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PREDISCHAGE LUNG ULTRASOUND AS A PREDICTOR OF REHOSPITALIZATION OR MORTALITY ACUTE HEART FAILURE PATIENTS

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Abstract

Backgroud: Persistent congestion is a major cause of rehospitalization in patients with acute heart failure (AHF). Lung Ultrasound (LUS) is an easy and valid examination in assessing pulmonary congestion. The number of B-lines correlates very strongly with the amount of extravascular lung fluid (EVLW). The aim of this study is to determine if LUS pre-discharge can predict rehospitalization or mortality.

Methods: This single centered cohort study included 127 consecutive AHF patients. LUS on 28 antorolateral chest wall segment was done double blindly before discharging the patient to calculate the B-line. Clinical data, Composite Congestion Score (CCS) and echocardiography were collected. Cox proportional hazard regression analysis was performed to assess the independent predictor of rehabilitation or mortality during 120 days of observation.

Results: The patients were 57.4 ± 7.8 years old, most were male (66.9%), with LV EF 36.7 ± 7.2%. The etiology of heart failure was caused by coronary heart disease (56.7%) and hypertensive heart disease (40.9%). The median number of B-lines was 24 (15 - 39). Hospitalization or death occurred in 43 patients (33.8%) during the median observation of 120 days (73-120). Patients with B-line pre-discharge ≥30 had a lower mean survival (log rank X2 48.14; p <0.001). In multivariate analysis, B-line pre-discharge ≥30 was the strongest independent predictor of rehabilitation or mortality (HR 4.71; 95% CI 2.15 - 10.32). Other independent predictors are Composite Congestion Score (CCS) ≥ 3 (HR 4.26; 95% CI 2.07 - 8.77) and NYHA functional class III (HR 2.87; 95% CI 1.49 - 5, 53).

Conclusion: Persistent pulmonary congestion in AHF patients as assessed by B-line pre-discharge ≥30 is a strong independent predictor of rehospitalization or mortality. LUS could potentially help to guide the timing of discharge from AHF hospitalization, the follow-up scheduling and the therapy tailoring. Further randomized clinical studies are needed to definitely support the routine use of LUS.

Introduction

Acute Heart Failure (AHF) is a major disease causing hospitalization for populations over 65 years old. It is estimated that there are one million cases of AHF hospitalization each year in the United States and Europe.[1] Prognosis of AHF patients is still very poor and has not progressed in the past two decades.[2,3] Mortality during hospitalization ranges from 4% to 7%. Mortality after 2-3 months ranges from 7-11%.[2]

Worsening signs and symptoms of congestion are the main reasons for patients with heart failure for rehospitalization.[4] Nearly 90% of AHF patients had a chief complaint of dyspnea upon arrival at the ER. Rales are found in almost 70% of patients. Chest radiographs carried out in 90% of AHF patients showed three quarters of which was a radiological evidence of pulmonary congestion.[5]

Lung Ultrasound (LUS) is a new non-invasive examination used for evaluation of pulmonary congestion. The presence of fluid in the lungs will cause changes in artifacts called the *B-line*.[6] The number of B-lines correlates very strongly with extravascular lung water (EVLW). LUS is very useful to distinguish AHF with acute non-cardiogenic shortness of breath with very good accuracy.[7]

Persistent pulmonary congestion upon discharge is a major predictor of morbidity and mortality. LUS is a non-invasive bedside examination to assess pulmonary interstitial fluid. This examination is very easy, fast, and does not require sophisticated technology and has a very good reproducibility. With all the above advantages, the researchers are interested in determining whether pre-discharge LUS can be used as a stratification tool for risk of rehospitalization and mortality in AHF patients.

