Evidence tables: Inferior vena cava collapsibility index (IVC-CI)

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<th>Author (Year)</th>
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<td>Stawicki et al (2009)</td>
<td>Prospective hemodynamic status evaluation utilizing intensivist bedside ultrasonography (INBU) in the surgical intensive care unit (SICU). The authors specifically focus on correlations between central venous pressure (CVP) and IVC-CI</td>
<td>Prospective study of 124 patients, of whom 63 had both CVP and IVC-CI available for comparison</td>
<td>Both CVP and IVC-CI measurements were grouped according to predefined ranges. For CVP, these were &lt;7, 7-12, and &gt;12 mmHg. For IVC-CI, the ranges were &lt;0.20, 0.20-0.60, and &gt;0.60. There was a clear, step-wise correlation between CVP and IVC-CI ranges. Few (&lt;5%) patients with IVC-CI &lt;0.20 had CVP &lt;7 while most (&gt;60%) patients with IVC-CI &gt;0.6 had CVP &gt;7. Noting that approximately half of study patients fell into the intermediate IVC-CI range, the authors emphasize that the ability of IVC-CI to help define intravascular “volume overload” or “volume depletion” is highest at the two extremes of IVC-CI (i.e., close to 1.0 or 0.0).</td>
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<td>Goonewardena et al (2009)</td>
<td>Serial concurrent assessments of the inferior vena cava (IVC) sonographic dimensions and brain natriuretic peptide (BNP) levels to identify patients with acute decompensated heart failure (ADHF)</td>
<td>This study included 75 patients who were admitted with a primary diagnosis of acute decompensated heart failure (ADHF)</td>
<td>During the 30-day follow-up, 31 patients presented back to the Emergency Department or required re-admission to the hospital. Patients who required re-admission to hospital had larger sonographic IVC dimensions on both hospital admission and discharge. Re-admitted patients had persistently “plethoric” IVCs with lower IVC-CI on discharge (36% versus 87% for those who were not re-admitted). At discharge, only serum sodium, log-transformed BNP measurement, IVC size, and IVC-CI significantly predicted re-admission in ADHF patients.</td>
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<td>Wallace et al (2010)</td>
<td>Prospective investigation to determine the importance of different anatomic (vascular) locations when measuring the inferior vena cava (IVC) diameter during quiet respiration</td>
<td>Thirty-nine volunteer participants were studied</td>
<td>Significant variability in IVC-CI was seen between the different anatomic measurement areas [listed as mean (±SD)]: (a) IVC-CI 20% (±16%) at the level of the diaphragm; (b) 30% (±21%) at the level of the hepatic vein inlet; and (c) 35% (±22%) at the level of the left renal vein. Among healthy volunteers, measurements of respiratory variation in IVC collapse are equivalent at the level of the left renal vein and at 2 cm caudal to the hepatic vein inlet. IVC-CI measurements taken at the junction of the right atrium and IVC are not equivalent to the other two studied sites [Editor's comment – It has been described that the diaphragm tethers the IVC at the RA junction and this may differ from other areas of the IVC that are more distensible. Sonographers should be aware of these important measurement discrepancies, including consequences of any potential biases, as well as alternative approaches to IVC-CI determination].</td>
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<td>Blair et al (2009)</td>
<td>Study was performed to determine if IVC size and respirophasic variation could be useful in predicting increased left ventricular filling pressure (LVFP) in patients with chronic heart failure</td>
<td>Seventy-two patients with chronic heart failure were prospectively studied in order to determine if IVC size and collapsibility could predict a pulmonary capillary wedge pressure of ≥15 mmHg. All patients underwent right heart catheterization and limited echocardiographic examination [focused on the IVC size and collapsibility].</td>
<td>The authors conclude that an IVCmax dimension of 2.0 cm and IVC-CI of 45% were the optimal cutoff values to predict increased (≥15 mmHg) pulmonary capillary wedge pressure (PCWP). In the context of these PCWP predictive characteristics, sensitivity and specificity for IVCmax dimension were 75% and 83%, respectively. For IVC-CI, the respective sensitivity and specificity were 83% and 71%.</td>
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<td>Fields et al (2011)</td>
