National Board of Examination - Journal of Medical Sciences
Volume 2, Issue 11, Pages 1121–1134, November 2024
DOI 10.61770/NBEJMS.2024.v02.i11.007

ORIGINAL ARTICLE

An Observational Study of Patients Presenting in Hypotension and Shock to Emergency Room by Applying RUSH Protocol

Santhosh K B[1,*] and Praveen Kumar N[2]
[1]*Assistant Professor, Department of Emergency Medicine, Subbaiah Institute of Medical Sciences and Research Centre, Shivamogga, Karnataka, India*
[2]*Assistant Professor, Department of Emergency Medicine, Kanachur Institute of Medical Sciences, Mangaluru, Karnataka, India*

Accepted: 04-September-2024 / Published Online: 07-November-2024

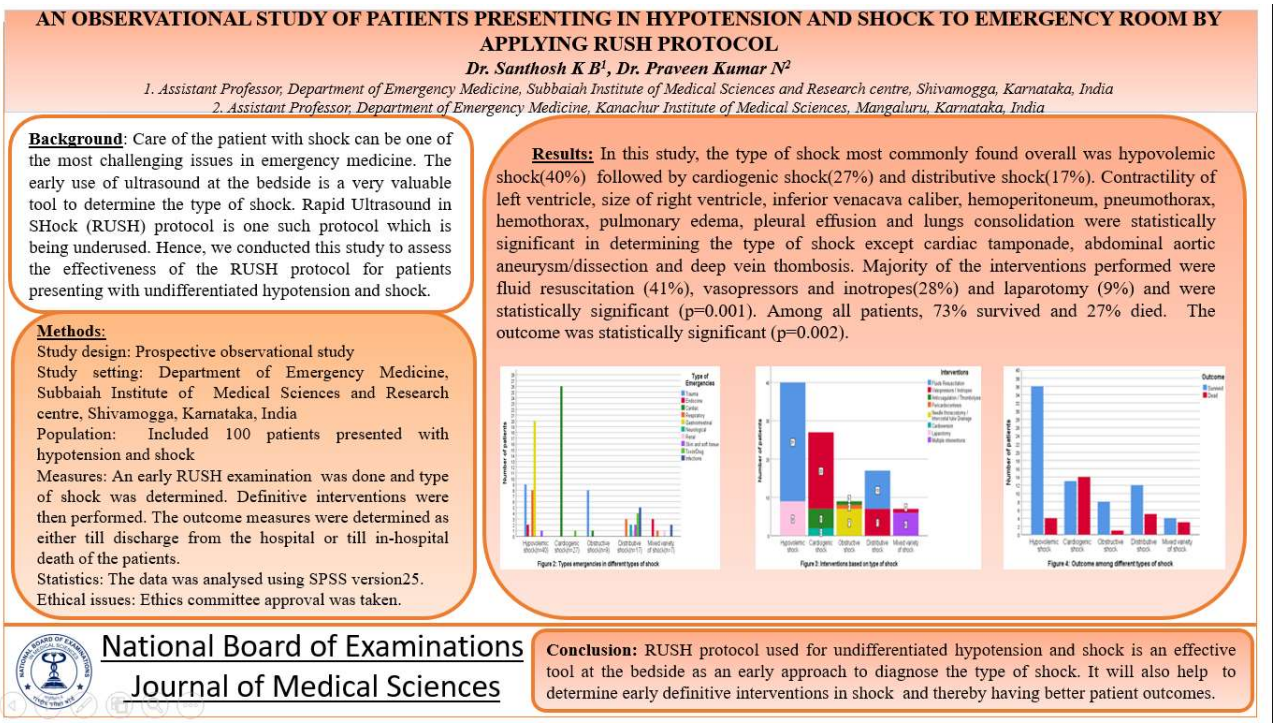
Abstract

Introduction: Care of the patient with shock can be one of the most challenging issues in emergency medicine. The early use of ultrasound at the bedside in such emergency is a very valuable tool to determine the type of shock. Rapid Ultrasound in SHock (RUSH) protocol done by emergency physicians is one such protocol which is being underused. Hence, we conducted this study to assess the effectiveness of the RUSH protocol for patients presenting with undifferentiated hypotension and shock. **Materials and methods:** This was prospective observational study done on a total of 100 patients presented with hypotension and shock. We performed an early bedside sonographic examination for participants based on RUSH protocol and type of shock was determined. Then the definitive interventions were performed as per the type of shock. The outcome measures were determined either till the survival to discharge from the hospital or till the in-hospital death of the patient. The data was analysed using SPSS version25. **Results:** In this study, the type of shock most commonly found overall was hypovolemic shock (40%) followed by cardiogenic shock (27%) and distributive shock (17%). Contractility of left ventricle, size of right ventricle, inferior venacava caliber, hemoperitoneum, pneumothorax, hemothorax, pulmonary edema, pleural effusion and lungs consolidation were statistically significant in determining the type of shock except cardiac tamponade, abdominal aortic aneurysm/dissection and deep vein thombosis. Majority of the interventions performed were fluid resuscitation (41%), vasopressors and inotropes (28%) and laparotomy (9%) and were statistically significant (p=0.001). Among all patients, 73% survived and 27% died. The outcome was statistically significant (p=0.002). **Conclusion:** RUSH protocol used for undifferentiated hypotension and shock is an effective tool at the bedside as an early approach to diagnose the type of shock. It will also help in determining early definitive interventions in shock states and thereby having better patient outcomes.