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Methodology

This is a prospective cohort study in acute heart failure patients at H. Adam Malik Hospital in Medan from January 2019 to October 2019, after obtaining approval from the local Ethics and Research Committee. Research samples were collected by consecutive sampling method. The inclusion criterias include: (a) Aged > 18 years (b) Diagnosed with acute heart failure based on ESC Guidelines for the diagnosis and treatment of acute and chronic Heart Failure 2016 (c) History of hospitalization in the last 12 months. Exclusion criterias including (a) pneumonia or pulmonary fibrosis (b) severe stenosis or regurgitation of the mitral valve and aortic valve (c) planned for revascularization during the observation period (d) moderate pleural effusion.

Before the patient was discharged , Composite Congestion Score (CCS), echocardiography and LUS was assessed. LUS was performed in the supine position using a 2.5 - 3.6 MHz cardiac probe. Sector width of 75^0 and depth of 15 cm. LUS was performed in 28 regions and B-line was calculated based on the semiquantitative method. LUS per region was stored as a 3-second clip. Analysis is carried out off line. The B-line is a discrete, hyperechoical vertical artifact, shaped like a comet-tail that originates from the pleural line extending to the bottom of the screen and moves in sync with respiration. Decisions regarding discharging time and patient therapy were in the discretion of the treating doctor. The treating doctor did not know the results of the LUS examination. CCS was calculated by a modified Everest Score. Laboratory and ECG data were collected at the time the patient was treated. The outcome of the study was obtained from three sources,: 1) telephone interviews every month, 2) interviews when patients went to an outpatient clinic, 3) medical records of RSUP. H. Adam Malik Medan.

Categorical data were presented with frequency and percentage. Continious data were tested by independent T test or Mann Whitney and categorical data were tested by Chi-squere or Fisher test. All variables with $P < 0.1$ in bivariate analysis were analyzed with logistic regression to get an independent predictor of B-line ≥ 30 before being discharged. Bivariate analysis with cox regression analysis was used to assess the relationship of each dependent variable with rehospitalization or mortality. All dependent variables with $P < 0.1$ will be included in the multivariate cox regression analysis. Kaplan Meier was used to estimate the probability of survival of patients based on the number of B-lines. The difference between the two curves was analyzed by log rank test.

Results

There were 151AHF patients who met the inclusion criteria, as many as 24 patients were excluded due to significant plural effusion, pneumonia, and pulmonary fibrosis.So the analysis of this study was conducted on 127 AHF patients. The basic characteristics of patients based on B-line counts shown in table 1. Echocardiography and LUS in 109 patients (85.8%) were performed 24 hours before being discharged, 13 patients (10.2%) within two days before being discharged, and the remaining 5 patients (3.9%) were done within 3 days before the patient being discharged.

The subjects were 57.4 ± 7.8 years old, most were male (66.9%), with LV EF 36.7 ± 7.2. The etiology of heart failure is mainly caused by CHD (56.7%) and HHD (40.9%). The median number of B-lines in the group B-line ≥ 30 was 24 (15 - 39) and in group B-line < 30 was 45 (36.5 - 60.5).

Nearly one third of all patients (27.6%) discharged with persistent clinical congestion marked by CCS ≥ 3. Laboratory results showed that group B-line ≥ 30 had significantly worse kidney function with higher creatinine and BUN levels. The B-line group ≥ 30 has a lower LV EF (35.6 ± 6.3) compared to the average LV EF (40.6 ± 7.1) in group B-line < 30 ($p < 0.001$). Hemodynamic congestion markers E/e' and IVC diameter were found to be significantly higher in the B-line ≥ 30. Maximum velocity tricuspid valve regurgitation (TR Vmax) obtained from 85 patients and E/A ratio obtained from 106 patients also significantly higher in the group B-line ≥ 30. The Spearman correlation (table 2) shows the number of B-lines have a strong correlation with E/e', IVC diameter, CCS and moderate correlation with E/A and TR Vmax.

Multivariate logistic regression analysis was performed to determine the independent predictor of the B-line before being discharged ≥ 30 (table 3). CCS ≥ 3, E / e 'average> 15, and creatinine ≥ 1.4 mg / dL are independent predictors of B-line before being discharged ≥ 30. This model has an AUC of 0.94.

