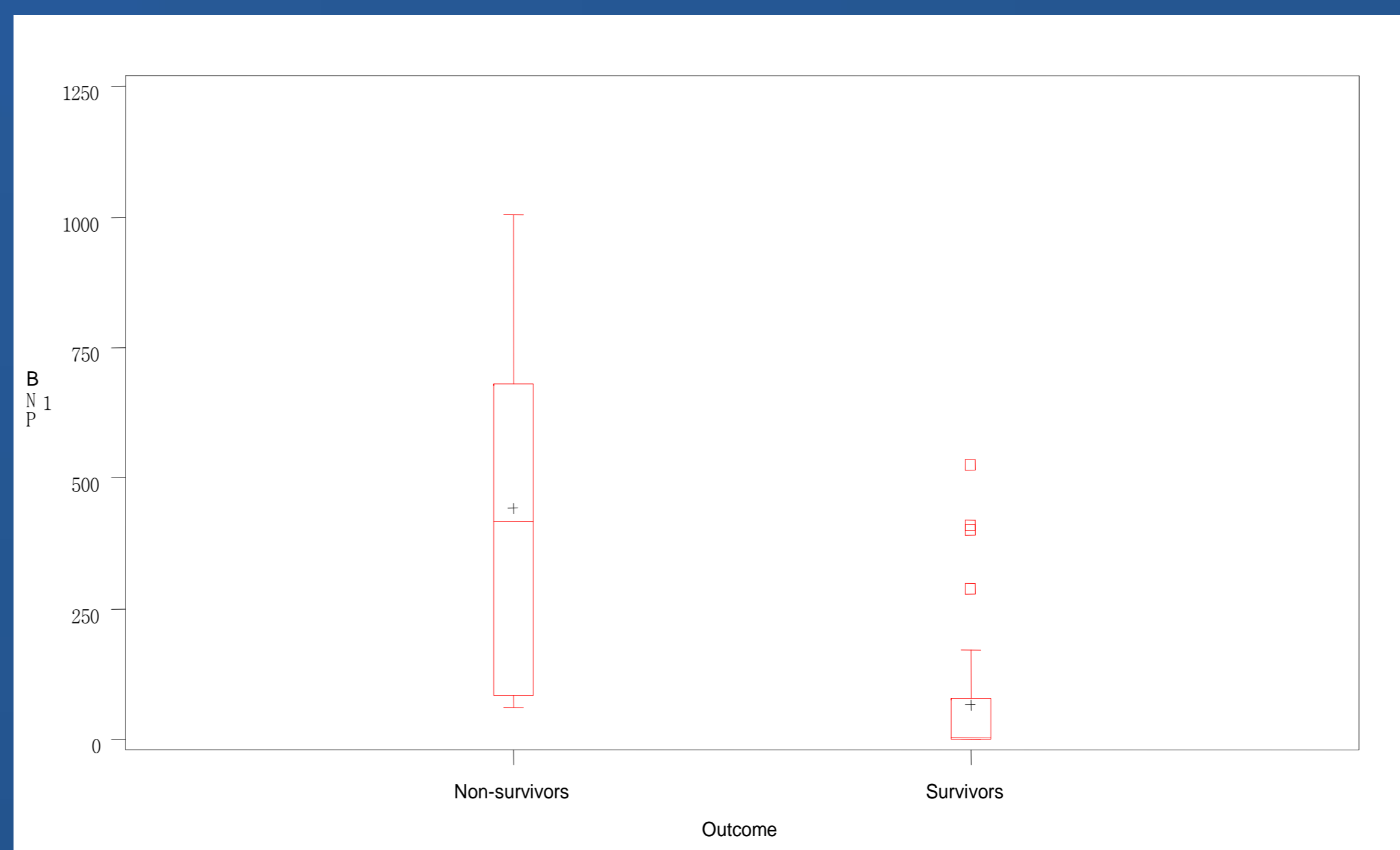
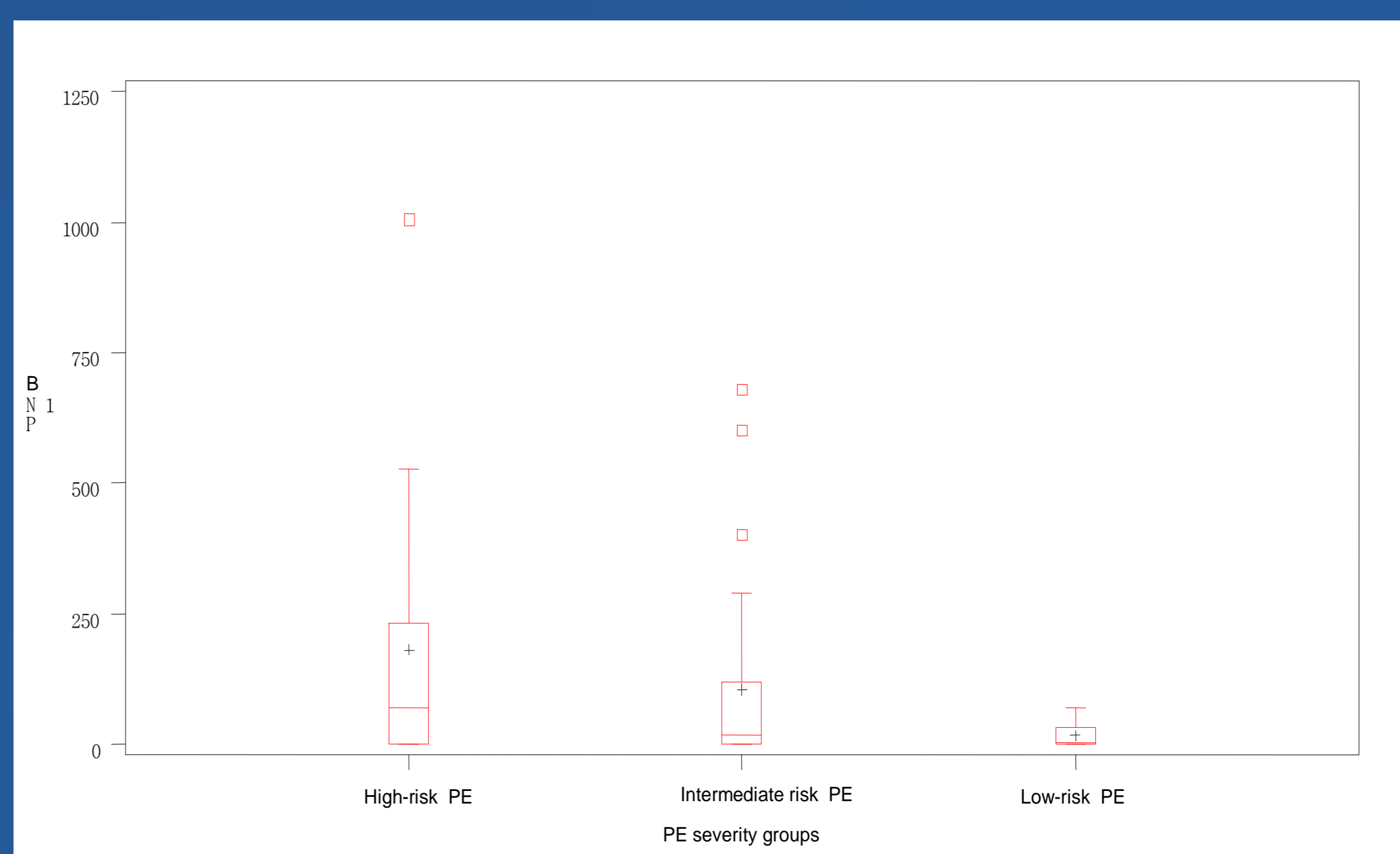
The Friedman test was used to determine the dynamics of cardiac biomarkers release. The data showed a significant increase in cTnT and NT-proBNP release between initial and first control sampling, in both the high- and intermediate-risk PE patient groups (P<0.001). NT-proBNP levels >500pg/mL might detect patients with persistent RVD 48 hours following admission and therefore could provide additional information regarding risk stratification, Table 2. Initial BNP correlated with the PE outcome, concentrations ≥526 pg/mL showed a negative predictive value of 100%, Figure 1.

