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Emergency Medicine

A STUDY ON POINT-OF-CARE MULTIORGAN ULTRASONOGRAPHY FOR THE EVALUATION OF NONTRAUMATIC UNDIFFERENTIATED HYPOTENSION AT A TERTIARY CARE HOSPITAL

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ABSTRACT **Background:** Undifferentiated hypotension is typical emergency department presentation and a critical determinant of patient outcomes, necessitating rapid identification of its aetiology for effective management. **Objectives:** This research aimed to evaluate clinical profile, ultrasonographic findings, and diagnostic accuracy of point-of-care ultrasonography in patients with undifferentiated hypotension in the emergency department. **Methods:** The cross-sectional research involved one hundred ten adult patients (aged over 18) suspected of experiencing shock, conducted in emergency medicine division of the S.S. Institute of Medical Sciences and Research Centre in Davangere, Karnataka, India. Point of care. Ultrasonography was used to examine a number of organs systematically, and the results were compared to the final diagnosis made at conclusion of hospital stay. **Results:** Hypovolemic shock, septic shock, as well as cardiogenic shock have been found to be the most common causes of shock by ultrasonography. There was strong agreement among ultrasonographic and final clinical diagnoses, with sensitivity and specificity for ultrasonographic vs. final clinical diagnoses being close to 80% or higher across the majority of shock categories. **Conclusion:** Multiorgan point-of-care ultrasonography (POCUS) is an invaluable diagnostic tool that assists emergency physicians in identifying the causes of undifferentiated hypotension in (ED) emergency department as well as providing prompt, targeted care.

KEYWORDS : Point-of-care ultrasonography, hypotension, emergency department, shock.

INTRODUCTION

In emergency rooms, undifferentiated hypotension is typical and a key indicator of patient outcome. [1]. If untreated, it results in acute circulatory failure characterized by inadequate oxygen delivery to tissues, potentially causing irreversible damage, organ failure, and mortality. [2]. Emergency physicians must promptly identify and begin goal-directed treatment for hypotension, a common emergency. [3]. In particular, traditional methods, including monitoring of vital signs (for example, blood pressure and pulse rate) [4], are often not specific, and invasive techniques to assess hemodynamic status can be time-consuming and unavailable in urgent settings [5]. Because it provides a quick, non-invasive, bedside diagnostic tool to evaluate patients who are hemodynamically unstable, POCUS is promising method with its introduction [6]. The aim of this research was to: (1) explain clinical characteristics of individuals with hypotension who arrive at the emergency room, (2) elucidate ultrasound results in individuals with undifferentiated hypotension, and (3) Assess effectiveness of POCUS in identifying underlying cause of hypotension in this scenario.

Materials/Patients And Methods

A prospective observational research has been conducted in the emergency medicine department of the S.S. Institute of Medical Sciences & Research Centre in Davangere, Karnataka, from August 2016 - August 2018. One hundred and ten adult patients (over the age of eighteen) who arrived at ED with a Clinical concern of shock have been involved in research.

Ethical Clearance:

On 24 October 2016, the S.S. Institute of Medical Sciences & Research Center's Institutional Ethics Review Board (IERB) approved the research (IERB No: 58-2016; Ref: IERB/DISSER/20-2016).

Patient Selection:

Patients who had at least one symptom of hypoperfusion, involving altered mental status, unresponsiveness, respiratory distress, syncope, abdominal pain or severe chest, or generalized fatigue, as well as systolic blood pressure (SBP) of <90 millimeters of mercury (as verified by two measurements during the initial evaluation) were included. The exclusion criteria involved a patient's reported "low blood pressure" condition, thoracic trauma, or severe abdominal pain within 24 hrs before enrollment, or abnormalities on the echocardiogram suggestive of an acute myocardial infarction.

Data Collection:

Interviews were used to record presenting complaints and demographic information (age, sex). Vital signs, involving blood pressure (BP), respiratory rate, pulse rate, as well as urine output, as well as clinical indicators of shock, were evaluated during a comprehensive clinical examination. A predesigned, pretested proforma documented findings.

