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RESEARCH ARTICLE

The Value of a Simplified Lung Ultrasound Protocol in the Pre-Discharge Evaluation of Patients Hospitalized with Acute Heart Failure

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Optimal timing of hospital discharge in patient with acute heart failure (AHF) is an important factor of preventing rehospitalizations.

Aim. To evaluate the value of a simplified lung ultrasound (LUS) protocol in assessing pre-discharge status of patients with AHF, correlating the US findings with the values of NT-proBNP levels.

Methods. 24 patients (18 men, 6 women, mean age 68,2 years) hospitalized with acute heart failure underwent LUS examination in the afternoon of the day before hospital discharge, applying a simplified LUS protocol, using three basal examination areas on the right side (anterior, lateral and posterior) and two basal examination areas on the left side (lateral and posterior). The LUS score was represented by the sum of B lines. In the next morning the value of NT-proBNP was also determined. The correlation between LUS findings and NT-proBNP values was analyzed using Fisher`s exact test (significant if alpha<0,05).

Results. 6 patients had <15 B lines, 16 patients had >15 B lines and 2 patients had pleural effusion on LUS, while 16 patients had the value of NT-proBNP >1000pg/ml at discharge. The results of LUS examination correlated significantly (p=0.0013) with the NT-proBNP values – only one patient not having increased NT-proBNP in the group with >15 B lines.

Conclusions. Despite a relatively good clinical status, the majority of patients had high NT-proBNP values at the time of hospital discharge. LUS proved to be a useful tool in identifying patients with subclinical congestion reflected also by the high NT-proBNP levels. These patients may need a prolongation of hospitalization and/or a more careful follow-up to prevent early readmission.

Keywords: acute heart failure, biomarkers, lung ultrasound

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Background and aim

Acute heart failure (AHF) is defined as the rapid onset of, or change in, symptoms and signs of heart failure [1]. The incidence of cases with AHF is continuously increasing, the more frequent clinical form being the acute decompensation of chronic heart failure (or worsening heart failure). AHF still has an in-hospital mortality ranging from 3 to 7% and a relatively high rate of events after discharge – 5-15% mortality and 30% readmissions at 60 to 90 days [2].

Repeated hospital readmissions represent an independent risk factor for death, and also a large cost for the healthcare system. Preventing readmissions is a real challenge in clinical practice and involves multiple aspects of heart failure management: reaching the optimal medical and device therapy, diagnosis and treatment of comorbidities, patient education and monitoring, etc. [3,4]

One of the emerging factor of preventing early hospital readmissions is the management of the so called vulnerable or transition period which consist of the end of hospital stay and the first couple of weeks after discharge. It is a meaningful requirement that patients just before discharge have to be free of systemic and pulmonary congestion. However, clinical assessment of congestion could be misleading. Hemodynamic congestion could persist despite of an apparently good clinical status. Thus, other, non-clinical estimates of congestion have to be used for the proper evaluation of patients. Natriuretic peptides are the gold standard for this purpose. However, due to the cost and lack of general availability there is a trend to use other, more simple tools to evaluate congestion. Lung ultrasound has emerged as one of the most promising method in this regard [5,6].

Our aim was to test the value of a simplified lung ultrasound (LUS) protocol in assessing pre-discharge status of patients with AHF, correlating the LUS findings with the values of NT-proBNP, both reflecting the presence of subclinical (hemodynamic) congestion.

Methods

Study population

We enrolled in the study 24 consecutive patients (18 men, 6 women, mean age 68,2 years) hospitalized with acute heart failure in the Cardiological Department of the Clinical County Hospital Mureş, between 01.01.-30.06.2015. At the admission, all the patients signed the general consent form used in our institution, agreeing with anonymous data collection and usage for scientific purposes. Approval of local ethical committee (3865/01.03.2016) was obtained for confidential data processing and publication.

In every case, the clinical form of acute heart failure was worsening (acute) decompensated heart failure. Car-

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diac substrates were: dilated cardiomyopathy (17 patients, 70.8%), ischemic heart disease (8 patients, 33.3%), significant valvular heart disease (9 patients, 37.5%), hypertension (14 patients, 58.3%), atrial fibrillation (12 patients, 50%).

Study protocol

During the hospital stay all the patients underwent standard of care diagnostic and therapeutic procedures, as needed: e.g., clinical examination, ECG, chest X-ray, 2D, M-mode and Doppler echocardiography, laboratory tests, etc. Beyond these routine procedures, in the afternoon of the day before hospital discharge, lung ultrasound (LUS) examination was performed (Philips HD11XE, phased array probe). Also, in the morning of the discharge day blood was drawn for determination of the NT-proBNP level, the most used biomarker of congestion. The moment of hospital discharge was decided by the treating physician, on the basis of clinical well-being of the patient.

LUS protocol

Respecting the principles of LUS examination methodology in heart failure, described before, we used a simplified protocol, having in mind a practically more suitable examination approach [6,7]. We used three basal examination areas on the right side (anterior – medioclavicular line, lateral – mid axillary line and posterior – scapular line) and two basal examination areas on the left side (lateral – mid axillary line and posterior – scapular line), while the patients being in sitting position. Basal areas were chosen because of the greater sensibility for detecting lung congestion. The LUS score was calculated as the sum of B lines. The presence of pleural effusion was observed too. B lines represent vertically oriented comet-tail like artifacts ("lung rockets"), and are caused by lung (interlobular) congestion. They originate on the lung-pleura border and have a radial orientation (fig. 1). For the sum of B lines, based on current recommendation, a cut-off value of >15 was used for the presence of pulmonary congestion [6,7].

