Systematic Review

Utility of VExUS score in the peri-operative care unit, intensive care unit, and emergency setting - A systematic review

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ABSTRACT

Background and Aims: The venous excess ultrasound (VExUS) score presents a prospect of valuable clinical utility. The study aimed to systematically review the effectiveness of the VExUS score in detecting venous congestion across emergency, critical care, and peri-operative contexts; assessing its utility in improved patient outcomes; and exploring its relationship with established parameters. **Methods:** This systematic review was registered in the International Prospective Register of Systematic Reviews (CRD42023421034). A comprehensive literature search, employing pre-defined search terms related to the VExUS score in diverse clinical contexts, was conducted on articles published between 2000 and 15 May 2023 across databases- PubMed, PubMed Central, Cochrane, Scopus, Elsevier Clinical Key, and Google Scholar. Bias risk assessment was carried out using the Risk of Bias in Non-Randomised Studies tool. Given the significant heterogeneity across studies concerning participants, interventions, outcomes, and study designs, data pooling for a meaningful meta-analysis was not feasible. **Results:** The review included 15 articles comprising observational studies, case series, and case reports. Most patients exhibited moderate-to-severe venous congestion based on their baseline VExUS scores. Higher VExUS scores correlated with a greater risk of acute kidney injury (AKI) in post-operative patients. The VExUS score strongly correlated with central venous pressure; specific components, such as the intra-renal monophasic pattern, portal-pulsatility, and inferior vena cava diameter, exhibited robust predictive value for venous congestion. **Conclusion:** VExUS score is valuable in assessing and predicting venous congestion, especially regarding AKI prediction risk and guiding interventions. However, its utility in predicting outcomes in acute heart failure patients appears less certain.

Keywords: Intensive care unit, mortality, patient outcomes, peri-operative setting, venous congestion, venous excess ultrasound score, VExUS

INTRODUCTION

There has been an increase in interest in the diagnosis and treatment of fluid overload and venous congestion in recent years.[1-4] Fluid overload influences tissue perfusion in the presence of venous congestion and tissue oedema. Several later studies found a link between fluid overload and morbidity in the intensive care unit (ICU). Determining what constitutes clinically significant venous hypertension is a challenging aspect of haemodynamic evaluation with the existing tools and techniques.

Using Doppler imaging, point-of-care ultrasound (POCUS) allows clinicians to visualise vascular

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anatomy and assess blood velocities.[5,6] Several markers of high pressures associated with this congestive process have been proposed, including the assessment of large veins (vena cava, internal jugular) as well as the detection of abnormal venous waveforms suggestive of the systemic venous compliance limit in the portal vein, hepatic veins, and intra-renal veins.[7-11] Several ultrasound venous congestion indices have recently been studied regarding heart failure and cardio-renal syndrome. The emergence of the venous excess ultrasound (VExUS) score in recent times presents a prospect of a highly valuable clinical utility.

The purpose of this systematic review is to evaluate if the VExUS score can detect clinically significant venous congestion and its utility in emergency, critical care, and peri-operative settings and to investigate interventions based on baseline VExUS scores, their impact on patient outcomes, and explore any associations or correlations between the VExUS score and other established parameters.

METHODS

This review is in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) and Synthesis Without Meta-analysis (SWiM) reporting guidelines.[12] The systematic review was registered on the International Prospective Register of Systematic Reviews (vide registration no. CRD42023421034).

All types of studies that assessed the role and application of VExUS scores in assessing venous congestion were included. Studies in languages other than English that did not have full-text access were excluded. The population, intervention, comparator, outcome, and setting strategy determined the study's inclusion and exclusion criteria.

Population: Patients in emergency, critical care, and peri-operative settings;

Intervention: Done based on baseline VExUS Score (diuresis or haemodialysis or paracentesis);

Comparison: An association or correlation of VExUS score with established parameters such as central venous pressure (CVP) and inferior vena cava (IVC) diameter;

Outcome: Detection of clinically significant venous congestion, utility in an emergency, critical care, peri-operative settings, intervention response, improved/worsened patient outcome, and its association or correlation with other established parameters;

Setting: Either in ICU or emergency or peri-operatively.