Point-of-Care Ultrasonography (POCUS):

Portable GE LOGIQ e ultrasound machine (GE Healthcare) equipped with three probes—a cardiac probe (3S-RS, 2–4 MHz), linear probe (12 L-RS, 5 to 13 MHz), and a curvilinear probe (4C-RS, 2–5.5 MHz)—was used to perform bedside multi-organ POCUS on all unstable patients. The (IVC) inferior vena cava, abdomen, heart, leg veins, and lungs were all inspected using a standardized protocol. Pericardial effusion, (LV) left ventricular function, and (RV) right ventricular dilatation were evaluated using cardiac views (parasternal long-axis, subcostal, as well as apical four-chamber). Utilizing linear probe across lateral, anterior, as well as posterior thorax zones, lung views revealed consolidation, pleural effusion, air bronchograms, B-lines, A-lines, as well as lung sliding. In subcostal view, IVC collapsibility was measured within two cm of junction of right atrium. Free fluid in splenorenal pouch, pelvic cavity, and Morrison's pouch, as well as an abdominal aortic aneurysm, was assessed using abdominal views and the curvilinear probe. Leg vein views (common femoral, popliteal) with the linear probe assessed for thrombosis via compressibility.

Additional Investigations:

Clinical evaluation was supported by the following tests performed on patients: arterial blood gas analysis, chest X-ray, serum electrolytes, serum amylase / lipase, random blood sugar, complete hemogram, as well as 2D echocardiography.

Statistical Analysis:

Calculations were made to determine POCUS's specificity, sensitivity, positive predictive value (PPV), as well as negative predictive value (NPV). Agreement among final clinical diagnosis made at hospital

discharge and the ultrasonography diagnosis was evaluated using Cohen's Kappa coefficient.

RESULTS:

110 individuals that arrived at ED of S.S. Institute of Medical Sciences and Research Centre, Davangere, between August 2016 - August 2018 with hypotension were the subject of this prospective observational research. Majority of patients (69.1% male; male-to-female ratio 2.2:1) were 50–60 years of age or older, and the most common complaints were breathlessness and fever (Figure 1). At presentation, 95% had a systolic blood pressure (SBP) of ≤90 mmHg (mean, 88.29 mmHg), and all had an oxygen saturation of <90%.

Point-of-care ultrasonography (POCUS) identified septic shock as the most common aetiology (52 patients), followed by hypovolemic shock (24), cardiogenic shock (20), obstructive shock (7), mixed aetiology (3), and unknown (4), closely aligning with final diagnoses: 48 septic, 23 hypovolemic, 19 cardiogenic, 7 obstructive, 11 mixed, and 2 unknowns (Table 1). Cardiac POCUS revealed hyperkinetic left ventricle (LV) in 62.73% and hypokinetic LV in 29.09% (Figure 2). Lung ultrasound showed lung sliding in 96.36% and B-lines in 25.45% (Figure 3). Inferior vena cava (IVC) diameter was <2 cm in 75.45%. Abdominal ultrasound detected peritoneal free fluid in 30.91% (Figure 4).

Laboratory findings included a mean hemoglobin level of 11.22 g/dL and a mean serum lactate level of 8.29 mmol/L. POCUS reliability indices (Table 2) demonstrated high sensitivity and specificity, with values of 100% for obstructive shock, 91.30% for hypovolemic shock, 91.67% for septic shock, and 84.21% for cardiogenic shock, respectively. Cohen's kappa coefficients (Table 3) indicated perfect agreement for obstructive shock (κ is equal to one), very good for hypovolemic shock (κ=0.865), and good for septic (κ=0.780) and cardiogenic shock (κ=0.782).

DISCUSSION:

This prospective observational study evaluated POCUS in one hundred and ten patients presenting to ED with undifferentiated hypotension. From August 2016 to August 2018, it has been conducted at the S.S. Institute of Medical Sciences and Research Centre's Department of Emergency Medicine in Davangere. Patient cohort, predominantly aged 50–60 years or older and 69.1% male, frequently reported fever and breathlessness, indicative of acute systemic illness. Initial assessments confirmed severe hemodynamic instability, with most patients exhibiting systolic blood pressure ≤90 mmHg (mean 88.29 mmHg) and all showing oxygen saturation below 90%, highlighting the need for rapid diagnostic tools in such critical scenarios.

POCUS identified septic shock as the predominant aetiology, affecting nearly half the cohort, followed by hypovolemic, cardiogenic, and obstructive shock, with a smaller subset showing mixed or unknown causes. Finally, final diagnoses at hospital discharge confirmed these findings, with septic shock still being the most common, implying that POCUS was a reliable diagnostic tool. Septic shock has a high prevalence as it is commonly seen in EDs, and POCUS was critical in identifying signs of lung consolidation or peritoneal fluid for identification of infection source for early antimicrobial and fluid therapy. This ability is consistent with Volpicelli et al. [7] observations that POCUS may help in identifying sepsis-related abnormalities and thus helps in making POCUS practicable for expeditious management of this life-threatening condition.