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During the observation period, rehospitalization occurred in 8 patients (10.3%) and mortality in 3 patients (3.8%) within the group B-line < 30 (figure 1). In contrast, rehospitalization occurred in 25 patients (51%) and mortality in 7 patients (14.3%) within group B line ≥ 30 (figure 1).

As seen in the Kaplan-Meier curve (figure 2) the prognosis group B-lines ≥ 30 is worse than that of group B-lines < 30. The mean survival of the B-line < 30 was 116 days (95% CI 114 - 118 days), while the mean survival of group B-line ≥ 30 was 71 days (95% CI 93 - 105 days).

Bivariate and multivariate cox regression analyzes were performed to determine independent predictors of rehospitalization or mortality of AHF patients (table 4). Bivariate analysis showed variables related to the risk of rehospitalization and death were age, SBP ≤ 100 mmHg, CCS ≥ 3, functional NYHA class, creatinine ≥ 1.4 mg / dl, BUN ≥ 31 mg / dl, potassium, E / e '≥ 15, IVC ≥ 22 mm, IVC CI <50%, length of stay and B-line ≥ 30. In multivariate analysis, B-line ≥ 30 was the strongest independent predictor of rehospitalization or mortality (adjusted HR 4.71; 95 % CI 2.15 - 10.32). Other independent predictors were NYHA functional class III (adjusted HR 2.87; 95% CI 1.49 - 5.53), and CCS ≥ 3 (adjusted HR 4.26; 95% CI 2.07 - 8.77).

Discussion

The results of this study indicates significant persistent pulmonary congestion when AHF patients being discharged are independent predictors of major rehospitalization and mortality. AHF patients being discharged with a B-line ≥ 30 on LUS examination had a four-fold risk compared with patients being discharged with a B-line < 30. This study supports two previous studies. Coiro et al. showed a B-line pre-discharge> 30 was a very strong predictor of rehospitalization and mortality at 30 days of observation (HR 11.3; 95% CI 2.44 - 53.2).[8] B-line pre-discharge can increase risk stratification above BNP and NYHA classes. Gargani et al showed a B-line pre-discharge> 15 was the only independent predictor of 6-month re-hospitalization of AHF patients (HR 11.74; 95% CI 1.30 - 160.16).[9]

Several previous studies have also shown the B-line as a predictor of rehospitalization in patients with chronic heart failure in outpatient care. Miglioranza et al showed that B-line >30 (28 zone analysis) in HFrEF patients in outpatient clinics was the strongest independent predictor of 120-day re-hospitalization (HR 8.62; 95% CI 1.8 - 40.1).[10] Patients with B-lines <15 have a very good prognosis. None of these patients were rehospitalized during 120 days of observation. This study also showed that the ability of LUS discrimination as a predictor of re-hospitalization (c statistic 0.82; 95% CI 0.74 - 0.9) was better than NT-proBNP (c statistic 0.74; 95% CI 0.63 - 0.86), NYHA functional class (c statistic 0.71; 95% CI 0.59 - 0.84), clinical score (c statistic 0.70; 95% CI 0.57 - 0.82),

Gustafsson et al used hand-held echocardiography for LUS examination of CHF patients in outpatient clinics.[11] Analyzes were performed on 5 lung segments and a minimum of 3 B-lines was needed to be positive. Positive LUS was an independent predictor of rehospitalization and 6-month observation mortality (HR 2.9; 95% CI 1.3 - 6.6). Platz et al research also used hand-held echocardiography.[12] The analysis was done by counting the number of B-lines in 8 segments. The total number of B-lines ≥ 3 was an independent predictor of re-hospitalization and mortality during the 6-month observation (HR 4.08; 95% CI 1.95 - 8.54). It should be noted that in 81% of patients with B-line ≥ 3 no rales were found on physical examination. There was a significant increase in the prognostic value of LUS compared with congestion scores (AUC delta: 0.136; 95% CI 0.082 - 0.228).