A systematic literature search was conducted from 2000 till 15 May 2023 in the online databases of PubMed, PubMed Central, Cochrane, Scopus, Elsevier Clinical Key, and Google Scholar. The combination of keywords used for the search included 'VExUS Score', 'venous congestion score', 'portal pulsatile flow', and 'venous congestion' in clinical scenarios, including 'emergency', 'critical care', and 'peri-operative' settings. We further refined the search strategy by including additional terms such as acute heart failure, acute kidney injury (AKI) and outcomes, including improved patient outcomes and reduced overall mortality. The publications were also retrieved through cross-references from published articles [Figure 1].

Two independent reviewers conducted the screening and extraction process (reviewers: BG and PA). Extracted data included study design, baseline characteristics (age, sex, and co-morbidities), clinical condition of patients, baseline VExUS score, VExUS

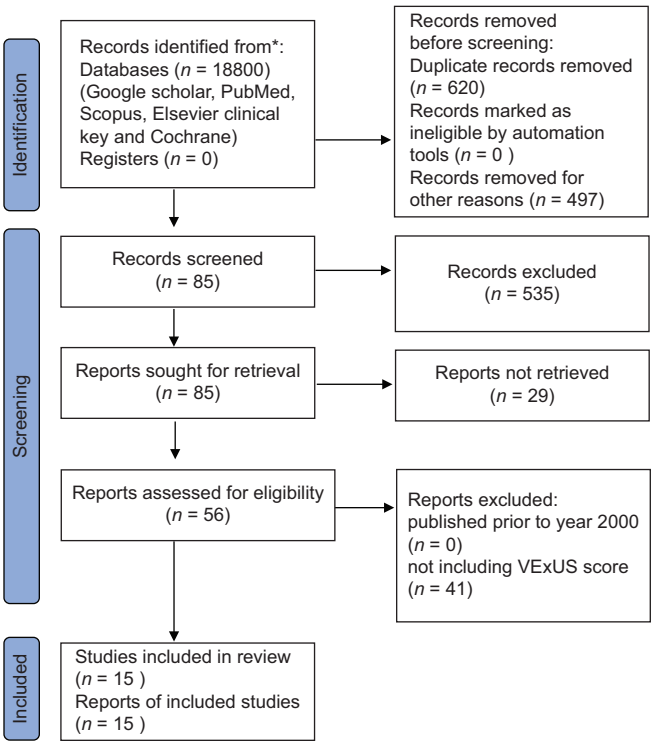

Figure 1: Preferred reporting items for systematic review and meta-analysis (PRISMA) flow chart. VExUS - venous excess ultrasound score, n-number of articles

score after treatment, outcome of patients, and association with other well-established markers. The mutual consensus among authors was taken in case of discrepancies.

An Excel sheet was prepared to summarise the characteristics and findings of the included studies to develop a preliminary synthesis of findings, explore relationships within and between studies, and assess the robustness of the synthesis. Given the limited literature on using VExUS in clinical settings, we considered all the studies published on this topic in conformity with the PRISMA guidelines and SWIM checklists. The Risk of Bias in Non-Randomised Studies of Exposures tool[13] was used to assess the risk of bias.

RESULTS

In this systematic review, we identified 15 articles that were observational studies (both prospective and retrospective), case series, and case reports. However, no randomised controlled trials were identified in the available literature up to the point of manuscript preparation. We followed the checklist and guidelines of the SWiM reporting items. Because there were heterogeneity and substantial differences in terms of participants, interventions, outcomes, and study designs, it was not possible to pool the data for a meaningful meta-analysis.

Table 1 provides a detailed summary of the characteristics of each study included in our review. The patients exhibited a variety of general conditions, such as clinical signs of fluid overload, critical illness requiring mechanical ventilation, acute heart failure, cardio-renal syndrome, impending AKI, post-trauma patients with head injury, undiagnosed hyponatraemia, assessment of the cause of systemic venous congestion, and ruling out the cause of anuria.

