The Study of Rapid Ultrasound in Shock in Patients of Undifferentiated Hypotension Presenting to Emergency Department

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Abstract :

Background: Patients with hypotension or shock usually have high mortality rates, and use of traditional physical examination techniques only may be misleading for rapid diagnosis and treating the same. RUSH (Rapid Ultrasound for Shock and Hypotension) protocol is used in patients with undifferentiated shock to improve accurate diagnosis of shock. **Methods:** A prospective observational study was done from April to June 2022 at emergency department in 100 patients who presented with hypotension. This included patients who had systolic blood pressure (SBP) of <90 mmHg, along with tachypnoea and tachycardia. Patients RUSH examination was performed. The patients were followed up to document their final diagnosis. **Results:** In our study, the mean age of patients with hypotension was 58.8±8.7 years with male preponderance of 53%. The hypovolemic shock (40%) was found to be the most common subtype of shock. 86% of patients were correctly diagnosed with RUSH study. The sensitivity, specificity, PPV and NPV of RUSH in shock patients was 36.69%, 25.7%, 26.5%, 87.25% respectively and disease prevalence 31.5% and accuracy 68.75%.Cohens Kappa index was 0.5 showed a moderate agreement of the RUSH protocol in diagnosis of causes of shock with the final diagnosis. **Conclusion:** This study advocates the use of RUSH protocol in patients presenting with undifferentiated hypotension in the emergency department. It narrows the possible differentials of shock and guides the emergency physician to an early initial therapy, thereby improving the final outcome of patient.

Keywords : Emergency department, Hypotension, Rapid Ultrasound for Shock and Hypotension, Shock.

Introduction:

Shock is a state of circulatory insufficiency that creates an imbalance between tissue oxygen supply (delivery) and demand (consumption), resulting in end-organ dysfunction. The mechanisms that can result in shock are frequently divided into four categories: Hypovolemic, Cardiogenic, Distributive and Obstructive.[1] Patients with hypotension or shock usually have high mortality rates. It depends upon the clinical assessment done and the duration of hypotension.[2] Due to overlapping signs in different types of shock, the routine clinical assessment is not sufficient to reach the early diagnosis. Bedside ultrasound is ideal for the evaluation of critically ill patients in shock as it allows direct visualization of pathology and provides accurate differentials in a minimum time-consuming approach. It helps to reach accurate diagnosis in undifferentiated hypotension.[3-5]

Among resuscitative ultrasound techniques, the Rapid Ultrasound for Shock and Hypotension (RUSH) is an emergency ultrasound protocol for identification of aetiology of shock. It is a rather quick non-invasive examination completed at bedside without shifting the patient for imaging. The visualisation of the pathology can help to diagnose and exclude multiple different diagnoses rapidly. Studies advocate the initial integration of bedside ultrasound for evaluation of the patient with shock results in a more accurate initial diagnosis and an improved patient outcome.[3, 5] Thus, bedside ultrasound has become an essential component in the evaluation of the hypotensive patient.[4]

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Table 1: RUSH Protocol: Ultrasonographic findings seen with classic shock states[7]

RUSH Evaluation	Hypovolemic shock	Cardiogenic schock	Obstructive shock	Distributive schock
Pump	Hypercontractile heart Small chamber size	Hypocontractile heart Dilated heart size	Hypercontractile heart Pericardial effusion Cardiac tamponade RV strain Cardiac thrombus	Hypercontractile heart (early sepsis) Hypocontractile heart (late sepsis)
Tank	Flat IVC and IJV Peritoneal fluid (fluid loss) Pleural fluid (fluid loss)	Distended IVC/IJV Lung rockets (pulmonary edema) Pleural fluid Peritoneal fluid (ascites)	Distended IVC Distended jugular veins Absent lung sliding (pneumothorax)	Normal or small IVC (early sepsis) Peritoneal fluid (peritonitis) Pleural fluid (empyema)
Pipes	Abdominal aortic aneurysm Aortic dissection	Normal	DVT	Normal

Practitioners used to perform Swan-Ganz catheterization technique in hypotensive patients, providing immediate intravascular hemodynamic data. The data was reliable but large studies demonstrated no significant improvement in mortality in these patients receiving such prolonged invasive monitoring thus its use was declined.[6] RUSH includes a 3-step shock ultrasound protocol- the pulmonary evaluation along with cardiac, abdominal and the venous examination (Table 1).[7]

The components of the RUSH exam are: **HI-MAP**.

