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FACE-HF: Focused Assessment by Chest Sonography and Echocardiography in Acute Heart Failure Patients

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Abstract

Background: Acute heart failure (AHF) is a life-threatening condition that necessitates urgent evaluation and treatment with an urgent need for hospital admission. Among the available imaging modalities, echocardiography is the method of choice due to its feasibility and cost-effectiveness. Lung ultrasonography in emergency department, critical and cardiac care units is becoming popular. The present study aimed to assess the value of the focused echocardiography and lung ultrasound protocol for guiding treatment and its effect on the hospitalization period in AHF patients admitted to the CCU, 6 months re-hospitalization and mortality. **Methods:** This study included 40 consecutive patients admitted to the Cardiology and Angiology department after disposition from the emergency department at Alexandria main university hospital in Egypt with the diagnosis of (AHF). Patients were divided into 2 groups, 20 patients received the standard treatment while the other group received a modification of medication doses according to daily imaging changes. All patients were followed up for 6 months to assess the 6 months HF rehospitalization and death rates. **Results:** Group II patients had a significantly shorter duration of hospitalization; 6.45 ± 2.01 days compared to 9.10 ± 3.82 days among group I patients (P = 0.02). There was no significant difference between the two groups regarding the 6 months rehospitalization and death rates. **Conclusion:** The focused echocardiography and lung ultrasound-guided therapy for AHF patients resulted in a shorter duration of hospitalization without increased adverse events.

Keywords

Acute Heart Failure, Lung Ultrasonography, Echocardiography, N-Type

Pro-BNP

1. Introduction

Heart failure is a clinical syndrome characterized by typical symptoms (e.g. dyspnea, ankle edema and fatigue) that could be accompanied by signs (e.g. elevated jugular venous pressure, pulmonary crackles and peripheral edema) caused by a structural and/or functional cardiac abnormality, resulting in reduced cardiac output and/or elevated intracardiac pressures at rest or during stress [1]. Acute heart failure (AHF) is regarded as a life-threatening condition that necessitates urgent evaluation and treatment with the urgent need for hospital admission [1]. The main presentation of the AHF patients will be resulting from fluid overload (pulmonary congestion and/or peripheral oedema) or, less often, low cardiac output [2] [3].

Plasma natriuretic peptides (NPs) level (BNP, NT-proBNP or MR-proANP) should be measured in all patients with acute dyspnea and suspected AHF to help in the differentiation of AHF from non-cardiac causes of acute dyspnea. NPs have high sensitivity, and normal levels in patients with suspected AHF make the diagnosis unlikely. Elevated levels of NPs do not confirm the diagnosis of AHF, as they may also be present in other cardiac and non-cardiac conditions [4]-[11].

Transthoracic echocardiography (TTE) is the method of choice for assessment of myocardial systolic and diastolic function of both left and right ventricles in subjects with suspected heart failure to establish the diagnosis and this is a class I recommendation in ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure [1].

Point-of-care ultrasonography (PoCUS) has become a widely used diagnostic tool in the ED. It could be performed at bedside in few minutes and it should be regarded as a part of the physical examination [12] [13] [14]. This approach will aid in reaching a rapid diagnosis and initiating prompt therapies.

The aim of the present study was the assessment of the role of focused echocardiography and lung ultrasound protocol for the guidance of treatment and its effect on hospitalization period in acute heart failure patients admitted to the CCU as well as its impact on the 6 months re-hospitalization and mortality.

2. Methods

This single-center study included 40 consecutive patients admitted to a tertiary care university hospital with the diagnosis of acute heart failure.

The study patients were divided into 2 groups:

Group I included 20 patients who received the standard of care treatment.

Group II (the focused echocardiography and lung ultrasound group) included 20 patients who received a modification of medication doses according to the

daily imaging changes.

Patients with altered mental status, severe mitral stenosis, mitral valve prosthesis, those on hemodialysis or with lung fibrosis were all excluded from the study.

After giving informed consent, all patients were subjected to thorough history taking, clinical examination, laboratory analysis including NT-Pro BNP measurement as well as routine echocardiography. While patients in group II were subjected additionally to daily focused echocardiogram including (E wave velocity, E/A ratio, TDI of medial and lateral mitral annulus, E/e' ratio, IVC diameter and IVC collapsibility index) as well as lung ultrasound examination (to detect B lines and pleural effusion) to assess the extent of pulmonary congestion.