Data from RCTs and large registries showed that most hospitalizations were caused by congestion.[13,14] Therefore, adequate decongestion is one of the main targets during hospitalization.[15,16] In practice, it is very difficult to determine the adequacy of decongestion therapy.

Conventionally, the state of euvolemia is evaluated based on clinical examination. To be more accurate, this examination is arranged systematically called a composite congestion score (CCS). The effectiveness of this method was evaluated in the post hoct analysis of EVEREST, DOSE-AHF, CARRESS-HF and PROTECT studies. These studies consistently show congestion residuals based on clinical examination at discharge are independent predictors of rehospitalization and mortality.[5,17,18] A quarter of the total patients (27%) in this study turned out to be home with clinically significant congestion marked by CCS score ≥ 3. In line with previous studies, these patients had a higher risk of re-hospitalization and mortality.

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This study also shows LUS can improve patient risk stratification. This is due to better echocardiography accuracy in assessing pulmonary congestion. The discovery of LUS has made cardiologists able to see the cascade stages that were lost between hemodynamic congestion and clinical congestion. Intermediate events such as interstitial congestions can be detected with LUS as a B-line.[19] This study found that as many as 18 patients (20%) with CCS <3 apparently being discharged with a B-line> 30.

The number of B-lines also changes rapidly in response to therapy. This causes LUS to be very potential to be used as an adequate parameter of decongestion therapy. Noble et al showed that every 500 ml of liquid released there was a 2.7 B-line decrease compared to before hemodialysis (p = 0.02).[20] Facchini et al showed that the B-line number was reduced from an average of 53.4 ± 17.2 to 31.7 ± 13.5 after 24-hour continuous furosemide diuretic therapy (p <0.01).[21] Cortellaro et al also showed that the B-line decreased significantly after 3 hours of standard AHF therapy (from 1.59 ± 0.40 to 0.73 ± 0.44; p <0.001).[22] Even after 24 hours of therapy, the B-line decreased significantly compared to the 3rd hour (from 0.73 ± 0.44 to 0.38 ± 0.33; p <0.001).

Pulmonary congestion begins with an increase in left ventricular filling pressure. Not surprisingly, LUS correlates with a marker of increased left ventricular filling pressure. But keep in mind the severity of pulmonary congestion is also determined by the permeability of the alveolar-capillary membrane and lymphatic drainage ability. This study found that LUS was strongly correlated with E/e ', IVC diameter, E/A and TR Vmax. Gargani et al show the number of B-lines correlated with NT-proBNP (r = 0.69; p <0001).[23] Frassi et al. show the number of B-lines is related to the severity of diastolic dysfunction.[24] Miglioranza et al show B-lines correlate well with NT-proBNP (r = 0.72; P <0.0001) and E/e '(r = 0.68; p <0.0001).[25] Agricola et al show the number of B-lines correlated with PCWP (r = 0.48; p = 0.01).[26]

Other important information obtained from this study is that the B-line before being discharged> 30 tends to occur in patients with severe clinical congestion (CCS> 3) and haemodynamic congestion (high E/e) and poor kidney function. This is consistent with previous research conducted by Rubio-Gracia et al.[18] Aronson et al show hemodynamic status, renal function and the severity of congestion influencing the patient's response to diuretics.[27] Kidney is an organ with low vascular resistance. Renal artery pressure gradients with renal veins must be maintained high enough to maintain renal blood flow and glomerular filtration.[28] This pressure gradient can decrease due to low systolic blood pressure or central venous pressure that is still high.[29,30] Chronic kidney disease (CKD) also interferes with the natriuretic response to diuretics. This is due to a decrease in tubular secretion and an increase in natriuresis threshold.[31]