- **H**eart,
- **I**nferior vena cava (IVC),
- **M**orrison's/FAST abdominal views,
- **A**orta, and
- **P**neumothorax.

A simpler way is to think of:

Step 1: **Pump** (Heart): Tamponade, LVEF, and RV size (A limited echocardiogram which rules out cardiac tamponade, ejection fraction or LV contractility, RV size, diastolic collapse)

Step 2: **Tank** (Intravascular): IVC, thoracic and abdominal compartments (IVC, FAST examination showing Morrison's pouch, splenorenal recess, bladder and hypogastric region; also, pulmonary oedema and tension pneumothorax)

Step 3: **Pipes** (Large Arteries/Veins): Aorta and femoral/popliteal veins. (DVT scan).[7]

This is performed by using a portable ultrasound machine and the probes used are phased-array transducer (3.5–5 MHz) for adequate thoracoabdominal intercostal scanning, and a linear array transducer (7.5–10 MHz) for venous examinations and pneumothorax evaluation.

Methodology:

This study was a prospective observational study done from April to June 2022. A total of 100 patients who presented with hypotension and shock were included in the study. This included patients who had systolic blood pressure of <90 mmHg, with tachypnoea and tachycardia. Excluded patients were the patients not giving consent or with age < 18 years. Approval of the ethics committee was taken(Institutional Ethics committee vide no. GCSMC/EC/Research

project/APPROVE/2 022/358 dated 16/05/2022). The clinical evaluation and immediate resuscitation were done according to standard treatment protocols. RUSH examination by a portable ultrasound machine was done along with treatment; also the required investigations were done without delay. All patients were tracked till documentation of final diagnosis by second physician (other than emergency physician) taking care of the patient. The agreement between the diagnosis provided by RUSH and the final diagnosis was investigated by sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of RUSH for diagnosis, and the Cohen's kappa index was used for level of agreement. It was calculated using MedCalc statistical software. [values $\leq$0 was considered as no agreement and 0.01–0.20 as none to slight, 0.21–0.40 as fair, 0.41– 0.60 as moderate, 0.61–0.80 as substantial, and 0.81–1.00 as almost perfect agreement].

Results:

In our study of 100 patients, the mean age group of patients presenting with hypotension was 58.8±8.7 years with male preponderance of 53%.The mean systolic blood pressure (SBP) was 72.8±8.96mmHg and diastolic blood pressure (DBP) was 49.46±5.9mmHg.The mean pulse rate of patients in this study group was 109.06.The mean of hyperthermic patients (septic shock) was 13.33%.

The patients correctly diagnosed clinically as with the final diagnosis were 42%, whereas total of 86% of patients were correctly diagnosed using RUSH protocol as per the final diagnosis according to the final diagnosis. (Table 2)

According to the results observed the most common shock observed was hypovolemic shock (40%), cardiogenic shock (33%), distributive shock (14%) obstructive shock (13%). (Table 3 and Figure 2) The traumatic causes were 20% while non-traumatic causes included 80% of total patients out of which hypotension due to cardiogenic causes was 48% with the maximum prevalence of cardiogenic shock. We observed a mortality rate of 39%. (Table 4 and Figure 1)

Cohens Kappa index was 0.5, showed a moderate agreement of the diagnosis by RUSH protocol with the final diagnosis.

Table 2: Comparison of diagnosis of patients using clinical findings and RUSH protocol examination (n=100)

No. of patients	Correctly diagnosed	Misdiagnosed
Clinical findings	42%	58%
RUSH protocol examination	86%	14%