Based on the available studies[14-23] that used VExUS scores to predict venous congestion, it was found that most patients had a baseline VExUS score ranging between 2 and 3, indicating moderate-to-severe venous congestion. Clinicians used the VExUS scores to guide interventions such as diuretics, ascites drainage, haemofiltration, and dialysis [Table 2]. In most cases, interventions based on VExUS scores resulted in a reduction of the VExUS score, improved venous congestion, and improved patient outcomes. In one reported case, a patient scheduled for cholecystectomy had surgery deferred due to moderate venous congestion reflected by the VExUS score.[21]

Moderate and severe congestion, according to VExUS scores, was associated with subsequent development of AKI, and increasing VExUS score correlated with higher AKI risk in patients with acute coronary syndrome. Improvement in VExUS score correlated significantly with the resolution of AKI injury ($P = 0.003$) congestion [Table 3]. The baseline VExUS score was found to be a poor predictor of an appropriate response to diuretic-induced fluid depletion in predicting readmission in acute heart failure patients; it was revealed that the VExUS score was not found to be helpful in guiding therapy or predicting complications in acute heart failure patients, compared to other parameters such as IVC size, intra-renal pattern, and portal vein pulsatility. Table 4 summarises miscellaneous uses of VExUS scores, where various authors have used VExUS scores to guide fluid depletion caused by diuretics, manage hyponatraemia in dubious causes, and predict readmission in acute heart failure patients.

A strong association between VExUS score and CVP ($P < 0.001$) has been found, indicating that VExUS score is a reliable indicator of venous congestion.[10,11] The intra-renal monophasic pattern had a high predictive value for venous congestion. Portal pulsatility >50%, IVC diameter >2 cm, and VExUS score were all effective at predicting venous congestion to varying degrees. VExUS score outperformed IVC diameter in predicting right atrial pressure (RAP) ≥12 mmHg. The accuracy of VExUS and femoral venous doppler (FVD) for detecting venous congestion was moderate, with a higher agreement between VExUS and FVD compared to that between FVD and CVP. VExUS score, along with specific components such as the intra-renal monophasic pattern, portal pulsatility, and IVC diameter, can be valuable in predicting venous congestion and assessing the severity of the condition.[18,19,23] Table 5 summarises the association of VExUS scores with other parameters.

DISCUSSION

This systematic review revealed the utility of the VExUS score in detecting clinically significant venous congestion across diverse medical settings in guiding interventions, predicting the risk of AKI, and assessing the severity of venous congestion.

Table 1: Baseline characteristics of patients, study design, setting, co-morbidities, and general condition for which VExUS score was used

Author	Year	*n*	Study design	Setting	Age (years)	Sex (%)	Surgery	
Original studies								
Pierre-Grégoire Guinot *et al*.[9]	2022	81	Prospective, observational single-centre	ICU	68±11	F 37 M 63	Cardiac surgery 49, Septic shock 13, Cardiogenic shock 12	
Juan J. Menéndez-Suso, *et al*.[10]	2022	33	Prospective observational	ICU	12.2		None	
Marta Torres-Arrese, *et al*.[11]	2023	74	Prospective, multi-centre observational	Emergency	79.5	F 51, M 49		
William Beaubien-Souligny, *et al*.[14]	2020	145	Prospective	Post-op cardiac patients	66±13			
Vimal Bhardwaj, *et al*.[15]	2020	30	Prospective	ICU	59.53±16.47	M 70, F 30		
August Longino *et al*.,[16]	2023	56	Observational	Patients undergoing right heart catheterisation	59±11.8	M 68, F 32	Right heart catheterisation	
V. Bhardwaj *et al*.[17]	2023	107	Prospective observational	Post-operative patients with cardiac disease	55.67±12.76	F 72 M 28	Post-operative cardiac surgery	
Stefan Andrei *et al*.[18]	2023	180	Retrospective observational	3 ICU	62±16	M 59, F 41	Cardiac (24%), neurological (19%), respiratory (18%) and sepsis (14%).	
Jesús Antonio Viana-Rojas, *et al*.[19]	2023	77					At each increasing degree of VExUS, a higher proportion of patients developed AKI	
Case series or reports								
Rita Varudo, *et al*.[20]	2022	1	Case report	ICU	20	F	Patient underwent right-sided decompressive craniectomy	
Philippe Rola, *et al*.[21]	2021	5	Case series of 5 patients	ICU	75	M		
				ICU	45	M	Planned to take for cholecystectomy, deferred because of poor clinical condition	Patient was under evaluation and denied any past medical history
				Post-op ICU	81	M	Mitral valve replacement	Moderate pulmonary HT and post-MVR
				ICU	57		None	Grade-1 pulmonary HT
				Post-op ICU	28	F	Emergency LSCS	Pregnant female, gravida 5, twin, severely anaemic, septic shock (triple inotropes)
Keevan Singh *et al*.[22]	2021	1	Case report	Peri-operative	49	M	Hernia repair	
Edgardo Banille, *et al*.[23]	2021	1	Case report	Paediatric cardiology setting	13	F	Recent AKI	
Daniel Manzur-Sandoval, *et al*.[24]	2022	1	Case report	COVID ICU	83	M		