Cardiac ultrasound reflected the diverse pathophysiological underpinnings with hyperkinetic left ventricles in early septic states and hypokinetic ventricles in cardiogenic states. Free fluid was often identified by abdominal ultrasound in a substantial percentage of patients, critical for hypovolemic or septic sources, and lung ultrasound demonstrated signs of pulmonary edoema that helped distinguish from other respiratory causes. Dilated right heart chambers and pericardial effusion were used to accurately detect obstructive shock cases such as pulmonary thromboembolism and cardiac tamponade. These findings are also consistent with Atkinson et al.'s ACES approach [8], which suggests that POCUS can provide insight into shock mechanisms at the bedside, allowing for targeted interventions such as thrombolysis or pericardiocentesis in time-sensitive situations.

The reliability of POCUS was notably high for obstructive and hypovolemic shock, with strong agreement to final diagnoses (κ values approaching or reaching 1), and good concordance for septic and cardiogenic etiologies (κ around 0.78–0.865). Mixed etiologies posed a challenge, with lower sensitivity due to overlapping ultrasonographic features, a limitation also noted by Ghane et al. [9], though its high specificity supported its role in ruling out specific causes. This diagnostic accuracy, comparable to Shokoohi et al.'s report [10] of reduced uncertainty, suggests POCUS can streamline ED workflows, optimize resource allocation, and hasten patient disposition—crucial advantages in resource-limited contexts.

This multi-organ assessment is superior to single-organ protocols in the assessment of cardiac, lung, abdominal, and vascular pathology as compared with Rose et al.'s UHP [11] and Perera et al.'s RUSH [12]. It offers pathophysiological understanding regarding the fluids and vasopressors to be used and procedural interventions, potentially leading to improved patient outcomes. For instance, the identification of obstructive shock as perfect in line with Ahn et al.'s study [13] in cases such as tamponade shows its lifesaving utility. Altogether, these outcomes place POCUS as an essential adjunct to the emergency physician's armamentarium and close the gap between diagnostic ambiguity to definitive management with high dependability and relevance.

CONCLUSION:

This study also demonstrates that POCUS is a very helpful diagnostic technique for ED patients with undifferentiated hypotension. Thus, POCUS allows emergency physicians to accurately identify the aetiology of the shock, such as septic, hypovolemic, cardiogenic, and obstructive shock, and intervene early. The possibility of having it at the bedside, its relatively low cost, and minimal interference with the patient's condition further adds to its great value in the critical care environment. The concordance of POCUS findings with final clinical assessment further establishes its accuracy and provides a connexion between the patient's first encounter and a more extensive examination. Thus, the ability to use serial POCUS in the context of treatment response makes it applicable in future considerations of ED reassessment. Taking into consideration the noted limitations concerning the single-centre study design and operator-related variability, the results of this study endorse POCUS as a groundbreaking tool that helps emergency physicians deal with undifferentiated hypotension more effectively.

Table 1: Provisional and Final Diagnoses of Hypotension Etiologies (n=110)

Provisional diagnosis	Final diagnosis						Total
	Cardiogenic shock	Hypovolemic shock	Obstructive shock	Septic shock	Mixed	Unknown	
Cardiogenic shock	16	0	0	1	3	0	20
Hypovolemic shock	1	21	0	1	1	0	24
Obstructive shock	0	0	7	0	0	0	7
Septic shock	2	2	0	44	4	0	52
Mixed	0	0	0	0	3	0	3
Unknown	0	0	0	2	0	2	4
Total	19	23	7	48	11	2	110

Description: Compares POCUS-based provisional diagnoses with final clinical diagnoses at hospital discharge for cardiogenic, hypovolemic, obstructive, septic, mixed, and unknown shock etiologies. Rows represent provisional diagnoses; columns represent final diagnoses.

Table 2: Reliability Indices Of POCUS For Shock Subtypes In ED (n=110)

	Cardiogenic shock (n-20)	Hypovolemic shock (n-24)	Obstructive shock (n-7)	Septic shock (n-52)	Mixed (n-3)	Unknown (n-4)
Sensitivity	84.21%	91.30%	100.00%	91.67%	27.27%	100.00%
Specificity	95.60%	96.55%	100.00%	87.10%	100.00%	98.15%
PPV	80.00%	87.50%	100.00%	84.62%	100.00%	50.00%
NPV	96.67%	97.67%	100.00%	93.10%	92.52%	100.00%

Description: Presents specificity, PPV, sensitivity, as well as NPV of

POCUS for every shock subtype (cardiogenic, hypovolemic, obstructive, septic, mixed, unknown). Values are percentages.