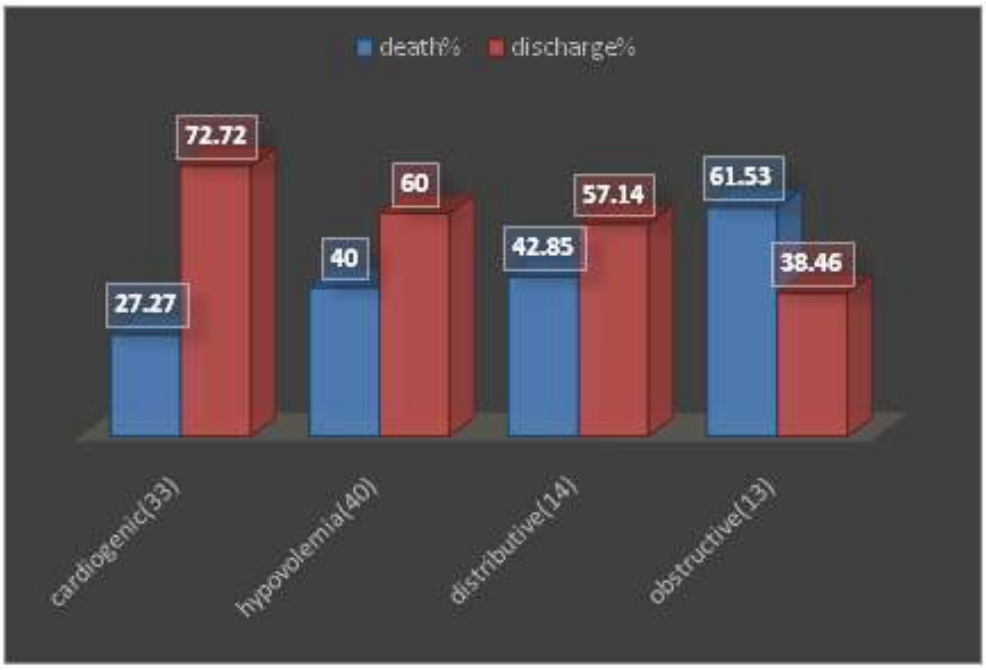
Table 3: Duration of stay of patients based on RUSH classification

Type of shock based on RUSH criteria	No. of Patients	Length of ICU stay (in days)
Cardiogenic	33	2.5+0.9
Distributive	14	3.2+1.1
Obstructive	13	1.8+0.4
Hypovolemic	40	2.2+0.7

Table 4: Outcome amongst patients based on RUSH criteria

RUSH criteria	Outcome	
	Death (%)	Discharge (%)
Cardiogenic shock	9 (27.27%)	24 (72.72%)
Hypovolemic shock	16 (40%)	24 (60%)
Distributive shock	6 (42.85%)	8 (57.14%)
Obstructive shock	8 (61.53%)	5 (38.46%)

Figure 1: Outcome of the patients



Discussion:

