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EDITORIAL COMMENT

Is the Inferior Vena Cava Really Superior?

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Estimation of volume status is a critical component in the care of patients with heart failure. Such assessments are used on a routine basis to guide therapeutic decision making, including adjustment of diuretics, whether to initiate or uptitrate beta-adrenergic blockers, and whether to hospitalize a patient. Traditionally, the cornerstone of volume assessment has been the history and physical examination, but there are concerns regarding its accuracy. Thus, a variety of additional techniques for assessing volume status have been tested, including measurement of biomarkers (e.g., natriuretic peptide levels) and performance of imaging studies (e.g., echocardiography).

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In this issue of *iJACC*, Pellicori et al. (1) provide an important contribution to the literature. In their study of nearly 700 patients (568 with heart failure) evaluated in a "specialist community clinic" in the United Kingdom, the maximal diameter of the inferior vena cava (IVC_{max}) at approximately 3 cm from the right atrium was measured by echocardiography. The study's noteworthy findings included that IVC_{max} was a reproducible measurement; there was a broad distribution of IVC_{max} among patients with heart failure; IVC_{max} was correlated with natriuretic peptide levels and clinical markers of congestion including the jugular venous pressure (JVP); and an increased IVC_{max} was independently associated with the composite endpoint of heart failure hospital admission and cardiovascular death, as well as overall mortality, in multivariable models that were adjusted for other risk factors including N-terminal pro–B-type natriuretic peptide (NT-proBNP) level. This is the first large study of patients with heart failure to demonstrate that IVC assessed by echocardiography has powerful prognostic utility, and the investigators are to be congratulated for moving the field forward.

Importance of IVC and right atrial pressure in left heart failure. The rationale for measuring the IVC in left heart failure is that IVC distention is related to an increased right atrial pressure (RAP) (2), and several lines of evidence demonstrate that elevated RAP is an adverse risk factor in left heart failure. First, elevated JVP, reflecting elevated RAP, was independently associated with the risk of hospitalization and death from pump failure in the SOLVD (Studies of Left Ventricular Dysfunction) treatment trial (3). Second, in patients with left ventricular (LV) systolic heart failure, a reduced right ventricular ejection fraction (which ultimately would result in an elevated RAP) is a risk factor for mortality (4,5). Third, RAP often mirrors LV filling pressure in chronic heart failure, whether the LV ejection fraction is reduced (6–8) or preserved (9), and elevated LV filling pressure has been shown to be associated with adverse outcomes in patients with advanced heart failure (10).

How best to estimate RAP in heart failure? In prior studies (2,11,12), the maximal diameter of IVC, which is the method used in the current study (1), correlated modestly with RAP with correlation coefficients between these 2 parameters ranging from r = 0.48 (2) to r = 0.56 (12). IVC collaps-

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ibility with inspiration was shown to more accurately measure RAP as compared with IVC_{max} (2), although combining both approaches may be preferable (11). Three-dimensional echocardiographic measurement of right atrial volume has also been shown to have utility in assessing RAP (12).

It is also important to consider whether echocardiographic measurement of IVC_{max} is more useful than clinical examination of the jugular veins for estimation of RAP. Although the investigators stated that the RAP "evaluation by physical examination is unreliable" (1), by receiver-operating characteristic analysis the area under the curve (AUC) for clinical estimation of RAP >12 mm Hg in the ESCAPE (Evaluation Study of Congestive Heart Failure and Pulmonary Artery Catheterization Effectiveness) trial was 0.74 (13), which is very similar to the published AUC for estimating RAP by ultrasound (0.76) (11,12). In the current study, the methodology for IVC_{max} measurement was rigorous, but less information was provided concerning the evaluation of the JVP. The categories used to assess the jugular veins were described ("not visible, raised 1 to 4 cm, raised to earlobe"), but such categories would reflect drastically different RAPs depending upon the angle at which the patients lay during examination (e.g., jugular venous distention to the earlobe is very different if a patient is supine or upright). Further, it was not reported who performed the physical examination nor how experienced they were in assessing the JVP. Unfortunately, in my observation, lack of such details regarding the methodology of the clinical evaluation is not uncommon in the published literature when clinical assessment is not the primary focus of the investigation, but one which should be considered when assessing studies that purport to demonstrate that a new technique (whether it is a biomarker or an imaging technique) is superior to the history and physical examination.