Key words: RUSH, Shock, POCUS, Hypotension, Ultrasound

*Corresponding Author: Santhosh K B
Email: santhosh.achar15892@gmail.com

Graphical Abstract



Introduction

Shock is a state of circulatory insufficiency that creates an imbalance between tissue oxygen supply and demand, resulting in end organ dysfunction [1-3]. Shock is typically divided into four categories: hypovolemic, cardiogenic, obstructive, and distributive [4]. Since each type of shock requires a special treatment, we need quick detection techniques for all kinds of shock in the emergency room [5]. In a busy emergency room, the cause of shock and the optimal initial therapeutic approach can still be not clear even for an experienced clinician at the bedside. Traditional physical examination techniques can be misleading given the complex physiology of shock [6]. The longer the duration of hypotension and shock higher is the mortality. Therefore, early diagnosis and initial care must be accurate and prompt to improve the patient outcomes [7]. Failure to make the correct diagnosis and act appropriately can lead to potentially disastrous outcomes and high-risk situations. Laboratory investigations and more specialized investigations such as computed tomography (CT) scan and radiologist performed abdominal ultrasound or echocardiogram which are needed to establish an accurate diagnosis are time consuming and not always readily available especially after hours.

The use of bedside ultrasound has been described in the evaluation of undifferentiated shock for well over two decades [8-12]. In this study, multi-organ point-of-care ultrasound (PoCUS) by using Rapid Ultrasound in SHock (RUSH) protocol was attempted as an early approach to improve the accuracy and to narrow the differential diagnoses thus guiding the

emergency physician (EP) in early goal-directed therapy for better outcome in patients presenting with hypotension/shock.

The need of the study is to assess the effectiveness of RUSH protocol that incorporates a bedside stepped examination for an early approach to undifferentiated hypotension and shock in emergency care.

Materials and Methods

This study was a prospective observational study done from March 2022 to February 2023 conducted on total of 100 patients who presented with hypotension and shock to Emergency Department to Subbaiah Institute of Medical Sciences and Research Centre, Shivamogga, Karnataka. This included patients who had systolic blood pressure of ≤90 mmHg with diastolic blood pressure of ≤60 mmHg. Approval of the ethics committee was taken. The following criterias were used for the selection of patients.