Table 2. Baseline NT-proBNP plasma levels in patients with PE at the admittance to the ICU with differences between severity groups and outcome

| Characteristic | Total (n=45) | Patients (No) | | | | |
|------------------------|----------------|-----------------------|-----------------------------|--------------------|---------------------|---------------------|
| | | High-risk PE (n=11) † | Intermediate risk PE (n=23) | Low-risk PE (n=11) | Survivors (n=41) †† | Non-survivors (n=4) |
| Plasma pro-BNP (mg/mL) | | | | | | |
| mean±std: | 3131.7±5364.8 | 5903±8093.4 | 3082.4±4496.4 | 463.1±605.1 | 2632.1±4808.3 | 8252.5±8688.4 |
| median(lower/upper) | 775 (363-3477) | 3225 (484-5253) | 941 (379-3687) | 226 (104-585) | 762(363-3225) | 7392 (1004-15500) |

NT-proBNP=N terminal pro brain natriuretic peptide. Categorical variables are expressed as mean and standard deviation and median with lower/upper quartile; P-values: †Kruskal-Wallis test, P=0.004; †† Mann-Whitney test, P=0.319.

Figure 1. Baseline BNP plasma levels in patients with PE at the admittance to the ICU with differences between severity groups and related to outcome.



Conclusion

Bedside echocardiography and increased levels of cTnT and NT-proBNP successfully detected hemodynamically stable PE patients with RVD, while initially increased levels of BNP detected patients with a higher risk of death. Serial sampling of NT-proBNP, up to 48 hours, might be useful in detecting patients with persistent RVD, and therefore could provide additional information in further risk stratification.

References: 1. Torbicki A, Perrier A, Konstantinides S, et al. Guidelines on the Diagnosis and Management of Acute Pulmonary Embolism: The Task Force for the Diagnosis and Management of Acute Pulmonary Embolism of the European Society of Cardiology (ESC). Eur Heart J 2008;29:2276-2315. 2. Sanchez O, Trinquart L, Colombet I, Durieux P, Huisman MV, Chatellier G, Meyer G. Prognostic value of right ventricular dysfunction in patients with haemodynamically stable pulmonary embolism: a systematic review. Eur Heart J. 2008; 29(12):1569-77. Epub 2008 May 21.

Table 1. Differences in the initial echocardiography findings in acute PE at ICU admission between severity groups

| Characteristic* | Total (n=96) | Patients | | |
|--|--------------|---------------------|-----------------------------|--------------------|
| | | High-risk PE (n=26) | Intermediate-risk PE (n=50) | Low-risk PE (n=20) |
| Right ventricle dilatation (No., %) †: | 75 (78.3) | 24 (92.3) | 44 (88.0) | 7 (35.0) |
| Paradoxical movement of the septum (No., %) †: | 55 (57.3) | 18 (69.2) | 33 (66.0) | 4 (20.0) |
| Tricuspidal regurgitation (No., %) †: | 82 (85.4) | 25 (96.1) | 47 (94.0) | 10 (50.0) |
| Pulmonary hypertension (No., %) †: | 78 (81.2) | 25 (96.1) | 47 (94.0) | 6 (30.0) |
| Right ventricle hypokinesis (No., %) †: | 44 (45.8) | 17 (65.4) | 26 (52.0) | 1 (5.0) |

Categorical variables are expressed as numbers and percentages; P-values: *Fisher's exact test; † P<0.001.