<td>Determination of interater reliability of sonographic inferior vena cava evaluations by bedside clinician sonographers</td>
<td>Forty-six Emergency Department patients were studied [convenience sample]. Bedside ultrasound exams were performed by Emergency Medicine trained specialists. Sonographic determinations included visual estimation of IVC-CI followed by caliper measurements in M-mode and B-mode; Performing sonographers were blinded to the other sonographers' results.</td>
<td>A total of 92 ultrasound exams were performed (2 exams per patient). Intra-class correlation coefficients (ICC) were 0.81 (95%CI 0.67-0.89) for IVCmax diameter and 0.77 (95%CI 0.62-0.87) for IVCmax diameter. No significant differences were seen between caliper methods of IVC measurement (M-mode diameter, B-mode diameter, B-mode area). Agreement for visual IVC collapse estimation was 0.60 (95% CI 0.36-0.76) while for IVC-CI it was 0.52 (95% CI 0.27-0.71); Cohen’s weighted kappa for volume status based on visual estimation of IVC filling (size, shape, collapse) was 0.64 (95% CI 0.53-0.73). ICC values for M-mode diameter measurements were significantly higher in non-euvolemic patients and when obtained by sonographers with previous experience of ≥5 IVC ultrasound assessments. The authors conclude that the use of visual IVC collapse estimation methodology can be performed very rapidly and should be considered by clinicians familiar with traditional measurements of IVC parameters.</td>
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<td>Guiotto et al (2010)</td>
<td>A study to determine if sonographic IVC diameter and IVC collapsibility measurements could be utilized in optimization of fluid removal rate while avoiding hypotension during slow continuous ultrafiltration (SCUF)</td>
<td>Evaluation of 24 consecutive patients with acute decompensated heart failure (ADHF) and diuretic resistance who were admitted to medical ICU IVC diameters were determined by M-mode subcostal echocardiography during spontaneous breathing; It was evaluated before SCUF, at 12 hours, and just after the cessation of the procedure</td>
<td>Although there were no significant differences in mean arterial pressure, heart rate, respiratory rate, or IVC diameters before and after ultrafiltration, the IVC-CI increased significantly after SCUF. It is important to note that hypotension was observed only in patients who reached IVC-CI of &gt;30% and none of the non-hypotensive patients had IVC-CI above this level. IVC sonography is easy-to-perform, rapid, non-invasive, and provides excellent means for bedside monitoring of intravascular volume during SCUF procedures. [Editor’s comment – Due to study limitations, more research is needed to better define the utility and the optimal clinical application of this methodology]</td>
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<td>Masugata et al (2010)</td>
<td>Determination of age-related changes in IVC diameters</td>
<td>An evaluation of 200 patients was performed to determine IVC diameters and IVC-CI using M-mode ultrasound Mean age of study patients was 67±15 (range, 17-94 years) Minimal and maximal IVC diameters were obtained using M-mode sonography; IVC-CI was determined using minimal/maximal IVC determinations (versus traditional inspiratory/respiratory IVC diameter designation)</td>
<td>IVCmax diameter decreased significantly with advancing age (r= -0.221, p&lt;0.002). The respirophasic variation in IVC diameter increased significantly with advancing age (r=0.244, p&lt;0.001) Stepwise multiple regression demonstrated that age was an independent determinant for both IVCmax diameter and IVC-CI. The authors propose that age-related decreases in IVCmax diameter and increases in IVC-CI may indicate the decrease in right atrial pressure among some elderly patients, suggesting clinical implications of these findings in the context of dehydration and intravascular volume depletion</td>
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Table legend: Article rank [square brackets] is determined by the [number of citations]; ADHF = Acute decompensated heart failure; BNP = Brain natriuretic peptide; CVP = Central venous pressure; ICC = Intra-class correlation coefficient; ICU = Intensive care unit; IVC = Inferior Vena Cava; IVC-CI = Inferior vena cava collapsibility index; LVFP = Left Ventricular Filling Pressure; Min/Max = Minimal/Maximal; PCWP = Pulmonary Capillary Wedge Pressure; SCUF = Slow continuous ultrafiltration; SICU = Surgical ICU.

REFERENCES