Inclusion Criteria:

a) All patients presenting to emergency department with Hypotension / Shock.
b) Age ≥ 18years
c) Any sex

Exclusion criteria:

a) Patients with chronic heart failure, chronic renal failure, portal hypertension with ascites and hypoproteinemias
b) Any other chronic medical conditions causing accumulation of fluid in third space.
c) Patients with obvious external blood loss causing hypotension/shock.

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 and also the required investigations were done without delay.

The RUSH protocol involves a three part bedside physiologic assessment simplified as:

Step 1: The pump
Step 2: The tank
Step 3: The pipes

In the evaluation of the Pump, heart was evaluated for its left ventricle (LV) contractility, size of the right ventricle (RV), pericardial effusion and cardiac thrombus. In the evaluation of the Tank, inferior venacava (IVC) caliber, ascites/hemoperitoneum, pleural effusion/hemothorax, pneumothorax were evaluated. In the evaluation of Pipes, Abdominal Aortic aneurysm/dissection (AAA/AAD) and deep vein thrombosis (DVT) were evaluated. After evaluation of all three components of the RUSH protocol, the type of shock was determined based on the findings that are mentioned in the Figure 1 and then patient was started on the definitive interventions. The outcome measures are determined as either till the survival to discharge from the hospital or till the in-hospital death of the patient.

Rapid Ultrasound in SHock (RUSH) protocol: ultrasonographic findings seen with classic shock states

RUSH Evaluation	Hypovolemic Shock	Cardiogenic Shock	Obstructive Shock	Distributive Shock
Pump	Hypercontractile heart Small chamber size	Hypocontractile heart Dilated heart	Hypercontractile heart Pericardial effusion Cardiac tamponade RV strain Cardiac thrombus	Hypercontractile heart (early sepsis) Hypocontractile heart (late sepsis)
Tank	Flat IVC Flat jugular veins Peritoneal fluid (fluid loss) Pleural fluid (fluid loss)	Distended IVC Distended jugular veins 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 (sepsis source) Pleural fluid (sepsis source)
Pipes	Abdominal aneurysm Aortic dissection	Normal	DVT	Normal

Figure 1. Ikbal Sasmaz et al. [13]

Statistical Procedures

The data was entered in Microsoft Excel. Then statistical software SPSS version 25 was used for the analysis of the data. Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± Standard deviation (Minimum-Maximum) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. Chi-square/ Fisher's Exact test has been used to find the significance of study parameters on categorical scale between two or more groups. The results were determined as statistically significant if the p value is </=0.05.

Results

In this study, majority of study participants were in the age group of 51-60 years (22%) followed by 41-50 years (18%). The mean age of the patients was 49.20±17.166 yrs. Minimum age was 18years and maximum age was 85years. Male study participants were 62% and female study participants were 38%. The means of different vitals of the patients in this study were systolic blood pressure (SBP) 74.64±10.93 mmHg, diastolic blood pressure (DBP) 43.86±24.31mmHg, heart rate 130.10±18.00 per minute, respiratory

rate 29.79±5.84 per minute, SpO2 89.71±5.42%, temperature 98.50±2.21°F, capillary refill time 3.20±1.12 seconds and capillary blood glucose 143.55±85.31 mg/dL.

Majority of the presentations were cardiac (27%) followed by gastrointestinal (20%) and trauma (17%) emergencies. The type of shock most commonly found overall was Hypovolemic shock (40%) among which 50% were found in gastrointestinal emergencies, Cardiogenic shock was predominantly found in cardiac emergencies (96.3%) likewise Obstructive shock in Trauma (88.9%), Distributive shock in infections (29.4%) and Mixed variety of shock in Endocrine emergencies (42.9%). The type of emergency was statistically significant in determining the type of shock (p=0.0001). This has been illustrated in the Table 1 and Figure 2.