The lung ultrasound examination protocol for evaluating B lines was performed by scanning 28-region protocol on the anterior chest with the patient in the semi-sitting position (around 45 degrees). The number of B-lines in the antero-lateral chest scan is summed to generate a quantitative B-line score for assessing the severity of pulmonary congestion [15] [16] [17] [18] [19].

Score	Number of B-lines	Pulmonary congestion
0	≤5	Absent
1	6 - 15	Mild degree
2	16 - 30	Moderate degree
3	>30	Severe degree

Modification of the doses of IV diuretics (dose escalation, shift to IV infusion, or combining different classes of diuretics) was made according to the daily lung ultrasound examination changes.

The primary treatment targets within group II (the focused echocardiography and lung ultrasound-based treatment group) in priority order were;

1) Relief of symptoms of congestion;

2) Resolution of pulmonary congestion on LUS (total B lines score <5 and resolution of pleural effusion);

3) An E/e' of <15;

4) Decrease of IVC diameter and increase IVC collapsibility index >50%.

Decongestive pharmacologic therapy consisted mainly of loop diuretics and vasodilators. The starting dose of loop diuretics (furosemide or torsemide) was 2.5 times the patient's usual dose in the form of intravenous shots. In more severe cases, the starting diuretic treatment of furosemide was 5 - 10 mg/hour in the form of continuous intravenous infusion. The diuretic dose was uptitrated or downtitrated according to the daily clinical, focused echocardiographic and lung ultrasound assessment and if diuretic resistance is noted, early combination with thiazide diuretics or mineralocorticoid receptor antagonists (MRA) at diuretic doses was considered.

Other pharmacologic evidence-based HF therapies such as beta-blockers, an-

giotensinconverting enzyme inhibitors (ACEI), Angiotensin-receptor blockers (ARBs) were administered as usual during hospitalization.

All patients were followed up for 6 months by phone call or scheduled visits to assess the 6 months HF rehospitalization and death rates.

3. Results

The mean age was 62.40 ± 11.29 years and 58.80 ± 10.32 years for group I and II respectively. 55% of group I patients were females, while only 25% of group II patients were females as shown in Table 1.

Among group II patients, the mean IVC diameter was 23.30 ± 3.06 mm on the first day of assessment and decreased to 19.79 ± 3.16 mm on the last assessment day (p value < 0.01). Moreover, the mean IVC collapsibility index was 32.30% ± 14.40% at baseline assessment and was improved to 50.75% ± 8.32% at the day

Table 1. The baseline characteristics, clinical and laboratory data of both groups.

	Group 1 (n = 20)	Group 2 (n = 20)	P-value
Age	62.40 ± 11.29	58.80 ± 10.32	0.299
Gender (Male)	9 (45%)	15 (75%)	0.053
Past History			
Previous HF	18 (90%)	19 (95%)	1
Prior HF Hospitalization	11 (55%)	12 (60%)	0.749
Hypertension	14 (70%)	15 (75%)	0.723
D.M	15 (75%)	12 (60%)	0.311
AF	6 (30%)	3 (15%)	0.451
Renal disease	8 (40%)	7 (35%)	0.744
COPD	2 (10%)	4 (20%)	0.661
IHD	19 (95%)	17 (85%)	0.217
Congested neck viens (>5 cm)	7 (35%)	8 (40%)	0.744
SBP	118.0 ± 24.41	119.0 ± 21.25	0.891
DBP	73.50 ± 13.87	73.50 ± 11.37	1
HR	93.50 ± 17.17	92.70 ± 11.83	0.865
Basal crepitations	10 (50%)	12 (60%)	0.451
L.L. oedema	13 (65%)	14 (70%)	0.238
Serum K level	4.20 ± 0.72	4.12 ± 0.64	0.713
Serum Creatinine	1.51 ± 1.09	1.50 ± 1.16	0.924
Baseline BNP	9718.8 ± 10,109.2	9523.2 ± 3163.5	0.172
Discharge BNP	2155.4 ± 1972.7	2111.6 ± 1655.6	0.449
Ejection Fraction	34.0 ± 10.70	33.40 ± 8.39	0.738
Mitral Regurgitation	12 (60%)	11 (55%)	0.209

of discharge or a day before discharge (p value < 0.01) as shown in Table 2 and Figure 1.