Author	Co-morbidities	General Condition	Risk of Bias assessment[12]
Original studies			
Pierre-Grégoire Guinot *et al*.[9]	HT, DM, Cardiomyopathy Ischaemic, Valvular disease, CKD	Fluid overload and absent fluid responsiveness	Low
Juan J. Menéndez-Suso, *et al*.[10]	Critically ill children	Critically ill requiring ICU care	Low
Marta Torres-Arrese, *et al*.[11]	78.4% - cardiovascular disease, 43.2% - previous pulmonary disease.	Acute CHF (NT-proBNP >500 pg/mL)	Low

Contd...

Table 1: Contd...

Author	Co-morbidities	General Condition	Risk of Bias assessment[12]
	Original studies		
William Beaubien-Souligny, *et al*.[14]	CHF with LVEF ≤40% in 31 and stage III CKD in 37 patients	CHF reduced EF or stage III CKD	Low
Vimal Bhardwaj, *et al*.[15]	Cor pulmonale with AKI, Decompensated HF with AKI, Myocarditis with AKI	Patients with evidence of AKI	There is a low risk of bias except for concerns about uncontrolled confounding.
August Longino *et al*.,[16]	Establishing the link between VExUS and pMSF, as estimated by RAP		High
V. Bhardwaj *et al*.[17]	Adult post-cardiac surgery patients were assessed for venous congestion using the VExUS score and FVD	To assess clinically significant venous congestion	Low
Stefan Andrei *et al*.[18]			Low risk of bias except for concerns about uncontrolled confounding
Jesús Antonio Viana-Rojas, *et al*.[19]		Predicting the risk of AKI in patients with ACS	
	Case series or reports		
Rita Varudo, *et al*.[20]	Closed-skull traumatic brain injury with SDH, SAH and diffuse cerebral oedema.	Initial GCS 4	NA
Philippe Rola, *et al*.[21]	Alcoholic cirrhosis and severe reduced EF 20% and congestive cardiomegaly.	End-stage cardiorenal syndrome and ascites.	NA
		NA	
	Post-operatively massive transfusion positive 2910-mL fluid balance	NA	
	Worsening lower extremity oedema and ascites.	NA	
	DIC post-surgery, anuric, hypotensive on triple inotropes	NA	
Keevan Singh *et al*.[22]	DCMP, EF 20%.	Significant dyspnoea on rest	NA
Edgardo Banille, *et al*.[23]	Ebstein anomaly	Differentiate fluid overload as cardiac/renal	NA
Daniel Manzur-Sandoval, *et al*.[24]	Severe SARS-CoV-2 pneumonia	ARDS, Saturation 69%. oliguria refractory to crystalloid	NA

ACS - acute coronary syndrome. ARDS - acute respiratory distress syndrome, AKI - acute kidney injury CHF - congestive heart failure, CKD - chronic kidney disease, COV - COVID-19, ICU - intensive care unit, W - women, M - men, SARS - severe acute respiratory syndrome, GFR - glomerular filtration rate, DCMP - dilated cardiac myopathy, DM - diabetes mellitus, HT - hypertension, EF - ejection fraction, MVR - mitral valve replacement, NA - not applicable, NYHA - New York Heart Association Classification, VExUS - venous excess ultrasound score, SDH - subdural haematoma, SAH - subarachnoid haemorrhage, GCS - Glasgow coma score, FVD - femoral vein Doppler, RAP - right atrial pressure, COVID - coronavirus disease, Post-op - postoperative, NT-proBNP - N-terminal pro b-type natriuretic peptide, LSCS - Lower segment caeserean section