Table 1. Type of emergencies in different types of shock

Type	Hypovolemic shock	Cardiogenic shock	Obstructive shock	Distributive shock	Mixed variety of shock	Total
Trauma	9(22.5%)	0(0.0%)	8(88.9%)	0(0.0%)	0(0.0%)	17(17.0%)
Endocrine	2(5.0%)	0(0.0%)	0(0.0%)	0(0.0%)	3(42.9%)	5(5.0%)
Cardiac	0(0.0%)	26(96.3%)	1(11.1%)	0(0.0%)	0(0.0%)	27(27.0%)
Respiratory	8(20.0%)	0(0.0%)	0(0.0%)	3(17.6%)	1(14.3%)	12(12.0%)
Gastrointestinal	20(50.0%)	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)	20(20.0%)
Neurological	0(0.0%)	0(0.0%)	0(0.0%)	2(11.8%)	0(0.0%)	2(2%)
Renal	0(0.0%)	0(0.0%)	0(0.0%)	1(5.9%)	1(14.3%)	2(2.0%)
Skin and soft tissue	1(2.5%)	0(0.0%)	0(0.0%)	2(11.8%)	0(0.0%)	(3.0%)
Toxin/Drug	0(0.0%)	1(3.7%)	0(0.0%)	4(23.5%)	0(0.0%)	5(5.0%)
Infections	0(0.0%)	0(0.0%)	0(0.0%)	5(29.4%)	2(28.6%)	7(7.0%)
Total	**40(100.0%)**	**27(100.0%)**	**9(100.0%)**	**17(100.0%)**	**7(100.0%)**	**100(100.0%)**

Fisher's exact test (p=0.001)