The mean number of B lines at the initial LUS assessment was 63.40 ± 21.45 and 4.45 ± 2.46 at the day of or/a day prior to patients' discharge (p value < 0.01) as shown in Table 3 and Figure 2.

Regarding the morbidity and mortality outcomes, patients of group II (the focused echocardiography and LUS based treatment protocol) had a shorter duration of hospitalization, 6.45 ± 2.01 days compared to 9.10 ± 3.82 days among group I patients (P = 0.02). The rate of recurrent HF hospitalization within 6 months was 35% and 30% for groups I and II, respectively (P = 0.739). The 6-month all-cause mortality rate was 15% and 20% for groups I and II, respectively (P = 0.681) as shown in Table 4.

Table 2. The daily variations of IVC diameter and collapsibility index among group II patients.

IVC	Reading						Discharge (n = 20)	T	p
	1st (n = 20)	2nd (n = 20)	3rd (n = 20)	4th (n = 10)	5th (n = 8)	6th (n = 2)			
Diameter (mm)									
Min. - Max.	18.0 - 28.0	17.0 - 29.0	14.0 - 27.0	16.0 - 26.0	16.0 - 25.0	16.0 - 23.0	14.0 - 26.0		
Mean ± SD.	23.30 ± 3.06	22.10 ± 3.52	20.50 ± 3.47	21.50 ± 3.57	20.88 ± 3.04	19.50 ± 4.95	19.75 ± 3.16	11.384	<0.001*
Median	23.0	23.0	20.50	21.50	20.50	19.50	20.0		
Collapsibility index									
Min. - Max.	10.0 - 60.0	18.0 - 60.0	20.0 - 65.0	25.0 - 60.0	35.0 - 60.0	45.0 - 60.0	35.0 - 65.0		
Mean ± SD.	32.30 ± 14.40	35.60 ± 13.58	43.50 ± 12.47	42.50 ± 10.61	49.37 ± 9.80	52.50 ± 10.61	50.75 ± 8.32	6.840*	<0.001*
Median	32.50	30.0	45.0	42.50	47.50	52.50	50.0		

Table 3. The daily variations of B-Lines score using 28 points scanning protocol among group II patients.

	Reading						Discharge	Z	p
	1st	2nd	3rd	4th	5th	6th			
B. Lines	(n = 20)	(n = 20)	(n = 20)	(n = 10)	(n = 8)	(n = 2)	(n = 20)		
Min. - Max.	32.0 - 122.0	17.0 - 102.0	1.0 - 78.0	3.0 - 42.0	2.0 - 23.0	3.0 - 5.0	1.0 - 10.0		
Mean ± SD.	63.40 ± 21.45	49.30 ± 20.16	21.60 ± 21.51	20.90 ± 14.65	8.88 ± 7.68	4.0 ± 1.41	4.45 ± 2.46	3.920*	<0.001*
Median	59.0	45.50	10.50	17.50	5.50	4.0	4.50		

Table 4. Shows the morbidity and mortality outcomes of both study groups.

	Group 1 (n = 20)	Group 2 (n = 20)	P-value
6 months recurrent HF hospitalization	7 (35%)	6 (30%)	0.739
All-cause mortality within 6 months	3 (15%)	4 (20%)	0.681
Mean hospitalization duration (Days)	9.10 ± 3.82	6.45 ± 2.01	0.020