IMPEDANCE-HF (Non-Invasive Lung IMPEDANCE-Guided Preemtive Treatment in Chronic Heart Failure Patients) showed that information on the degree of pulmonary congestion can be used as a guideline for pharmacological intervention can provide enormous clinical benefits.[32] Pulmonary congestion in the study was assessed by Lung Impedance. The diuretic dose of the experimental group is adjusted based on the Lung Impedance value. This study shows that therapy based on Lung Impedance can reduce rehospitals (HR 0.51; 95% CI 0.38 - 0.68) and mortality (HR 0.52; 95% CI 0.3 - 0.78). The data provided by Lung Impedance in the IMPEDANCE-HF study can actually be obtained through LUS. Therefore, LUS can be used as a guideline in the treatment of AHF patients.

Some limitations in this study are that this study was that this was a single centered study, so that it causes obstacles to the generalization of the results of this study. In addition, the research samples were also relatively small, resulting in many cofounding factors that were not detected in this study. Nevertheless, the results of the study show that the B-line has a very strong prognostic value. Therefore the results of this study can be a hypothesis that must be validated by RCT and multicenter study. Persistent congestion is closely related to therapy while in hospital, especially diuretics and vasodilators. Unfortunately, these therapies and doses were not recorded in this study. Likewise, patient therapy after discharge from hospital was not reported in this study

In conclusion, persistent pulmonary congestion in AHF patients as assessed by B-line pre-discharge ≥30 is a strong independent predictor of rehospitalization or mortality. LUS could potentially help to guide the timing of discharge from AHF hospitalization, the follow-up scheduling and the therapy tailoring. Further randomized clinical studies are needed to definitely support the routine use of LUS.