Table 3: Cohen's Kappa Agreement Between POCUS And Final Diagnoses (n=110)

Types of shock	Final diagnosis (clinical and biochemical)	Ultrasonographic Diagnosis	Cohen's k coefficient	Strength of agreement
Hypovolemic shock(n-23)	23	24	0.865	Very good
Septic shock(n-48)	48	52	0.780	good
Cardiogenic shock(n-19)	19	20	0.782	good
Obstructive shock(n-7)	7	7	1	perfect
Mixed etiology(n-11)	11	3	0.403	moderate
Unknown etiology (n-2)	2	4	0.658	good

Description: Displays each shock subtype's Cohen's kappa (κ) coefficients and degree of agreement among final ultrasonography and diagnosis. Strength categories are good (0.61– 0.80), very good (0.81 to 0.99), moderate (0.21 to 0.40), as well as perfect (1.0); κ values range from 0 to 1.

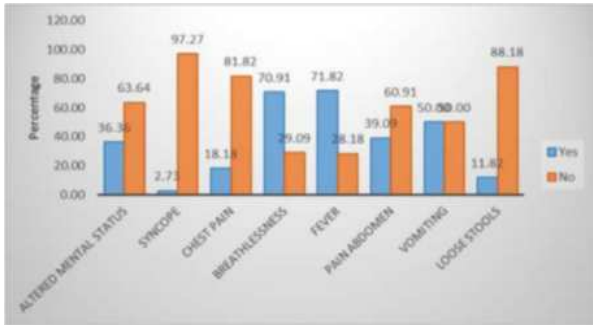

Figure 1: Chief Complaints of Patients Presenting to ED with Hypotension (n=110)

Description: Bar graph illustrating the frequency of chief complaints (e.g., fever, breathlessness) among patients. Y-axis: number of patients; X-axis: complaint types.

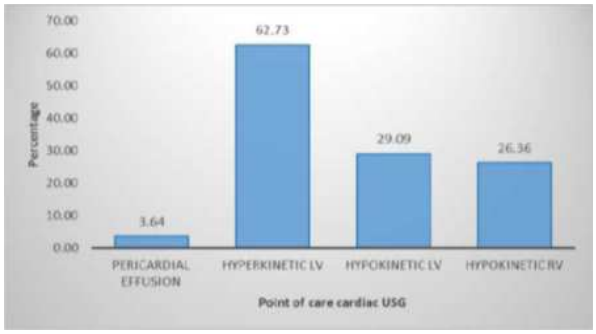

Figure 2: Cardiac POCUS Findings in Patients with Hypotension (n=110)

Description: Pie chart showing the percentage distribution of cardiac ultrasound findings (e.g., hyperkinetic LV, hypokinetic LV, pericardial effusion). LV = left ventricle

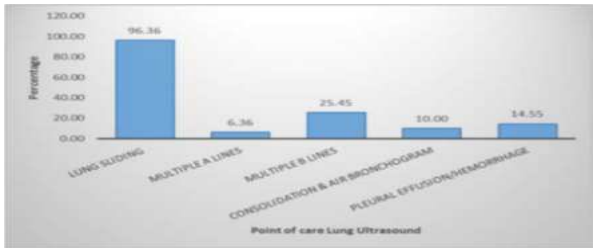

Figure 3: Lung POCUS Findings in Patients with Hypotension (n=110)

Description: Bar graph depicting the percentage of patients with lung ultrasound findings (e.g., lung sliding, B-lines, pleural effusion). Y-axis: percentage; X-axis: finding types.

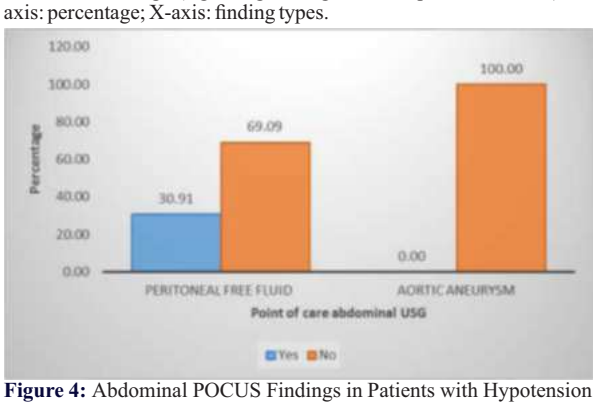

Figure 4: Abdominal POCUS Findings in Patients with Hypotension (n=110)

Description: Bar graph indicating the percentage of patients with peritoneal free fluid detected by abdominal ultrasound. Y-axis: percentage; X-axis: presence/absence of free fluid.

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