Anaesthesiologists often face challenges in fluid management during surgery for heart failure patients. It is crucial to balance the fluid needs of the patients in the peri-operative period, where avoiding fluid overload is as important as preventing excessive diuresis. Singh K *et al*.[21] reported the successful management of a case of hernia surgery in a male with dilated cardiomyopathy with the use of VExUS assessment of portal vein pulsatility, which guided a furosemide infusion. While an enlarged IVC may indicate fluid responsiveness in some instances, it may not provide a comprehensive evaluation. The VExUS score, which includes portal and hepatic venous waveforms, can aid in assessing the patient's intravascular status, guide fluid management decisions, and avoid complications such as pulmonary oedema and AKI.[22]

Several studies[15-24] have reported the use of VExUS scores to predict moderate-to-severe venous congestion in patients. Clinicians have utilised these scores to guide interventions such as diuretic administration, ascites drainage, haemofiltration, and dialysis. In most cases, intervention based on VExUS scores resulted in a reduction of the score, indicating successful management of venous congestion. The use of the VExUS scores has also enabled physicians to monitor the effectiveness of the therapeutic strategy of management of hyponatremia, where the differential diagnosis between cerebral salt wasting and syndrome of inappropriate antidiuretic hormone secretion (SIADH) in critical patients can be challenging. In one such case management, authors achieved negative fluid balance, and subsequent improvements were observed in hepatic and portal

Table 2: Studies depicting baseline VExUS score (to guide intervention) and post-intervention status of VExUS scores and clinical outcome

Author	Year	*n*	Baseline VExUS score	Intervention	Post-intervention VExUS score	Interpretation	Clinical outcome
Keevan Singh *et al*.[22]	2021	1	2	Furosemide infusion (20 mg/h for 4 h).	1	A large diuresis of approximately 4500 mL over 12 h and significant relief of his dyspnoea.	Improved
Edgardo Banille, *et al*.[23]	2021	1	3	Hydrochlorothiazide 1 mg/kg/day and spironolactone 2 mg/kg/day.	2	Initial anuria improved moderately later	Improved
Daniel Manzur-Sandoval, *et al*.[24]	2022	1	3	Furosemide for an adequate urine output	1	Guide fluid therapy or removal	Improved
Rita Varudo, *et al*.[20]	2022	1	2	Furosemide and intermittent 3% hypertonic saline	1	Maintain negative fluid balance.	Improved
Philippe Rola, *et al*.[21]	2021	1	3	Continuous drainage of ascites was done until a total of 12 L had been removed. I/V furosemide at a higher dose until a net balance of negative 1000 cc per 8 h obtained	2	POCUS with VExUS scoring can identify pathological congestion and guide therapy.	Improved
Philippe Rola, *et al*.[21]	2021	1	2	Planned for cholecystectomy but, owing to venous congestion, was discharged home on a furosemide prescription.	-	Recognition of the plethoric IVC and abnormal Doppler findings of the portal vein led to the diagnosis of AHF and prevented an unnecessary surgical procedure.	No details available after discharge
Philippe Rola, *et al*.[21]	2021	1	3	Furosemide at a high dose until a net negative balance of 1200 cc over 24 h.	2	A negative balance of 3200 cc over 24 h and dobutamine requirement further decreased.	Improved
Philippe Rola, *et al*.[21]	2021	1	3	Haemodialysis was started with ultra-filtration of 2.5 L. Furosemide infusion (200 mg/day) + spironolactone 50 mg	2	Patient spontaneously produced 800 mL of urine and eventually achieved a negative fluid balance of 15.5 L. Later on, the patient was discharged home with oral bumetanide and spironolactone.	Improved
Philippe Rola, *et al*.[21]	2021	1	3	Emergent ultrafiltration and 5 L of fluid were taken over 24 h. An IVC filter was placed for the mobile DVT.	2	Over 48 h, the patient's lactate normalised, and vasopressor requirements improved. The patient was eventually extubated 3 days later and discharged.	Improved