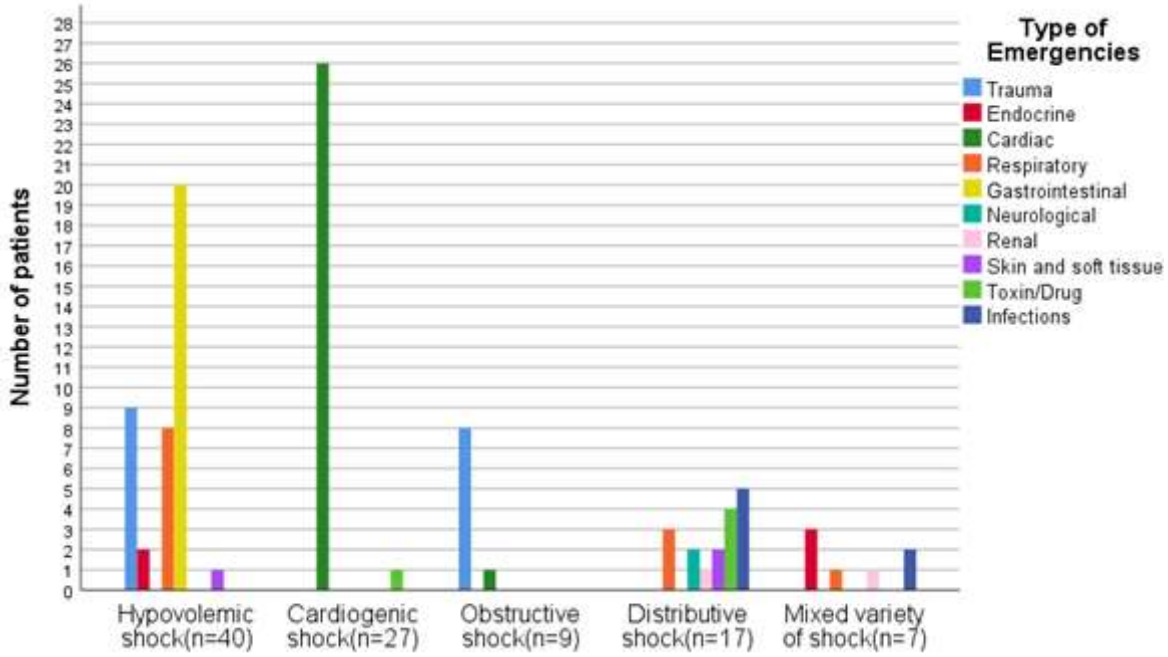


Figure 2. Types of emergencies in different types of shock

1. Findings based on RUSH protocol: The following findings were made by applying the RUSH protocol (Table 2).

a. Pump: LV was hypercontractile in Hypovolemic shock (10%), Cardiogenic shock (7.4%), Distributive shock (52.9%) and hypocontractile in Cardiogenic shock (92.6%), Obstructive shock (22.2%), and mixed variety of shock (85.7%). LV contractility was statistically significant in determining the type of shock (p=0.001). RV was dilated in Cardiogenic shock (55.6%), Obstructive shock (66.7%), Distributive shock (23.5%) and mixed variety of shock (14.3%). RV size was also statistically significant in determining the type of shock (p=0.001). But Cardiac tamponade was present in only Obstructive shock (11.1%) and was statistically not significant in determining the type of shock (p=0.159)

b. Tank: IVC was collapsing in Hypovolemic shock (100%), Distributive shock (64.7%), Mixed variety of shock (85.7%) and dilated in Cardiogenic shock (81.5%), Obstructive shock (66.7%). IVC caliber was statistically significant in determining the type of shock (p=0.001). Hemoperitoneum was present in Hypovolemic shock (22.5%) and was also statistically significant in determining the type of shock (p=0.010).

Pneumothorax was present in Obstructive shock (22.2%) likewise Hemothorax in Obstructive shock (55.6%), Pleural effusion in Hypovolemic shock (2.5%) and mixed variety of shock (14.3%), Pulmonary edema in Cardiogenic shock (29.6%) and Distributive shock (5.9%). Lungs consolidation in Hypovolemic shock (17.5%) and Distributive shock (17.6%). RUSH findings of lungs were statistically significant in determining the type of shock (p=0.001)

c. Pipes: Abdominal aorta aneurysm/dissection (AAA/AAD) was

present in only 2.5% patients having Hypovolemic shock and was statistically not significant in determining the cause of shock (p=1.000). Deep vein thrombosis was present in Obstructive shock (11.1%) and was also statistically not significant in determining the type of shock (p=0.159).