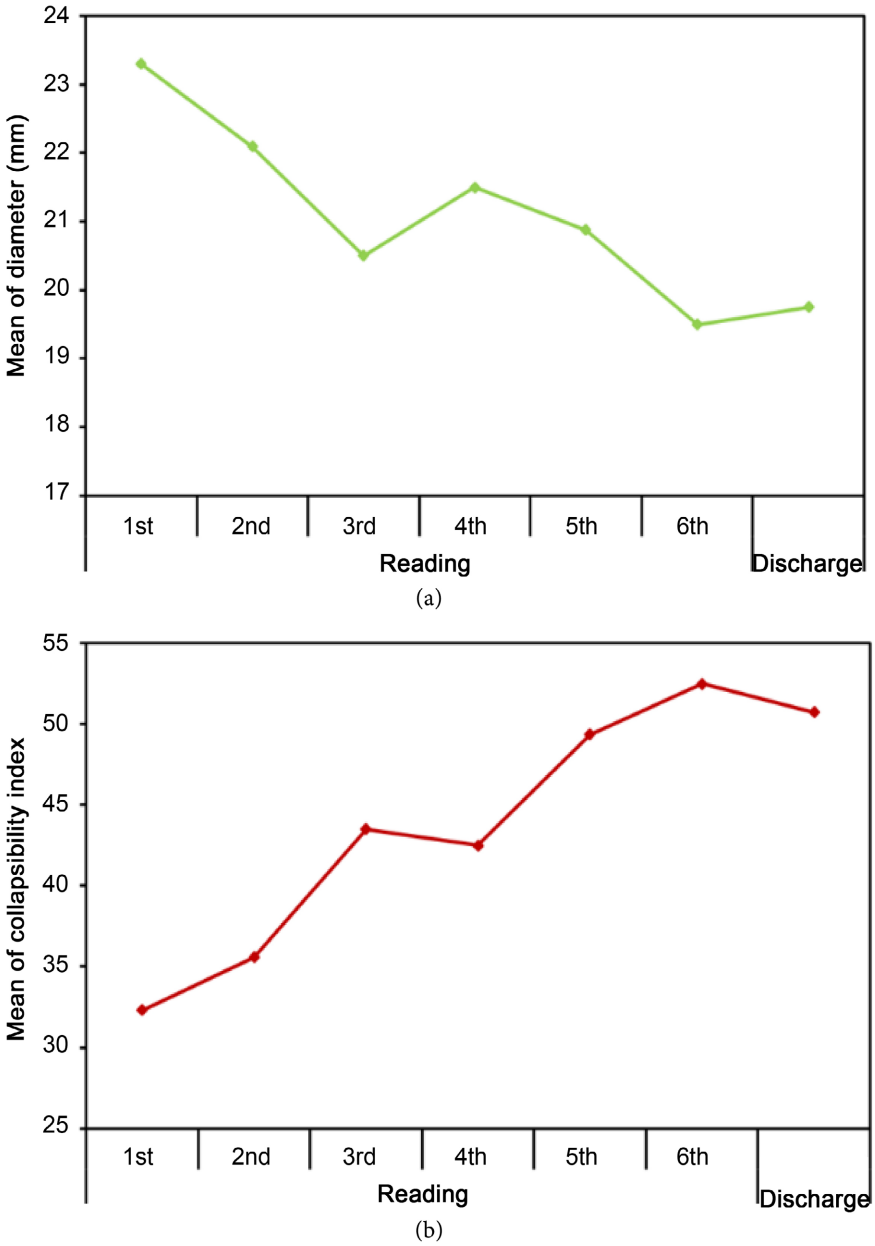

Figure 1. Shows the improvement in IVC diameter ((a)-on the left), and IVC collapsibility index ((b)-on the right) from admission to discharge in group II patients.