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Figure And Table

Table 1 Baseline Characteristics

Variable	All patients (n = 127)	B-line> 30 (n = 49)	B-line <30 (n = 78)	P value
Demographic				
Age (years)	57.4 ± 7.8	58.9 ± 8.3	56.5 ± 7.4	0.101[#]
Male	85 (66.9)	33 (67.3)	52 (66.7)	0.927[a]
Etiology of Heart Failure				
CHD	72 (56.7)	30 (61.2)	42 (53.8)	0.359[a]
HHD	52 (40.9)	17 (34.7)	35 (44.9)	
Cardiomyopathy	3 (2,4)	2 (4,1)	1 (1,3)	
Komorbid				
Diabetes mellitus	40 (31.5)	17 (34.7)	23 (29.5)	0.675[a]
Hypertension	75 (59.1)	27 (55.1)	48 (61.5)	0.594[a]
COPD	16 (12.6)	4 (8.2)	12 (15.4)	0.358[a]
Atrial Fibrillation	21 (16.5)	10 (20.4)	11 (14.1)	0.493[a]
PCI / CABG	56 (44.1)	23 (46.9)	48 (61.5)	0.153[a]
Clinical Parameters				
SBP (mmHg)	120 (110-130)	110 (110 - 117.5)	130 (118.7 - 135)	**<0.001[*]**
DBP (mmHg)	70 (70-80)	70 (65 -75)	75 (70 - 80)	**0.002[*]**
Heart Rate (x / minute)	77.9 ± 9	79.6 ± 7.8	76.8 ± 9.5	0.081[#]
NYHA Class II	81 (63.8)	28 (57.1)	53 (67.9)	.297[a]
NYHA III class	46 (36.2)	21 (42.9)	25 (32.1)	
Orthopnea score (min – max)	0 (0 - 1)	0 (0 - 1)	0 (0 - 0)	**<0.002[*]**
TVJ score	1 (0 - 2)	2 (1-2)	1 (0 - 1)	**<0.001[*]**
Edema Score	1 (0 - 1)	1 (1-2)	0 (0 - 1)	**<0.001[*]**
CCS	2 (1 - 3)	3 (2 - 3)	1 (0 - 2)	**<0.001[*]**
CCS ≥ 3	35 (27.6)	31 (63.3)	4 (5,1)	<0.001[a]
ECG				
QRS duration> 120 ms	52 (40.9)	19 (38.8)	33 (42.3)	0.835[a]
Laboratory				
Creatinine (mg / dL)	1.4 (1.1-1.7)	1.7 (1.5 -2.2)	1.2 (0.9 - 1.4)	**<0.001[*]**
BUN (mg / dL)	31 (24 -38)	35 (28.5 -45.5)	28 (23 -34.2)	**0,001[*]**
Hemoglobin (gr / dL)	12.7 ± 2.3	12.1 ± 2.2	13 ± 2.3	0.051[#]
Hematocrite (%)	38.2 ± 6.9	36.3 ± 6.6	38.6 ± 6.6	0.060[#]
Sodium (mEq / L)	135 (134 -137)	135 (133 -137)	135 (134 -136,2)	.857*
Potassium (mEq / L)	4 (3.6 - 4.7)	4.1 (3.7 - 5)	4 (3.3 - 4.4)	0.057*
Echocardiography & LUS				
LV EF (%)	38.7 ± 7.2	35.6 ± 6.3	40.6 ± 7.1	**<0.001[#]**
E / e 'average	15 (12-18)	18 (15-22)	13 (12-15)	**<0.001[*]**
TR Vmax (m / s) (n = 85)	2.9 (2.4 - 3)	2.9 (2.7 -3.2)	2.5 (1.8 - 2.9)	**<0.001[*]**
E / A (n = 106)	1.5 (1.1-1.8)	1.8 (1.5-2.4)	1.3 (0.8 - 1.6)	**<0.001[*]**
IVC (mm)	21 (17-24)	24 (21.5 - 25.5)	17.5 (15 -21.2)	**<0.001[*]**
IVC CI <50%	56 (44.1)	27 (55.1)	29 (37.2)	0.072[a]
B-line	24 (15 - 39)	45 (36.5 -60.5)	18 (9-23)	**<0.001[*]**
Home Therapy				
Furosemide	125 (98.4)	49 (100)	76 (97.4)	0,691[a]
ACE-i / ARB	115 (90.6)	41 (83.7)	74 (94.9)	0.074[a]
Beta Blocker	81 (63.8)	33 (67.3)	48 (61.5)	0.636[a]
Spironolactone	82 (64.6)	28 (57.1)	54 (69.2)	0.232[a]
Aspillet	79 (62.2)	26 (53.1)	53 (67.9)	0.135[a]
Clopidogrel	39 (30.7)	14 (28.6)	25 (32.1)	0.828[a]
Statins	87 (68.5)	30 (61.2)	57 (73.1)	0.229[a]
Nitrate	47 (37)	17 (34.7)	30 (38.5)	0.811[a]
Length of stay (days)	8 (7-9)	8 (7 - 9.5)	8 (6.7 - 8)	**0.009[*]**

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*Note: significant p <0.05; [a]chi square test; [#]t-test; *mann-whitney test; COPD, chronic obstructive pulmonary disease; PCI, percutaneous coronary intervention; CABG, coronary artery bypass graphic; SBP, systolic blood pressure; DBP, diastolic blood pressure; NYHA, New York Heart Association; CCS, composite congestion score; TVJ, jugular venous pressure; BUN, blood urea nitrogen; LV EF, left ventricular ejection fraction; TR Vmax, tricuspid regurgitation maximal velocity; IVC, inferior vena cava; IVC CI, inferior vena cava collapsibility index; ACE, angiotensin converting enzyme inhibitor ARB, Angiotensin Receptor Blocker.*

Table 2 Correlation of B-line with Hemodynamic Congestion

Variable Relationship	Correlation Coefficient (r)	P value
Number of B-lines with E / e '	0.73	<0.001 *
Number of B-lines with IVC	0.70	<0.001 *
Number of B-lines with TR Vmax (n = 85)	0.55	<0.001 *
Number of B-lines with E / A (n = 106)	0.59	<0.001 *