Where do we go from here? The time has come to assess whether routine incorporation of hand-carried echocardiography to assess filling pressures can improve clinical outcomes of patients with heart failure as compared with therapy based upon a carefully performed history and physical examination. An evidence base for such a trial is beginning to emerge. In a study in which hand-carried echocardiography, BNP levels, and clinical evaluation were used to estimate elevated LV filling pressures (pulmonary capillary wedge pressure >15 mm Hg) in patients with chronic systolic heart failure, IVC_{max} had the highest AUC (0.89) followed by BNP levels (0.88), evaluation of JVP (0.82), and a clinical congestion score (0.74) (14). Importantly, the combination of these parameters had better operating characteristics (AUC 0.97) than any individual test, highlighting the potential utility of combining hand-carried echocardiography with the traditional history and physical examination. The important study by Pellicori et al. (1) provides further impetus to move toward such a clinical trial and emphasizes that IVC measurement should be included in such an endeavor.

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REFERENCES

1. Pellicori P, Carubelli V, Zhang J, et al. IVC diameter in patients with chronic heart failure: relationships and prognostic significance. J Am Coll Cardiol Img 2013;6:16–28.
2. Kircher BJ, Himelman RB, Schiller NB. Noninvasive estimation of right atrial pressure from the inspiratory collapse of the inferior vena cava. Am J Cardiol 1990;66:493–6.
3. Drazner MH, Rame JE, Stevenson LW, Dries DL. Prognostic importance of elevated jugular venous pressure and a third heart sound in patients with heart failure. N Engl J Med 2001;345:574–81.
4. Di Salvo TG, Mathier M, Semigran MJ, Dec GW. Preserved right ventricular ejection fraction predicts exercise capacity and survival in advanced heart failure. J Am Coll Cardiol 1995;25:1143–53.
5. Meyer P, Filippatos GS, Ahmed MI, et al. Effects of right ventricular ejection fraction on outcomes in chronic systolic heart failure. Circulation 2010;121:252–8.
6. Campbell P, Drazner MH, Kato M, et al. Mismatch of right- and left-sided filling pressures in chronic heart failure. J Card Fail 2011;17:561–8.
7. Drazner MH, Brown RN, Kaiser PA, et al. Relationship of right- and left-sided filling pressures in patients with advanced heart failure: a 14-year multi-institutional analysis. J Heart Lung Transplant 2012;31:67–72.
8. Drazner MH, Hamilton MA, Fonarow G, Creaser J, Flavell C, Stevenson LW. Relationship between right and left-sided filling pressures in 1000 patients with advanced heart failure. J Heart Lung Transplant 1999;18:1126–32.
9. Drazner MH, Prasad A, Ayers C, et al. The relationship of right- and left-sided filling pressures in patients with heart failure and a preserved ejection fraction. Circ Heart Fail 2010;3:202–6.
10. Stevenson LW, Tillisch JH, Hamilton M, et al. Importance of hemodynamic response to therapy in predicting survival with ejection fraction less than or equal to 20% secondary to ischemic or nonischemic dilated cardiomyopathy. Am J Cardiol 1990;66:1348–54.

11. Brennan JM, Blair JE, Goonewardena S, et al. Reappraisal of the use of inferior vena cava for estimating right atrial pressure. J Am Soc Echocardiogr 2007;20:857–61.
12. Patel AR, Alsheikh-Ali AA, Mukherjee J, et al. 3D echocardiography to evaluate right atrial pressure in acutely decompensated heart failure correlation with invasive hemodynamics. J Am Coll Cardiol Img 2011;4:938–45.
13. Drazner MH, Hellkamp AS, Leier CV, et al. Value of clinician assessment of hemodynamics in advanced heart failure: the ESCAPE trial. Circ Heart Fail 2008;1:170–7.
14. Goonewardena SN, Blair JE, Manuchehry A, et al. Use of hand carried ultrasound, B-type natriuretic peptide, and clinical assessment in identifying abnormal left ventricular filling pressures in patients referred for right heart catheterization. J Card Fail 2010;16:69–75.

Key Words: echocardiography ■ heart failure ■ physical examination ■ prognosis.