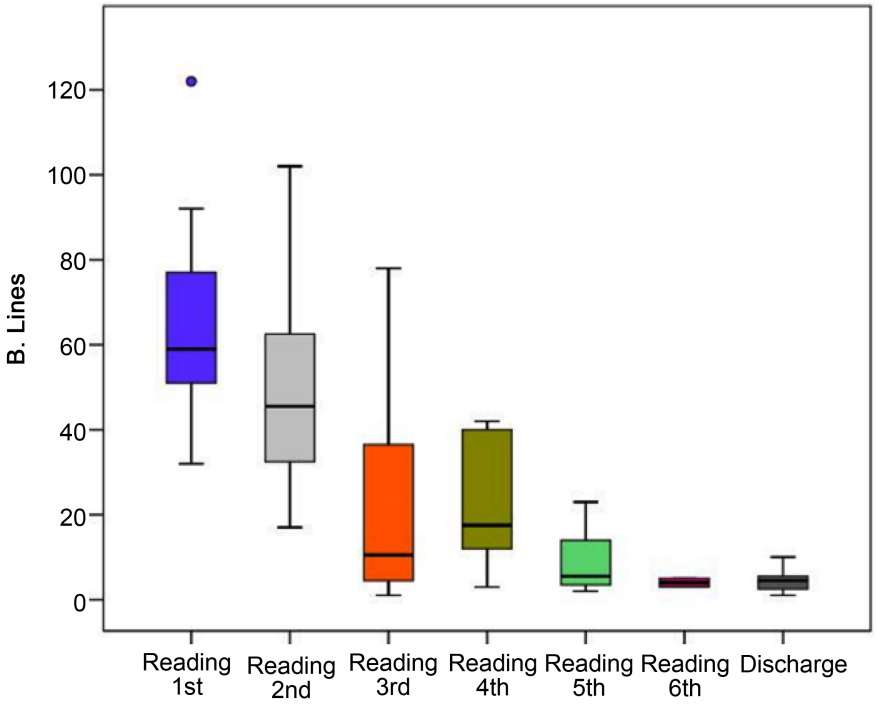

Figure 2. Shows the comparison of different days' assessments according to B lines among group II patients.

4. Discussion

The last years have witnessed marked progress in both pharmacological and device-based treatment of chronic heart failure, which has reflected on long-term survival. On the other hand, the prognosis of acute heart failure remains poor concerning mortality and rehospitalization with a worsening heart failure state. This could be attributed to the paucity of improvements in the acute management of those patients.

Congestion and volume overload are regarded as the main reasons for hospitalization in acute heart failure patients. However, many patients are discharged without losing body weight and some of them still have persistent signs of congestion [20] [21]. The congestion state caries a poor outcome and it is considered as an important target for therapy [22] [23].

The gold standard for evaluating hemodynamic congestion in HF patients is cardiac catheterization to measure right atrial pressure and PCWP. However, the invasive nature of catheterization limits its routine use in practice. No single non-invasive test can accurately detect hemodynamic congestion, and the ability to detect congestion by hemodynamic measurements remains a diagnostic challenge because it usually precedes clinical symptoms [24]. The available data suggested that a pre-discharge clinical assessment of congestion is often not systematically performed [25].

The current study was designed to test the role of focused echocardiography and lung ultrasonography for the guidance of treatment in a small cohort of acute heart failure patients. The results within this population were compared

with those of group I (the standard care group). Treatment in this standard care group is reflecting the standard in-hospital treatment for AHF in our tertiary care hospital. 40 patients with acute heart failure were included in our study. Clinical, laboratory, echocardiographic evaluation was done for all patients. Daily focused echocardiography and lung ultrasound assessment were done on the patients of group II, and the treatment plan was modified accordingly.

Among acute heart failure patients, a shorter hospitalization period has a positive effect on both patient's prognosis and national health resources. Moreover, advanced heart failure and related acute decompensation have become the single most costly medical syndrome in cardiology [25].

Regarding the feasibility and safety of the focused echocardiography and lung ultrasound protocol for the management of acute heart failure, it is a feasible and safe tool, taking not more than 10 minutes for each study and without the occurrence of any adverse events.

The present study did not show a statistically significant difference between the two groups of patients regarding the 6 months rehospitalization and death rates despite a significantly shorter duration of hospitalization, this is maybe attributed to the small sample size which is one of the study limitations.

ESCAPE trial was a multi-center trial that included 433 acute heart failure patients. Patients were assigned to receive therapy guided by clinical assessment and a PAC (pulmonary artery catheters) or clinical assessment alone. The target in both groups was the resolution of clinical congestion, with additional PAC targets of a pulmonary capillary wedge pressure of 15 mm Hg and a right atrial pressure of 8 mm Hg (AHF treatment guided by pulmonaryartery catheter was non-useful compared with conventional therapy) [26]. It is noteworthy, however, that physicians treating ESCAPE trial patients had central venous pressure measurements and echocardiograms available daily basis in both groups, although their role for guiding treatment was not reported.

Jonas Ohman, *et al.* [27] conducted a clinical randomized trial on 120 acute heart failure patients who were divided into 2 arms; a standard care arm included 100 patients and a treatment arm included 20 patients. Both groups of patients were subjected daily to a focused echocardiographic assessment (to assess LV filling pressures E/e, septal E/e and IVC collapsibility index) and a thoracic ultrasound examination (searching for bilateral B lines using the rapid 6 areas method and bilateral pleural effusion). The management plan of the patients of the treatment arm was modified daily according to the echocardiographic and lung ultrasound examination. The study results showed that The CaTUS-guided therapy showed a significantly larger decongestion despite a shorter mean duration of hospitalization. Congestion parameters were significantly lower also at the time of discharge ($P < 0.05$ for all), without any significant difference in these parameters at the time of admission. The treatment arm showed better survival regarding the combined endpoint of 6-month all-cause death or rehospitalization due to AHF ($P = 0.017$).