*Note: significant p <0.05; * Spearman Correlation; IVC, inferior vena cava; TR Vmax, tricuspid regurgitation maximal velocity; CCS, composite congestion score.*

Table 3 Bivariate and Multivariate Analysis Predictors of B - lines Before Being Discharged ≥ 30

	Bivariate		Multivariate *	
Variable	**OR (CI)**	**P value**	**OR (CI)**	**P value**
SBP <100 mmHg	22.06 (4.82 - 100.82)	<0.001		
DBP <70 mmmHg	2.78 (1.31 - 5.91)	0.008		
Heart rate	1.03 (0.99 - 1.08)	0.033		
CCS ≥ 3	31.86 (9.97- 101.81)	<0.001	**19.45 (4.73 - 79.94)**	**<0.001**
Creatinine> 1.4 mg / dL	13 (5.43 - 31.08)	<0.001	**6.11 (1.93 - 19.38)**	**0.002**
BUN> 31 mg / dL	5 (2.29 - 10.88)	<0.001		
Hemoglobin	.84 (0.72 - 0.99)	0.041		
Hematocrite	.94 (0.89 - 1.00)	0.059		
Potassium	1.66 (1.05 - 2.63)	0.029		
LV EF ≤ 40%	3.24 (1.47 - 7.13)	0.003		
E / e average ≥ 15	16.12 (6.05 - 42.97)	<0.001	**5.01 (1.30 - 19.27)**	**0.019**
IVC ≥ 22 mm	7.03 (3.17 - 15.62)	<0.001	3.22 (0.93 - 11.10)	0.063
IVC CI <50%	2.07 (1.00 - 4.28)	0.049		
Duration of stay	1.37 (1.12 - 1.69)	0.002		

*Note: significant p <0.05; *Logistic Regressiton; SBP, systolic blood pressure; DBP, diatolic blood pressure; NYHA, New York Heart Association; CCS, composite congestion score; BUN, blood urea nitrogen; LV EF, left ventricular ejection fraction; TR Vmax, tricuspid regurgitation maximal velocity; IVC, inferioir vena cava; IVC CI, inferior vena cava collapsibility index.*