Statistical analysis

The correlation between the values of NT-proBNP levels and the presence of congestion or pleural effusion on LUS was studied using the Fisher`s exact test (significant if $\alpha<0.05$). 1000 pg/ml was chosen as cut-off value for NT-proBNP, based on current recommendations.

Results

6 patients (25%) had <15 B lines, 16 patients (66.6%) had >15 B lines and 2 (8.3 %) patients had pleural effusion on LUS, while 16 patients (66.6%) had the value of NT-proBNP >1000 pg/ml at discharge. The results of LUS examination correlated significantly (p=0.0013) with the NT-proBNP values – only one patient not having increased NT-proBNP in the group with >15 B lines (fig. 2). The presence of >15 B lines on LUS had a sensibility of

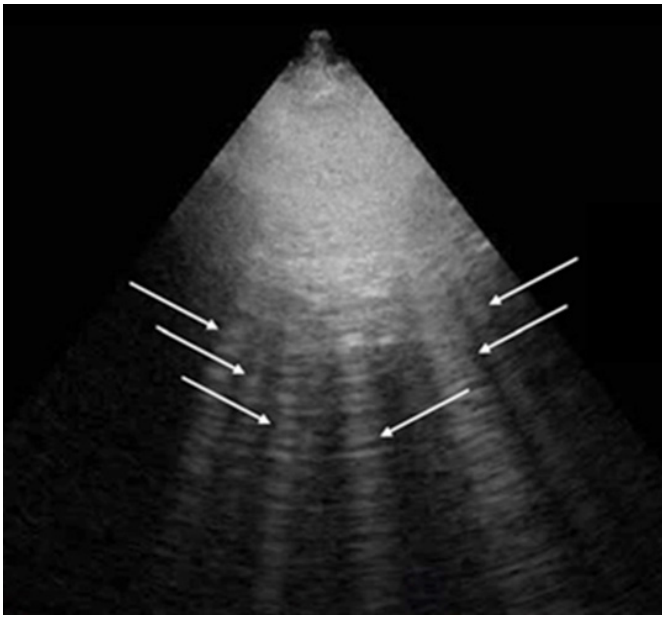

Fig. 1. Lung ultrasound image with B-lines (white arrows)

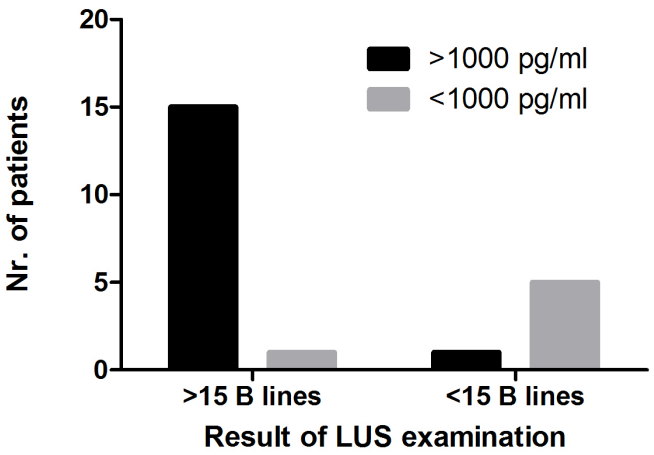

Fig. 2. Correlation between LUS examination results and NT-proBNP levels

93%, a specificity of 83% and a positive predictive value of 93% for NT-proBNP>1000 pg/ml.

Discussions

Preventing rehospitalizations of patients admitted with acute heart failure represents a continuous concern. In this regard, complex management of the so called vulnerable phase is very important. This includes the obtaining of a congestion-free status at discharge, which has to be objectively demonstrated. The presence of clinical or subclinical congestion could be tested in various ways, the level of NT-proBNP being the gold standard, however LUS could be considered as an emerging, bedside tool of assessment [1,5].

Our results confirm the observation of previous studies, that the majority of patients at discharge, despite of a good clinical status, remain with a subclinical congestion, reflected by increased NT-proBNP levels [5,8,9].

Our findings are in line with previous studies, which demonstrated that the results of LUS are highly correlated with the increased NT-proBNP levels at discharge. This is an important fact, having in mind the data confirming that the presence of (subclinical) congestion at discharge, demonstrated by LUS, is a good predictor of hospital readmissions [10-12].

Conclusions

Despite of a good clinical status, the vast majority of patients have subclinical congestion at the time of hospital discharge, fact reflected by the high NT-proBNP levels. The simplified, bedside protocol of LUS applied in our study is a potent and accurate tool of noninvasive assessment of subclinical congestion at the time of hospital discharge.

Demonstration of persisting congestion at discharge could imply important patient-management decisions in order to prevent early readmission: prolongation of admission, rethinking of treatment and a more careful postdischarge monitoring.

Conflicts of interest

The authors report no conflicts of interest.

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