In this study, the NT proBNP level at the time of admission and discharge was checked in all patients, the low availability and high costs of the NT proBNP kits rendered it difficult to be used for monitoring of the treatment during the hospital stay. There was no significant difference between both groups regarding the NT-proBNP level measured at admission or discharge.

Stiensen S, *et al*. [28] tested the hypothesis that using a relative NT-proBNP target may lead to improvement of the outcomes in comparison with conventional therapy. They conducted a prospective randomized controlled trial on 404 patients who were randomized to either NT-proBNP-guided or conventional treatment in a 1:1 fashion, with a predefined NT-proBNP target (>30% reduction from admission to discharge) versus conventional treatment. The results showed that there were no statistical differences in 6 months rehospitalization and death rates between both groups.

Luke J. Laffin, *et al*. [29] conducted a prospective trial on 82 patients with AHF to determine if focused cardiac ultrasound (FCU) of the inferior vena cava (IVC), as a prove of volume status, would predict readmission rates or not. All patients underwent FCU of the IVC on admission and then daily. Patients demonstrated improvement in heart failure physical examination findings and symptoms during the hospitalization. There was a reduction in the size of the IVC and a significant increase in patients with small collapsible vena cava. They concluded that FCU assessment of IVC size and collapsibility may show some usefulness in patients with AHF to predict the risk of readmission within 30 days of hospital discharge.

5. Study Limitations

1) Small numbers of patients were included in the study.
2) A short period of follow-up of patients.
3) No hemodynamic data of patients were available.
4) N-terminal pro-BNP was done only twice; on admission and discharge.

6. Conclusions

The focused echocardiography and lung ultrasound-guided therapy for AHF resulted in a shorter duration of hospitalization without increased adverse events. It is a feasible tool of monitoring and is recommended for use in clinical practice.

Future randomized trials with bigger populations are needed to define whether individualized focused echocardiographic and ultrasound-guided treatment could improve post-discharge prognosis (HF rehospitalization and death rates) or not.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Ponikowski, P., Voors, A.A., Anker, S.D., Bueno, H., Cleland, J.G., Coats, A.J., *et al*. (2016) 2016 ESC Guidelines for the Diagnosis and Treatment of Acute and Chronic Heart Failure. *European Journal of Heart Failure*, **18**, 891-975. https://doi.org/10.1002/ejhf.592

[2] Fuat, A., Murphy, J.J., Hungin, A.P.S., Curry, J., Mehrzad, A.A., Hetherington, A., *et al*. (2006) The Diagnostic Accuracy and Utility of a B-Type Natriuretic Peptide Test in a Community Population of Patients with Suspected Heart Failure. *British Journal of General Practice*, **56**, 327-333.

[3] Yamamoto, K., Burnett, J.C., Bermudez, E.A., Jougasaki, M., Bailey, K.R. and Redfield, M.M. (2000) Clinical Criteria and Biochemical Markers for the Detection of Systolic Dysfunction. *Journal of Cardiac Failure*, **6**, 194-200. https://doi.org/10.1054/jcaf.2000.9676

[4] Cowie, M.R., Struthers, A.D., Wood, D.A., Coats, A.J., Thompson, S.G., Poole-Wilson, P.A., *et al*. (1997) Value of Natriuretic Peptides in Assessment of Patients with Possible New Heart Failure in Primary Care. *The Lancet*, **350**, 1349-1353. https://doi.org/10.1016/S0140-6736(97)06031-5

[5] Krishnaswamy. P., Lubien, E., Clopton, P., Koon, J., Kazanegra, R., Wanner, E., *et al*. (2001) Utility of B-Natriuretic Peptide Levels in Identifying Patients with Left Ventricular Systolic or Diastolic Dysfunction. *The American Journal of Medicine*, **111**, 274-279. https://doi.org/10.1016/S0002-9343(01)00841-5

[6] Kelder. J.C., Cramer, M.J., Verweij, W.M., Grobbee, D.E. and Hoes, A.W. (2011) Clinical Utility of Three B-Type Natriuretic Peptide Assays for the Initial Diagnostic Assessment of New Slow-Onset Heart Failure. *Journal of Cardiac Failure*, **17**, 729-734. https://doi.org/10.1016/j.cardfail.2011.04.013

