Section: Anaesthesiology

Original Research Article

A STUDY ON ASSESSMENT OF FLUID RESPONSIVENESS COMPARING CENTRAL VENOUS PRESSURE VERSUS INFERIOR VENACAVA COLLAPSIBILITY INDEX

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Received : 18/10/2025
Received in revised form : 07/12/2025
Accepted : 24/12/2025

Keywords:
Central Venous Pressure; Ultrasonography; Shock; Hemodynamic Monitoring; Fluid Therapy; Vena Cava, Inferior.

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DOI: 10.47009/jamp.2026.8.1.9

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (1); 44-49

ABSTRACT

Background: Accurate assessment of fluid responsiveness is essential in the early management of shock. Conventional static markers such as central venous pressure (CVP) have limited predictive value, while dynamic ultrasound-based measures may provide better guidance for resuscitation. This study assessed fluid responsiveness in shocked patients by comparing CVP with the inferior vena cava collapsibility index (IVCCI) and evaluated the usefulness of bedside non-invasive ultrasound in estimating intravascular volume status. **Materials and Methods:** A prospective observational study was conducted at Government Vellore Medical College and Hospital. One hundred twenty-one adults with clinical shock received sequential 500-ml crystalloid boluses, and IVCCI and CVP were recorded at predefined intervals. Vital signs and haemodynamic responses were monitored throughout resuscitation. Consecutive sampling was used, and adults requiring fluid resuscitation and central venous access were included. Fluid responsiveness was defined by sustained haemodynamic improvement following a 500-ml bolus, and diagnostic accuracy was assessed using receiver operating characteristic (ROC) analysis. **Result:** Among 121 shocked adults, 52 (43%) were fluid responders and 69 (57%) were non-responders. The mean expiratory IVC diameter was 1.50 ± 0.45 cm, the mean inspiratory diameter was 0.90 ± 0.39 cm, and IVCCI averaged 40.15 ± 18.38%. IVCCI demonstrated higher diagnostic performance, with a 50% cut-off yielding 93.34% sensitivity and 91.1% specificity (AUC 0.88; 95% CI: 0.84–0.94). CVP showed lower accuracy, with 80.14% sensitivity, 81.6% specificity, and an AUC of 0.80 (95% CI: 0.75–0.90). Most patients (72%) had IVCCI <50%, and 75% had CVP values between 6–10 mmHg. IVCCI values were highest in hypovolemic shock and lowest in cardiogenic shock. **Conclusion:** IVCCI appears to be a practical and more accurate bedside measure than CVP for predicting fluid responsiveness in patients with shock, supporting its use as a non-invasive adjunct in early resuscitation assessment.

INTRODUCTION

Shock is a common presentation in emergency and critical care settings, and inadequate tissue perfusion leads to progressive organ dysfunction. Early haemodynamic support is essential to limit physiological deterioration, and resuscitative measures should be initiated concurrently with evaluation of the underlying cause. Shock may arise from hypovolemic, distributive, cardiogenic, or obstructive causes, and the frequent overlap of clinical features complicates accurate bedside assessment. Determining intravascular volume status is vital to early management, particularly because fluid loading is usually the first intervention in haemodynamically unstable patients. However, only about half of severely ill patients demonstrate a measurable improvement in cardiac output following a fluid challenge, indicating that volume assessment based only on clinical impression is unreliable.[1]

Conventional measures, such as pulmonary artery catheters and central venous pressure (CVP) monitoring, deliver information on cardiac filling pressures and output; however, these invasive techniques require time, expertise, and carry significant risks. CVP has historically been used to

ISSN (O): 2687-5365; ISSN (P): 2753-6556

guide fluid therapy and to estimate intravascular volume, but catheter placement may lead to arrhythmias, vascular or cardiac injury, pneumothorax, haemothorax, local bleeding, thrombosis, or infection.[1] These complications develop from the insertion and operation of central venous catheters and limit their routine use outside high-resource settings.[2]

Guidelines such as the Surviving Sepsis Campaign continue to reference CVP as a target during resuscitation, although its limitations as a predictor of volume responsiveness are recognised. Low CVP values may indicate relative hypovolemia, but the need for an invasive catheter restricts its application in emergency departments and prehospital environments.[3] A non-invasive method for estimating CVP would expand monitoring capabilities and reduce procedure-related complications.[4] The technical requirements of thoracic venous catheterisation, particularly in packed emergency departments.[5] Ultrasound has emerged as a useful point-of-care tool for assessing preload and guiding fluid therapy. Mobile devices and increasing clinician expertise make sonographic evaluation feasible in emergency medicine, anaesthesia, critical care, and trauma clinical care.[6]