ACS - acute coronary syndrome, AHF - acute heart failure, AKI - acute kidney injury, ICU - intensive care unit, IRVD - intra-renal venous Doppler, IVC - inferior vena cava, VExUS - venous excess ultrasound score, DVT - deep vein thrombosis, POCUS - point of care ultrasound

vein Doppler patterns, indicating a reduction in venous congestion. Concurrently, serum sodium levels showed improvement, suggesting better fluid and electrolyte management. Overall, the application of the VExUS score provided crucial guidance for decision-making and allowed clinicians to tailor the therapeutic approach to address venous congestion and achieve optimal fluid balance. Monitoring the VExUS score in real time facilitated adjustments to the treatment strategy, leading to improvements in clinical parameters and patient outcomes.[20] The use of the VExUS score in the ICU/emergency setting to assess fluid response to diuretics was investigated, and authors reported that renal venous impedance index and baseline portal pulsatility index were identified as the best predictors of an adequate response to diuretic-induced fluid depletion. The baseline VExUS score did not effectively predict the response to fluid depletion. VExUS scores have also been used for predicting readmission of acute heart failure patients. However, further research is needed to validate the use of multiorgan, venous Doppler scanning protocols such as the VExUS score in acute heart failure (AHF) patients.[11] For predicting AKI risk, the strongest

Table 3: VExUS score prediction of risk of developing AKI

Author	Year	*n*	VExUS score	Predicting the risk of developing subsequent AKI	Interpretation
Jesús Antonio Viana-Rojas, *et al*.[19]	2023	77	31 patients - VExUS >1	VExUS ≥1 was more frequently found in inferior vs anterior MI/NSTEMI (48.3 vs 25.8%, *P*=0.031). At each increasing degree of VExUS, a higher proportion of patients developed AKI	Predicting the risk of AKI in patients with ACS
Vimal Bhardwaj, *et al*.[15]	2020	30	In patients with resolving AKI VExUS improved (87%), with no change in 13% and worsened in none.	Resolution of AKI injury showed a significant correlation with improvement in VExUS grade (*P*=0.003). There was a significant association between changes in VExUS grade and fluid balance (*P*=0.006).	Combined grading of IVC, hepatic vein, and portal vein reliably demonstrates venous congestion.
William Beaubien-Souligny, *et al*.[14]	2020	145	VExUS scores were used to predict the risk of AKI in the post-operative period	As for moderate congestion (grade 2), only the VExUS C grading system was associated with the development of AKI (*P*=0.036).	As for moderate congestion (grade 2), only the VExUS C grading system was associated with the development of AKI.

ACS - acute coronary syndrome, AHF - acute heart failure, AKI - acute kidney injury, MI - myocardial infarction, NSTEMI - Non-ST elevated MI, VExUS - venous excess ultrasound score

Table 4: Predictability of various VExUS scores for miscellaneous causes

Author	Year	*n*	Use of VExUS score	Intervention	Interpretation
Pierre-Grégoire Guinot, *et al*.[9]	2022	81	To predict fluid depletion	Diuretics for fluid depletion are defined by a congestive score lower than 3.	Portal pulsatility index was the best predictor of appropriate response to diuretic-induced fluid depletion (AUC=0.80, CI95%: 0.70–0.92, *P*=0.001), followed by the renal venous impedance index (AUC=0.72, CI95% 0.61–0.84, *P*=0.001). Baseline VExUS score (AUC=0.66 CI95%: 0.53–0.79, *P*=0.012) was poorly predictive of appropriate response to diuretic-induced fluid depletion
Rita Varudo, *et al*.[20]	2022	1	To predict response to sodium correction	Furosemide and intermittent 3% hypertonic saline	After 24 h of negative fluid balance, a continuous 3% hypertonic saline solution was started, and occasional furosemide boluses were used to maintain negative fluid balance.
Marta Torres-Arrese, *et al*.[11]	2023	74	Predict readmission in acute heart failure patients	Early and multi-disciplinary follow-up visits	VExUS score does not contribute to the guidance of therapy or the prediction of complications, compared with the presence of an IVC >2 cm, a venous monophasic intra-renal pattern or a pulsatility >50% of the portal vein in AHF patients

ACS - acute coronary syndrome, AHF - acute heart failure, AKI - acute kidney injury, AUC - area under curve, DIC - disseminated intravascular coagulation, FVD - femoral vein Doppler, ICU - intensive care unit, IRVD - intra-renal venous Doppler, IVC - inferior vena cava, POCUS - point-of-care ultrasound, VExUS - venous excess ultrasound score

association between congestion and AKI was observed for VExUS C grade-3 congestion, which had a hazard ratio of 3.69.[14]

The evidence supporting the association between VExUS scores and clinically significant venous congestion is generally strong, with multiple studies providing consistent findings. The use of VExUS scores to guide clinical interventions and their correlation with AKI risk adds to the robustness of the evidence. Analysis of individual VExUS components revealed that the intra-renal venous Doppler pattern remains an independent variable associated with elevated CVP in critically ill children with a moderate level of evidence. The portal pulsatility index as a predictor of appropriate response for diuretic-induced fluid depletion in adult patients holds a moderate level of evidence. The effectiveness of VExUS scores in predicting outcomes in acute heart failure patients seems less clear, with a low level of evidence, and may require further investigation. The interpretation of the VExUS score to guide the management of hyponatremia may require concurrent clinical judgment and holds a low level of evidence.