[7] Gustafsson, F., Steensgaard-Hansen, F., Badskjaer, J., Poulsen, A.H., Corell, P., *et al*. (2005) Diagnostic and Prognostic Performance of N-Terminal ProBNP in Primary Care Patients with Suspected Heart Failure. *Journal of Cardiac Failure*, **11**, S15-S20. https://doi.org/10.1016/j.cardfail.2005.04.022

[8] Nielsen, O.W., Rasmussen, V., Christensen, N.J. and Hansen, J.F. (2004) Neuroendocrine Testing in Community Patients with Heart Disease: PLASMa N-Terminal Proatrial Natriuretic Peptide Predicts Morbidity and Mortality Stronger than Catecholamines and Heart Rate Variability. *Scandinavian Journal of Clinical and Laboratory Investigation*, **64**, 619-628. https://doi.org/10.1080/00365510410002878

[9] Kelder, J.C., Cowie, M.R., McDonagh, T.A., Hardman, S.M., Grobbee, D.E., Cost, B. and Hoes, A.W. (2011) Quantifying the Added Value of BNP in Suspected Heart Failure in General Practice: An Individual Patient Data Meta-Analysis. *Heart*, **97**, 959-963. https://doi.org/10.1136/hrt.2010.220426

[10] Kirkpatrick, J.N., Vannan, M.A., Narula, J. and Lang, R.M. (2007) Echocardiography in Heart Failure: Applications, Utility, and New Horizons. *Journal of the American College of Cardiology*, **50**, 381-396. https://doi.org/10.1016/j.jacc.2007.03.048

[11] Nagueh, S.F., Bhatt, R., Vivo, R.P., Krim, S.R., Sarvari, S.I., Russell, K., *et al*. (2011) Echocardiographic Evaluation of Hemodynamics in Patients with Decompensated Systolic Heart Failure. *Circulation: Cardiovascular Imaging*, **4**, 220-227.

https://doi.org/10.1161/CIRCIMAGING.111.963496

[12] Lichtenstein, D. and Axler, O. (1993) Intensive Use of General Ultrasound in the Intensive Care Unit. Prospective Study of 150 Consecutive Patients. *Intensive Care Medicine*, **19**, 353-355. https://doi.org/10.1007/BF01694712

[13] Lichtenstein, D. and Mezière, G. (2008) Relevance of Lung Ultrasound in the Diagnosis of Acute Respiratory Failure: the BLUE Protocol. *Chest*, **134,** 117-125. https://doi.org/10.1378/chest.07-2800

[14] Reissig, A., Copetti, R., Mathis, G., Mempel, C., Schuler, A., Zechner, P., *et al*. (2012) Lung Ultrasound in the Diagnosis and Follow-Up of Community-Acquired Pneumonia: A Prospective, Multicenter, Diagnostic Accuracy Study. *Chest*, **142**, 965-972. https://doi.org/10.1378/chest.12-0364

[15] Lichtenstein, D., Mézière, G., Biderman, P., Gepner, A. and Barré, O. (1997) The Comet-Tail Artifact, an Ultrasound Sign of Alveolar-Interstitial Syndrome. *American Journal of Respiratory and Critical Care Medicine*, **156**, 1640-1646. https://doi.org/10.1164/ajrccm.156.5.96-07096

[16] Feissel, M., Michard, F., Faller, J.P. and Teboul, J.L. (2004) The Respiratory Variation in Inferior Vena Cava Diameter as a Guide to Fluid Therapy. *Intensive Care Medicine*, **30**, 1834-1837. https://doi.org/10.1007/s00134-004-2233-5

[17] Jambrik, Z., Monti, S., Coppola, V., Agricola, E., Mottola, G., Miniati, M. and Picano, E. (2004) Usefulness of Ultrasound Lung Comets as a Nonradiologic Sign of Extravascular Lung Water. *The American Journal of Cardiology*, **93**, 1265-1270. https://doi.org/10.1016/j.amjcard.2004.02.012

[18] Labovitz, A.J., Noble, V.E., Bierig, M., Goldstein, S.A., Jones, R., Kort, S., *et al*. (2010) Focused Cardiac Ultrasound in the Emergent Setting: A Consensus Statement of the American College of Emergency Physicians. *Journal of the American Society of Echocardiography*, **23**, 1225-1230. https://doi.org/10.1016/j.echo.2010.10.005