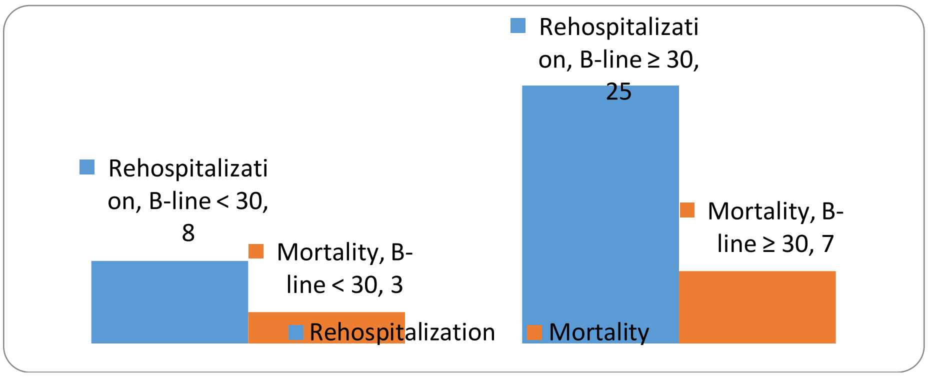

Figure 1. Rehabilitation and mortality based on B-line before being discharged

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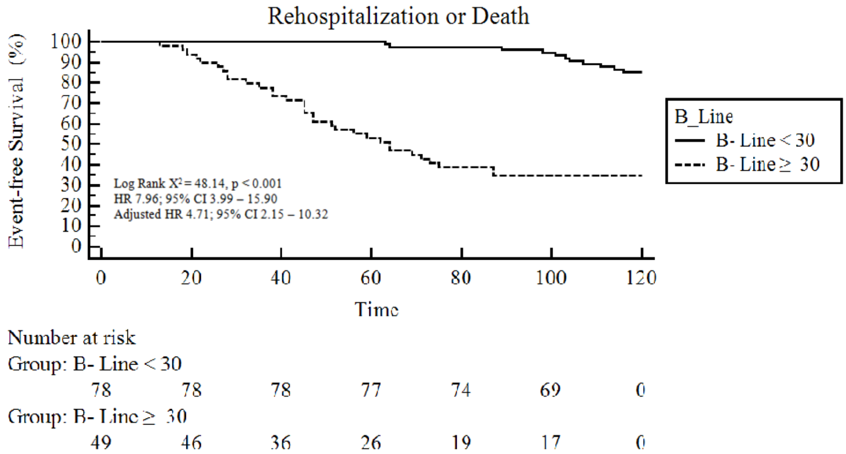

Figure 2. Kaplan-Meier Curves for Hospitalization or Mortality Based on B-line Before Discharged.

Table 4. Bivariate and Multivariate Analysis Predictors of Rehospitalization or Mortality

	Bivariate		Multivariate *	
Variable	**HR (CI)**	**P value**	**HR (CI)**	**P value**
Demographic				
Age	**1.06 (1.01 - 1.10)**	**0.004**		
Male	1.14 (0.59 -2.18)	0.694		
AHF etiology	1.51 (0.84 - 2.71)	0.163		
Komorbid				
Diabetes mellitus	0.76 (0.38 -1.51)	0.436		
Hypertension	0.94 (0.51 - 1.7)	0.848		
COPD	0.61 (0.53 - 1.72)	0.358		
Atrial Fibrillation	1.06 (0.47 - 2.38)	0.883		
PCI / CABG	0.97 (0.53 -1.77)	0.931		
Clinical Parameters				
SBP ≤ 100 mmHg	**4.36 (2.25 - 8.44)**	**<0.001**		
DBP ≤ 70 mmHg	1.40 (0.76 - 2.57)	0.271		
Heart rate	1.02 (0.99 - 1.05)	0.383		
NHYA Class III	**1.82 (0.99 - 3.33)**	**0.051**	**2.87 (1.49 - 5.53)**	**0.002**
CCS ≥ 3	**7.64 (4.11 - 14.20)**	**<0.001**	**4.26 (2.07 - 8.77)**	**<0.001**
Laboratory				
Creatinine ≥ 1.4 mg / dl	**2.81 (1.51 - 5.24)**	**.001**		
BUN ≥ 31 mg / dl	**2.10 (1.14 - 3.88)**	**0.017**		
Hemoglobin	.89 (0.78 - 1.02)	0.106		
Hematocrit	.97 (0.93 to 1.02)	0.279		
Sodium	0.92 (0.84 - 1.01)	0.109		
Potassium	**1.48 (1.04 -2.11)**	**0.030**		
Echocardiography				
LV EF ≤ 40%	1.27 (0.69 - 2.35)	0.433		
E / e average ≥ 15	**3.09 (1.58 - 6.03)**	**0.001**		
IVC ≥ 22 mm	**2.05 (1.12 - 3.74)**	**0.019**		
IVC CI <50%	**1.78 (1.21 - 2.62)**	**0.003**		
Ultrasound Lung				
B-line	**1.10 (1.08 -1.13)**	**<0.001**		
B-line ≥ 30	**7.96 (3.99 - 15.90)**	**<0.001**	**4.71 (2.15 - 10.32)**	**<0.001**
Duration of stay	**1.23 (1.05 - 1.45)**	**0.010**		

*Note: significant p <0.05; *Cox Regression; SBP, systolic blood pressure; DBP diatolic blood pressure; NYHA, New York Heart Association; CCS, composite congestion score; BUN, blood urea nitrogen; LV EF, left ventricular ejection fraction; TR Vmax, tricuspid regurgitation maximal velocity; IVC, inferioir vena cava; IVC CI, inferior vena cava collapsibility index.*