However, evidence directly comparing central venous pressure with inferior vena cava collapsibility index (IVCCI) for predicting fluid responsiveness in patients with shock remains limited and inconsistent, particularly in emergency and critical care settings. The inferior vena cava (IVC) is a compliant vessel that changes diameter with respiration and circulating volume.[7] During inspiration, negative thoracic pressure increases venous return, resulting in partial IVC collapse; during expiration, the vessel returns to its baseline diameter. Better collapsibility indicates reduced intravascular volume.[8] The collapsibility index is calculated as: [(expiratory diameter – inspiratory diameter) / expiratory diameter] × 100. This measurement gives a practical, non-invasive estimate of volume status and may help identify patients who are likely to respond to fluid resuscitation.[9,10]

A reliable, rapid, and non-invasive method to guide early fluid resuscitation is important to improve the accuracy of volume assessment and reduce the risks associated with invasive monitoring. Therefore, this study aimed to assess fluid responsiveness in shock patients by comparing CVP with the IVCCI and to evaluate the usefulness of bedside non-invasive ultrasound in estimating intravascular volume status.

MATERIALS AND METHODS

This was a prospective observational study conducted among 121 ICU patients with shock requiring fluid resuscitation and central venous catheterisation in the Department of Anaesthesia, Government Vellore Medical College and Hospital, over one year from February 2023 to January 2024. Written informed consent was obtained from patients or their legally authorised representatives, and the study was approved by the Institutional Ethics Committee, Government Vellore Medical College (IEC approval number: XXXXX).

Inclusion and exclusion criteria

Patients admitted to the intensive care unit with signs of shock who required fluid resuscitation and central venous catheterisation for haemodynamic monitoring were included. Pregnant patients and those in whom the IVC could not be visualised on ultrasound were excluded.

Methods: A consecutive sampling method was used, wherein all eligible patients admitted during the study period were included. Data were collected according to basic patient information and haemodynamic measurements. Fluid responsiveness was defined as a sustained improvement in haemodynamic parameters following a 500-mL crystalloid bolus, assessed through serial changes in mean arterial pressure, pulse rate, and oxygen saturation. Patient data including name, age, sex, residence, and relevant clinical and laboratory findings at admission were recorded, through direct evaluation and review of their medical records.

Patients who presented with shock received a planned sequence of fluid boluses. A 500-ml bolus was given at time zero, followed by additional 500-ml boluses at 30 minutes, 90 minutes, and 120 minutes. CVP and IVC measurements were taken just before and after each bolus to track how their intravascular volume changed during resuscitation. IVC diameter was measured in the long-axis subcostal view approximately 2 cm caudal to the hepatic vein–IVC junction, using multiple respiratory cycles for accuracy. Collapsibility index was calculated as (IVCmax − IVCmin) / IVCmax × 100, following the measurement principles described in the thesis. CVP was measured using a centrally positioned catheter with the transducer zeroed at the mid-axillary line. Ultrasound measurements were performed by trained anaesthesia residents under consultant supervision to minimise inter-observer variability.

Sample size was determined based on feasibility and the number of eligible patients admitted during the study period, as no prior local data were available to estimate effect size for IVCCI and CVP comparison. The primary outcome was fluid responsiveness, defined as a haemodynamic improvement following a 500-mL crystalloid bolus. Secondary outcomes included changes in IVCCI and CVP measurements over time and the diagnostic performance of IVCCI and CVP in predicting fluid responsiveness.

Statistical analysis: Data were analysed using SPSS 23.0. Continuous variables were presented as means and standard deviations, and categorical variables as numbers with percentages. The chi-square test was used to assess associations between categorical variables. ANOVA or the Student's t-test was applied to compare continuous variables. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were calculated. Receiver operating characteristic (ROC) curve

ISSN (O): 2687-5365; ISSN (P): 2753-6556

analysis was performed to determine diagnostic accuracy, and 95% confidence intervals were calculated for all estimates. A p-value <0.05 was considered statistically significant.

RESULTS

During the study period, 121 eligible patients were enrolled and included in the final analysis; no patients were excluded after enrolment. The mean age was 50.04 years and mean BMI was 21.04 kg/m²; males (67, 55.4%) and septic shock (56, 45.9%) were the most frequent [Table 1].