[19] Frassi, F., Gargani, L., Tesorio, P., Raciti, M., Mottola, G. and Picano, E. (2007) Prognostic Value of Extravascular Lung Water Assessed with Ultrasound Lung Comets by Chest Sonography in Patients with Dyspnea and/or Chest Pain. *Journal of Cardiac Failure*, **13**, 830-835. https://doi.org/10.1016/j.cardfail.2007.07.003

[20] Coiro, S., Porot, G., Rossignol, P., Ambrosio, G., Carluccio, E., Tritto, I., *et al*. (2016) Prognostic Value of Pulmonary Congestion Assessed by Lung Ultrasound Imaging during Heart Failure Hospitalisation: A Two-Centre Cohort Study. *Scientific Reports*, **6**, Article No. 39426. https://doi.org/10.1038/srep39426

[21] Komajda, M., Follath, F., Swedberg, K., Cleland, J., Aguilar, J.C., *et al*., Study Group on Diagnosis of the Working Group on Heart Failure of the European Society of Cardiology (2003) The EuroHeart Failure Survey Programme—A Survey on the Quality of Care among Patients with Heart Failure in Europe. Part 2: Treatment. *European Heart Journal*, **24**, 464-474. https://doi.org/10.1016/S0195-668X(02)00700-5

[22] Nieminen, M.S., Bohm, M., Cowie, M.R., Drexler, H., Filippatos, G.S., Jondea, G., Hasin, Y., *et al*. (2005) Executive Summary of the Guidelines on the Diagnosis and Treatment of Acute Heart Failure: The Task Force on Acute Heart Failure of the European Society of Cardiology. *European Heart Journal*, **26**, 384-416. https://doi.org/10.1093/eurheartj/ehi044

[23] Krim, S.R., Campbell, P.T., Desai, S., Mandras, S., Patel, H., Eiswirth, C., *et al*. (2015) Management of Patients Admitted with Acute Decompensated Heart Failure. *Ochsner Journal*, **15**, 284-289.

[24] Gheorghiade, M., Follath, F., Ponikowski, P., Barsuk, J.H., Blair, J.E., Cleland, J.G., *et al*. (2010) Assessing and Grading Congestion in Acute Heart Failure: A Scientific Statement from the Acute Heart Failure Committee of the Heart Failure Association of the European Society of Cardiology and Endorsed by the European Society of Intensive Care Medicine. *European Journal of Heart Failure*, **12**, 423-433. https://doi.org/10.1093/eurjhf/hfq045

[25] Stevenson, L.W. (2006) Are Hemodynamic Goals Viable in Tailoring Heart Failure Therapy? Hemodynamic Goals Are Relevant. *Circulation*, **113**, 1020-1027. https://doi.org/10.1161/CIRCULATIONAHA.104.478321

[26] Binanay, C., Califf, R.M., Hasselblad, V., O'Connor, C.M., Shah, M.R., Sopko, G., *et al*. (2005) Evaluation study of Congestive Heart Failure and Pulmonary Artery Catheterization Effectiveness: The ESCAPE Trial. *Journal of the American Medical Association*, **294**, 1625-1633. https://doi.org/10.1001/jama.294.13.1625

[27] Ohman, J., Harjola, V.P., Karjalainen, P. and Lassus, J. (2018) Focused Echocardiography and Lung Ultrasound Protocol for Guiding Treatment in Acute Heart Failure. *ESC Heart Failure*, **5**, 120-128. https://doi.org/10.1002/ehf2.12208

[28] Stienen, S., Salah, K., Moons, A.H., Bakx, A.L., van Pol, P., Kortz, R.A.M., *et al*. (2018) NT-proBNP (N-Terminal pro-B-Type Natriuretic Peptide)-Guided Therapy in Acute Decompensated Heart Failure. *Circulation*, **137**, 1671-1683. https://doi.org/10.1161/CIRCULATIONAHA.117.029882

[29] Laffin, L.J., Patel, A.V., Saha, N., Barbat, J., Hall, J.K., Cain, M., *et al*. (2018) Focused Cardiac Ultrasound as a Predictor of Readmission in Acute Decompensated Heart Failure. *The International Journal of Cardiovascular Imaging*, **34**, 1075-1079. https://doi.org/10.1007/s10554-018-1317-1