It is important to acknowledge the potential limitations and risk of bias inherent in observational studies and case studies as they may have methodological weaknesses that could impact the reliability and validity.

CONCLUSION

VExUS scores are valuable in assessing and predicting venous congestion, especially in the context of the risk of predicting AKI and guiding interventions. VExUS score, along with specific components such as the intra-renal monophasic pattern, portal

Table 5: Association of VExUS scores with other established parameters and interpretation

Author	Year	*n*	Association with other established parameters	Interpretation
Juan J. Menéndez-Suso, *et al*.[10]	2022	33	The VExUS score severity was strongly associated with the CVP levels (*P*<0.001).	IVC dilation (*P*<0.001) and severe HVD (*P*=0.026), mild IRVD (*P*=0.005), and severe IRVD (*P*=0.025) patterns were associated with elevated CVP.
Marta Torres-Arrese, *et al*.[11]	2023	74	Intra-renal monophasic pattern (AUC) 0.923, Sn 90%, Sp 81%, (PPV) 43%, and (NPV) 98%, portal pulsatility >50% (AUC=0.749, Sn=80%, Sp=69%, PPV=30%, NPV=96%) and An IVC of >2 cm (AUC=0.758, Sn=93.l%, and Sp=58.3) and the presence of an intra-renal monophasic pattern (AUC=0. 834, sensitivity=0.917, specificity=67.4%)	VExUS score does not contribute to the guidance of therapy or the prediction of complications, compared with the presence of an IVC >2 cm, a venous monophasic intra-renal pattern or a pulsatility >50% of the portal vein in AHF patients.
August Longino *et al*.[16]	2023	56	VExUS had a favourable AUC for prediction of a RAP ≥12 mmHg (0.99, 95%CI: 0.96–1) compared to IVC diameter (0.79, 95%CI: 0. 65–0.92)	A VExUS grade of 3 had a sensitivity of 1 and a specificity of 0.85 for RAP ≥12 mmHg
V. Bhardwaj, *et al*.[17]	2023	107	The accuracy of VExUS and FVD for detecting venous congestion was 80.37 (95% CI of 71.5 to 87.4) and 74.7 (95% CI of 65.4 to 82.6), respectively. The level of agreement between FVD and VExUS was moderate (Kappa=0.62, *P*<0.001), while the agreement between FVD and CVP was weak (Kappa=0.49, *P*<0.001)	FVD has good accuracy for detecting venous congestion and shows moderate agreement with VExUS grading.
Stefan Andrei, *et al*.[18]	2023	180	79/108 patients (73%) had a pulsatile femoral vein pattern at least at one-time point.	A pulsatile femoral vein pattern is associated with parameters of venous congestion.

ACS- acute coronary syndrome, AHF - acute heart failure, AKI - acute kidney injury, AUC - area under the curve, DIC - disseminated intravascular coagulation, FVD - femoral vein Doppler, ICU - intensive care unit, IRVD - intra-renal venous Doppler, IVC - inferior vena cava, POCUS - point of care ultrasound, Sn - sensitivity, Sp - specificity, VExUS - venous excess ultrasound score, CI - confidence interval, CVP - central venous pressure, RAP - right atrial pressure

pulsatility, and IVC diameter, can be valuable in predicting venous congestion and assessing the severity of the condition. However, their utility in predicting outcomes in AHF patients appears to be less certain. Further research is needed to validate the findings and determine the optimal use of VExUS scores in clinical practice, considering the specific patient population and clinical context. Healthcare providers can consider incorporating VExUS scores into their decision-making processes in critical care settings in identifying at-risk patients for venous congestion.

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Conflicts of interest

There are no conflicts of interest.

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