Most participants were non-responders 69 (57%), had IVCCI <50% in 87 (72%), and showed CVP 6–10 mmHg in 91 (75%) [Table 2].

Significant differences were observed between responders and non-responders across all vital parameters at each time point ($p < 0.05$) [Table 3].

Table 1: Baseline characteristics

Parameter		N (%) / Mean ± SD
Age (years)		50.04 ± 19.6
BMI (kg/m²)		21.04 ± 4.67
Sex	Male	67 (55.4%)
	Female	54 (44.6%)
Type of shock	Septic	56 (45.9%)
	Cardiogenic	42 (34.6%)
	Hypovolemic	21 (17%)
	Anaphylatic	2 (2%)
	Obstructive	0

Table 2: Fluid status and hemodynamic categories

Parameter	Category	N (%)
Fluid responsiveness	Responders	52 (43%)
	Non-responders	69 (57%)
IVCCI	<50%	87 (72%)
	>50%	34 (28%)
CVP (mmHg)	0–5	21 (17.7%)
	6–10	91 (75%)
	11–15	9 (7.7%)

Table 3: Comparison of vital parameters between responders and non-responders

Parameter	Category	Responders (N = 52)	Non-responders (N = 69)	p-value
Pulse (beats/min)	0 min	111.1 ± 2.6	115.5 ± 13.8	0.02
	30 min	108.08 ± 4.4	115.7 ± 3.9	0.001
	90 min	100.7 ± 4.3	111.2 ± 3.5	0.001
	120 min	95.4 ± 4.5	100.4 ± 4.4	0.001
Respiratory rate (breaths/min)	0 min	20.7 ± 2.4	24.46 ± 2.7	0.001
	30 min	19.9 ± 2.3	24.1 ± 2.5	0.001
	90 min	18.2 ± 2.1	23.1 ± 2.6	0.001
	120 min	16.9 ± 1.7	22.4 ± 2.5	0.001
SpO_2 (%)	0 min	93.6 ± 2.5	90.4 ± 2.0	0.02
	30 min	94.04 ± 2.2	90.4 ± 1.9	0.001
	90 min	94.6 ± 1.8	91.5 ± 1.4	0.001
	120 min	95.6 ± 1.8	91.7 ± 1.3	0.001
Mean arterial blood pressure (mmHg)	0 min	56.4 ± 2.6	48.2 ± 3.01	0.02
	30 min	60.1 ± 2.5	48.7 ± 3.2	0.001
	90 min	69.2 ± 1.19	55.2 ± 2.8	0.001
	120 min	75.4 ± 2.9	56.6 ± 2.56	0.001

The mean eIVCD was 1.50 ± 0.45 cm, the mean iIVCD measured 0.90 ± 0.39 cm, and IVCCI averaged 40.15 ± 18.38%. Minimum and maximum values were as follows: eIVCD 1.03–1.97 cm, iIVCD 0.50–1.30 cm, IVCCI 20.52–59.02%, and CVP 4.95–13.52 mmHg.

IVCCI was highest in hypovolemic shock at all-time points, beginning at 74.4%, while cardiogenic shock showed the lowest values, starting at 27.4% ($p = 0.001$) [Table 4].

Table 4: IVCCI variation across types of shock

Parameter	Time (min)	Hypovolemic	Septic	Cardiogenic	Anaphylactic	p-value
IVCCI (%) Across Different Types of Shock	0	74.4 ± 26.5	53.1 ± 16.1	27.4 ± 12.4	64.4 ± 27.9	0.001
	30	53.6 ± 16.9	49.8 ± 26.5	25.4 ± 10.8	53.4 ± 23.8	0.001
	90	44.2 ± 8.9	43.09 ± 8.14	17.7 ± 14.9	46 ± 15.8	0.001
	120	40.7 ± 10.2	40.5 ± 9.2	12.9 ± 15.6	40.8 ± 11.4	0.001

ISSN (O): 2687-5365; ISSN (P): 2753-6556

CVP showed a mean of 8.82 ± 3.54 mmHg (range 4.95–13.52). IVCCI showed a moderate negative correlation with CVP (r = –0.652, p = 0.001; N = 121).

IVCCI showed stronger diagnostic performance than CVP, with higher sensitivity at 93.34% and specificity at 91.10%, compared with 80.14% and 81.60% for CVP. Diagnostic accuracy was also better for IVCCI at 87.60%, whereas CVP measured 80.60%. IVCCI established a higher AUC of 0.88 compared with 0.80 for CVP [Table 5].