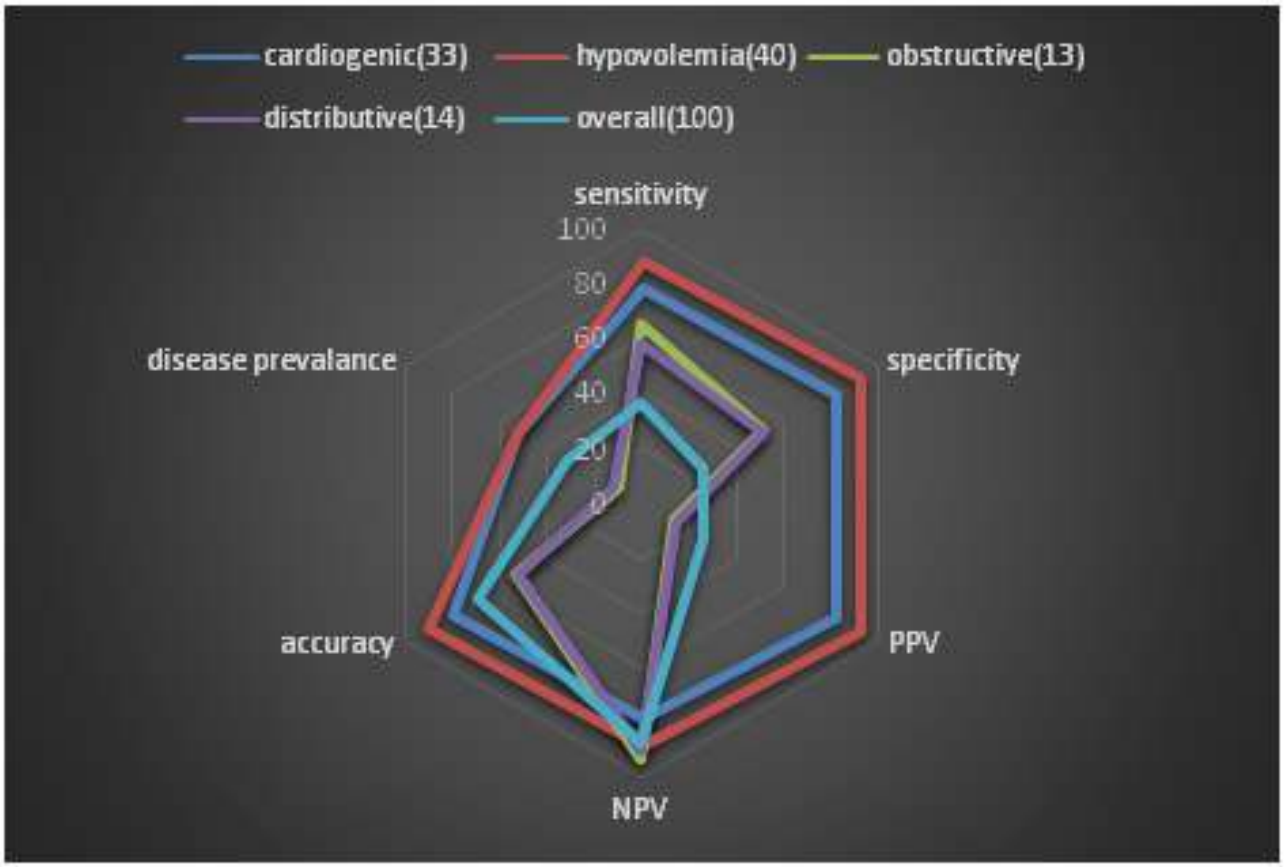
Prompt and accurate diagnosis of shock remains a challenge for a physician as no single and specific clinical parameter or diagnostic study can accurately predict the type of shock. This study showed that incorporation of bedside ultrasound helped emergency physicians to correctly identify the cause of a symptomatic and undifferentiated hypotension. Our results agreed with the study of Ghane et al[8] who applied RUSH Protocol by emergency physicians to predict the shock type in critically ill patients and reported the index of agreement (Kappa index = 0.71 and P= 0.000) between shock type diagnosed based on a similar protocol and final clinical diagnosis of patients. This is comparable to our study having the Cohen's kappa index of 0.5.

This study had sensitivity, specificity, PPV and NPV of RUSH in different type of shocks were 36.69%, 25.7%, 26.5%, 87.25% respectively. Disease prevalence is 31.5% and accuracy 68.75% (Table 5). Elbaih et al[9] reported that the sensitivity, specificity, PPV and NPV of RUSH in different types of shock is 94.2%, 96.2%, 87.8% and 96.1% respectively. Stawicki et al[10] noted that the sensitivity, specificity, PPV and PNV for US were 86.2%, 97.2%, 89.3%, 96.3% respectively.

Table 5: Reliability of RUSH protocol examination in clinical diagnosis (n=100)

Type of shock	Cardiogenic (n=33)	Hypovolemic (n=40)	Obstructive (n=13)	Distributive (n=14)	Overall (n=100)
Sensitivity	78.85%	88.46%	65.00%	58.33%	36.69%
Specificity	81.25%	91.67%	51.67%	51.14%	25.70%
Positive predictive value	82.00%	92.00%	13.00%	14.00%	26.50%
Negative predictive value	78.00%	88.00%	93.00%	90.00%	87.25%
Accuracy	80.00%	90.00%	53.00%	52.00%	68.75%
Disease prevalence	52.00%	52.00%	10.00%	12.00%	31.50%

Fig. 2: Reliability of RUSH protocol examination in clinical diagnosis



Limitations:

This study was conducted at a single centre. Due to a smaller number of patients in each subgroup of shock interpretation of the results must be done with caution. Further studies in multiple centres with higher number of patients are required.

Conclusion:

This study advocates the use of RUSH protocol examination in patients presenting with undifferentiated hypotension in the emergency department. The clinical evaluation in a critically ill patient with a rapidly deteriorating clinical condition required the addition of ultrasound. The use of RUSH

protocol aids in the rise of diagnostic accuracy, rules out the differentials and also guides the emergency physician to appropriate initial management thereby improving the final outcome of patient. It especially rules out hypovolemic, cardiogenic and obstructive shock and guides the clinician to begin a specific lifesaving resuscitative intervention earlier. Being a bedside, non-invasive, rapid accessible, with least disturbance to the patient, it is useful in emergency department as a screening tool to triage patients.

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