Table 5: Diagnostic parameters for IVCCI and CVP in predicting fluid responsiveness

Parameter	IVCCI	CVP
AUC	0.88	0.8
Standard error	0.028	0.036
95% CI	0.84–0.94	0.75–0.90
p-value (AUC vs 0.5)	<0.0001	<0.0001
Sensitivity (%)	93.34 (78.4–97.4)	80.14 (75.31–90.4)
Specificity (%)	91.10 (86.6–95.6)	81.60 (74.7–90.8)
Positive predictive value (%)	88.20 (86.2–97.7)	81.00 (74.1–90.6)
Negative predictive value (%)	83.40 (77.9–93.2)	80.20 (75.9–90.2)
Diagnostic accuracy (%)	87.60 (84.8–94.6)	80.60 (78.1–89.6)
Likelihood ratio (positive)	17.7 (8.9–26.1)	6.61 (4.6–9.5)
Likelihood ratio (negative)	0.18 (0.10–0.24)	0.17 (0.14–0.21)

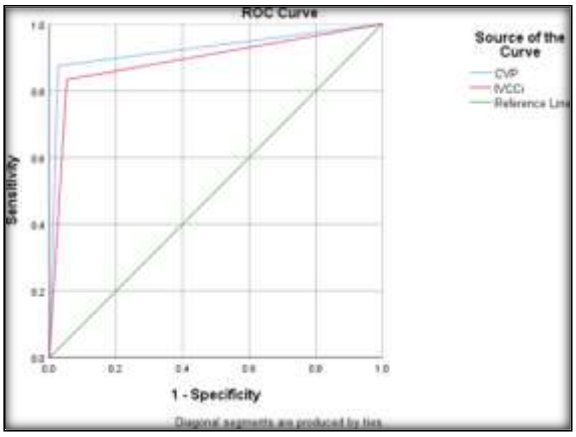

Figure 1: Receiver operating characteristic analysis for IVCCI and CVP

DISCUSSION

This study evaluated fluid responsiveness in 121 shocked patients using the IVCCI and CVP. IVC-Ci showed higher diagnostic performance, with a 50% cut-off yielding 93.34% sensitivity, 91.1% specificity, and an AUC of 0.88. CVP demonstrated lower sensitivity (80.14%), specificity (81.6%), and a smaller AUC, which may limit its reliability. IVC-Ci showed a consistent association with volume status and responded to serial fluid boluses, whereas CVP showed weaker performance. The study population included predominantly middle-aged adults with normal BMI, a male preponderance, and septic shock as the most common aetiology. Similarly, Nagi et al. found that in a cohort of 58 spontaneously breathing sepsis patients, responders and non-responders showed comparable demographics, mean ages of 52.03 ± 6.98 and 53.21 ± 6.18 years, with similar gender distribution.[11]

In our study, most patients were non-responders, and a majority showed lower IVCCI values with CVP falling within a common physiologic range. Similarly, Preau et al. reported that 56% of patients increased stroke volume with fluids, identifying them as responders, while 44% did not. An IVCCI cut-off of 48% predicted responsiveness, with an AUC of 0.89. Airapetian et al. reported a similar result in a group of 59 patients, where 49% were responders, and 51% were non-responders. Mean cIVC values were < 50% in both groups, and a cIVC above 42% showed 97% specificity for predicting responsiveness.[12,13] These findings are consistent with our observation that higher IVCCI cut-off values are required to reliably identify fluid responsiveness. Responders demonstrated better vital signs, with lower heart and respiratory rates and higher oxygen saturation and arterial pressure throughout follow-up. Similarly, Innocenti et al. found that responders tolerated higher fluid volumes (2010 ± 1254 ml vs 1119 ± 410 ml) and showed less pulmonary congestion (15 vs 26 cases), supporting our finding of better perfusion and respiratory stability in responders.[14] Monge et al. found that responders demonstrated better cardiac output rises during PLR (AUC 0.97), while non-responders showed minimal change.[15] These findings suggest that responders maintain better haemodynamic stability and tissue perfusion over serial assessments.

IVC measurements reproduced expected respiratory variation, with higher collapsibility in hypovolemic states and reliably lower values in cardiogenic shock. Similarly, Bortolotti et al. reported an IVCCI reference value of 39% and an inspiratory diameter <1.1 cm predicting responsiveness.[16] Nagi et al. found smaller IVCmax and IVCmin in responders and an IVCCI cut-off of 32%.[11] Kaptein et al. reported that an IVC diameter <2.1 cm with >50% collapse indicates hypovolemia, while a collapsibility <20% reproduces elevated right-atrial pressures, supporting higher IVCCI in hypovolemic and lower IVCCI in cardiogenic shock.[17] Therefore, higher IVCCI identifies hypovolemia and lower IVCCI indicates cardiogenic states, supporting respiratory-dependent IVC findings.

IVCCI demonstrated stronger diagnostic accuracy and an inverse correlation with CVP, showing

ISSN (O): 2687-5365; ISSN (P): 2753-6556

stronger predictive value for fluid responsiveness. Similarly, Ameen Hafez reported a strong inverse IVCCI–CVP correlation (r = –0.85), particularly when CVP was <10 cmH_2O.9 Ismail et al., an IVC-ci cut-off of 40% predicted fluid responsiveness with 93.3% sensitivity, 70.7% specificity, and an AUC of 0.908, while CVP showed lower diagnostic value despite high specificity.[18] Elsaeed et al. among 40 septic adults, 60% were fluid responders. IVC-CI >35% predicted responsiveness with 95.8% sensitivity, 93.7% specificity, and AUC 0.97, demonstrating strong diagnostic accuracy.[19] Thus, the higher diagnostic accuracy of IVCCI and its inverse correlation with CVP support its role as a reliable marker of fluid responsiveness in this study population. Minor variations in reported cut-off values across studies may show differences in ventilation status, timing of assessment, ultrasound technique, and definitions of fluid responsiveness. The lower diagnostic performance of CVP may reflect its dependence on intrathoracic pressure, venous compliance, and catheter-related technical factors, which reduce its reliability as a dynamic marker of preload.

Strengths: The strength of this study is the use of consecutive sampling and standardised ultrasound measurement across multiple time points, enhancing internal validity.

Limitations: The single-centre design limits broader applicability, and ultrasound measurements may vary with operator skill. Altered thoracic or abdominal pressures could affect IVC accuracy. CVP values were influenced by technical factors, and mixed shock types reduced physiological uniformity. These factors may limit external validity but do not negate the internal consistency of the findings.

Implications: Using IVCCI as a quick, non-invasive marker to guide fluid therapy offers stronger diagnostic value than CVP and supports more accurate early resuscitation decisions. Future studies should validate these findings in multicentre settings and explore the integration of IVCCI with dynamic indices for improved fluid responsiveness assessment.

CONCLUSION

IVCCI appears to be a more reliable and practical measure of fluid responsiveness than CVP in the studied population of patients with shock. It demonstrated higher diagnostic accuracy than CVP, avoided the need for invasive monitoring, and reflected real-time physiological changes during resuscitation. These findings support the use of IVCCI as a bedside tool to assist early fluid management and patient evaluation. Future studies should examine its performance across larger and more diverse clinical settings.

REFERENCES

1. Taha M, A. Pathophysiology and management of different types of shock. Narayana Med J 2017:14–39. https://doi.org/10.5455/nmj./00000120.
2. Citilcioglu S, Sebe A, Ay MO, Icme F, Avci A, Gulen M, et al. The relationship between the IVC diameter measured by bedside ultrasonography and the CVS value. Pak J Med Sci Q 2014;30:310–5. https://doi.org/10.12669/pjms.302.4375.
3. Dellinger RP, Levy MM, Rhodes A, Annane D, Gerlach H, Opal SM, et al. Surviving sepsis campaign: international guidelines for management of severe sepsis and septic shock: 2012. Crit Care Med 2013;41:580–637. https://doi.org/10.1097/CCM.0b013e31827e83af.
4. Marcelli E, Cercenelli L, Bortolani B, Marini S, Arfilli L, Capucci A, et al. A novel non-invasive device for the assessment of CVS in hospital, office and home. Med Devices (Auckl) 2021;14:141–54. https://doi.org/10.2147/MDER.S307775.
5. Vinson DR, Ballard DW, Stevenson MD, Mark DG, Reed ME, Rauchwerger AS, et al. Predictors of unattempted central venous catheterisation in septic patients eligible for early goal-directed therapy. West J Emerg Med 2014;15:67–75. https://doi.org/10.5811/westjem.2013.8.15809.
6. Su J, Tie X, Wei Y, Zhou R, Zou T, Qin Y, et al. Critical care ultrasound: development, evolution, current and evolving clinical concepts in critical care medicine. Front Med (Lausanne) 2025;12:1622604. https://doi.org/10.3389/fmed.2025.1622604.
7. De Lorenzo RA, Morris MJ, Williams JB, Haley TF, Straight TM, Holbrook-Emmons VL, et al. Does a simple bedside sonographic measurement of the IVC correlate with CVS? J Emerg Med 2012;42:429–36. https://doi.org/10.1016/j.jemermed.2011.05.082.
8. Seif D, Mailhot T, Perera P, Mandavia D. Caval sonography in shock: a noninvasive method for evaluating intravascular volume in critically ill patients. J Ultrasound Med 2012;31:1885–90. https://pubmed.ncbi.nlm.nih.gov/23197540/.
9. Ameen Hafez AA. Measurement of IVC collapsibility index and its correlation to CVS in adult critically ill patients: A prospective observational study. Glob J Anaesth Pain Med 2020;3. https://doi.org/10.32474/gjapm.2020.03.000170.
10. Muller L, Bobbia X, Toumi M, Louart G, Molinari N, Ragonnet B, et al. Respiratory variations of IVC diameter to predict fluid responsiveness in spontaneously breathing patients with acute circulatory failure: need for cautious use. Crit Care 2012;16:R188. https://doi.org/10.1186/cc11672.
11. Nagi AI, Shafik AM, Fatah AMA, Selima WZ, Hefny AF. IVC collapsibility index as a predictor of fluid responsiveness in sepsis-related acute circulatory failure. Ain-Shams J Anaesthesiol 2021;13. https://doi.org/10.1186/s42077-021-00194-y.
12. Preau S, Bortolotti P, Colling D, Dewavrin F, Colas V, Voisin B, et al. Diagnostic accuracy of the IVC collapsibility to predict fluid responsiveness in spontaneously breathing patients with sepsis and acute circulatory failure. Crit Care Med 2017;45:e290–7. https://doi.org/10.1097/CCM.0000000000002090.
13. Airapetian N, Maizel J, Alyamani O, Mahjoub Y, Lorne E, Levrard M, et al. Does IVC respiratory variability predict fluid responsiveness in spontaneously breathing patients? Crit Care 2015;19:400. https://doi.org/10.1186/s13054-015-1100-9.
14. Innocenti F, Savinelli C, Coppa A, Tassinari I, Pini R. Integrated ultrasonographic approach to evaluate fluid responsiveness in critically ill patients. Sci Rep 2023;13:9159. https://doi.org/10.1038/s41598-023-36077-5.
15. Monge García MI, Gil Cano A, Gracia Romero M, Monterroso Pintado R, Pérez Madueño V, Díaz Monrové JC. Non-invasive assessment of fluid responsiveness by changes in partial end-tidal CO2 pressure during a passive leg-raising manoeuvre. Ann Intensive Care 2012;2:9. https://doi.org/10.1186/2110-5820-2-9.
16. Bortolotti P, Colling D, Colas V, Voisin B, Dewavrin F, Poissy J, et al. Respiratory changes of the IVC diameter predict fluid responsiveness in spontaneously breathing

ISSN (O): 2687-5365; ISSN (P): 2753-6556

patients with cardiac arrhythmias. Ann Intensive Care 2018;8:79. https://doi.org/10.1186/s13613-018-0427-1.
17. Kaptein MJ, Kaptein EM. IVC collapsibility index: Clinical validation and application for assessment of relative intravascular volume. Adv Chronic Kidney Dis 2021;28:218–26. https://doi.org/10.1053/j.ackd.2021.02.003.
18. Ismail MT, El-Iraky AA, Ibrahim EE-DA, El Kammash TH, Abou-Zied AE. Comparison of IVC collapsibility and CVS in assessing volume status in shocked patients. Afr J Emerg Med 2022;12:165–71. https://doi.org/10.1016/j.afjem.2022.04.005.
19. Elsaeed AMR, Nor El-Din BME, El Taher WAM, Mostafa RH, Saleh AN. Internal jugular vein distensibility variation and IVC collapsibility variation with fluid resuscitation as an indicator for fluid management in spontaneously breathing septic patients. Ain-Shams J Anaesthesiol 2022;14. https://doi.org/10.1186/s42077-022-00226-1.

ISSN (O): 2687-5365; ISSN (P): 2753-6556