Table 2. Rapid Ultrasound in SHock (RUSH) findings

RUSH Findings		Type of shock						P value
		Hypovolemic shock (n=40)	Cardiogenic shock (n=27)	Obstructive shock (n=9)	Distributive shock (n=17)	Mixed variety of shock (n=7)	Total (n=100)	
LV	Hypercontractile	4(10.0%)	2(7.4%)	0(0.0%)	9(52.9%)	0(0.0%)	15(15.0%)	**0.001***
	Normal	36(90.0%)	0(0.0%)	7(77.8%)	8(47.1%)	1(14.3%)	52(52.0%)	
	Hypocontractile	0(0.0%)	25(92.6%)	2(22.2%)	0(0.0%)	6(85.7%)	33(33.0%)	
RV	Normal	40(100.0%)	12(44.4%)	3(33.3%)	13(76.5%)	6(85.7%)	74(74.0%)	**0.001***
	Dilated	0(0.0%)	15(55.6%)	6(66.7%)	4(23.5%)	1(14.3%)	26(26.0%)	
Cardiac Tamponade	Yes	0(0.0%)	0(0.0%)	1(11.1%)	0(0.0%)	0(0.0%)	1(1.0%)	0.159*
	No	40(100.0%)	27(100.0%)	8(88.9%)	17(100.0%)	7(100.0%)	99(99.0%)	
IVC	Collapsing	40(100.0%)	5(18.5%)	3(33.3%)	11(64.7%)	6(85.7%)	66(66.0%)	**0.001***
	Dilated	0(0.0%)	22(81.5%)	6(66.7%)	6(35.3%)	1(14.3%)	34(34.0%)	
POCUS of Abdomen	Hemoperitoneum	9(22.5%)	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)	9(9.0%)	**0.010***
	No Hemoperitoneum	31(77.5%)	27(100.0%)	9(100.0%)	17(100.0%)	7(100.0%)	91(91.0%)	
POCUS of Lungs	Normal	32(80.0%)	19(70.4%)	2(22.2%)	13(76.5%)	6(85.7%)	71(71.0%)	**0.001***
	Pneumothorax	0(0.0%)	0(0.0%)	2(22.2%)	0(0.0%)	0(0.0%)	2(2.0%)	
	Hemothorax	0(0.0%)	0(0.0%)	5(55.6%)	0(0.0%)	0(0.0%)	5(5.0%)	
	Consolidation	7(17.5%)	0(0.0%)	0(0.0%)	3(17.6%)	0(0.0%)	10(10.0%)	
	Pleural Effusion	1(2.5%)	0(0.0%)	0(0.0%)	0(0.0%)	1(14.3%)	2(2.0%)	
	Pulmonary edema	0(0.0%)	8(29.6%)	0(0.0%)	1(5.9%)	0(0.0%)	9(9.0%)	
AAA/AAD	Positive	1(2.5%)	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)	1(1.0%)	1.000*
	Negative	39(97.5%)	27(100.0%)	9(100.0%)	17(100.0%)	7(100.0%)	99(99.0%)	
DVT	Positive	0(0.0%)	0(0.0%)	1(11.1%)	0(0.0%)	0(0.0%)	1(1.0%)	0.159*
	Negative	40(100.0%)	27(100.0%)	8(88.9%)	17(100.0%)	7(100.0%)	99(99.0%)	

***Fisher's exact test**

2. Interventions: After determining the type of shock, the following interventions were performed. Hypovolemic shock required fluids resuscitation (77.5%) and laparotomy (22.5%). Cardiogenic shock required Vasopressors/Inotropes (74.1%), Anticoagulation/Thrombolysis (18.5%) and Cardioversion (7.4%). Obstructive shock required Needle thoracostomy / Intercostal tube drainage (77.8%), Anticoagulation/Thrombolysis (11.1%) and Pericardiocentesis (11.1%). Distributive shock required fluids resuscitation (58.8%) and Vasopressors/ Inotropes (41.2%). Mixed variety of shock required Multiple interventions (85.7%) and Vasopressors/Inotropes (14.3%). The interventions done based on the type of shock were statistically significant (p=0.001). These are illustrated in Table 3 and Figure 3.

Table 3. Interventions based on type of shock

Interventions	Hypovolemic shock	Cardiogenic shock	Obstructive shock	Distributive shock	Mixed variety of shock	Total
Fluid Resuscitation	31(77.5%)	0(0.0%)	0(0.0%)	10(58.8%)	0(0.0%)	41(41.0%)
Vasopressors/Inotropes	0(0.0%)	20(74.1%)	0.0%	7(41.2%)	1(14.3%)	28(28.0%)
Anticoagulation and Thrombolysis	0(0.0%)	5(18.5%)	1(11.1%)	0(0.0%)	0(0.0%)	6(6.0%)
Pericardiocentesis	0(0.0%)	0(0.0%)	1(11.1%)	0(0.0%)	0(0.0%)	1(1.0%)
Needle thoracostomy / Intercostal tube drainage	0(0.0%)	0(0.0%)	7(77.8%)	0(0.0%)	0(0.0%)	7(7.0%)
Cardioversion	0(0.0%)	2(7.4%)	0.0%	0(0.0%)	0(0.0%)	2(2.0%)
Laparotomy	9(22.5%)	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)	9(9.0%)
Multiple interventions	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)	6(85.7%)	6(6.0%)
Total	**40(100.0%)**	**27(100.0%)**	**9(100.0%)**	**17(100.0%)**	**7(100.0%)**	**100(100.0%)**

Fisher's exact test (p=0.001)

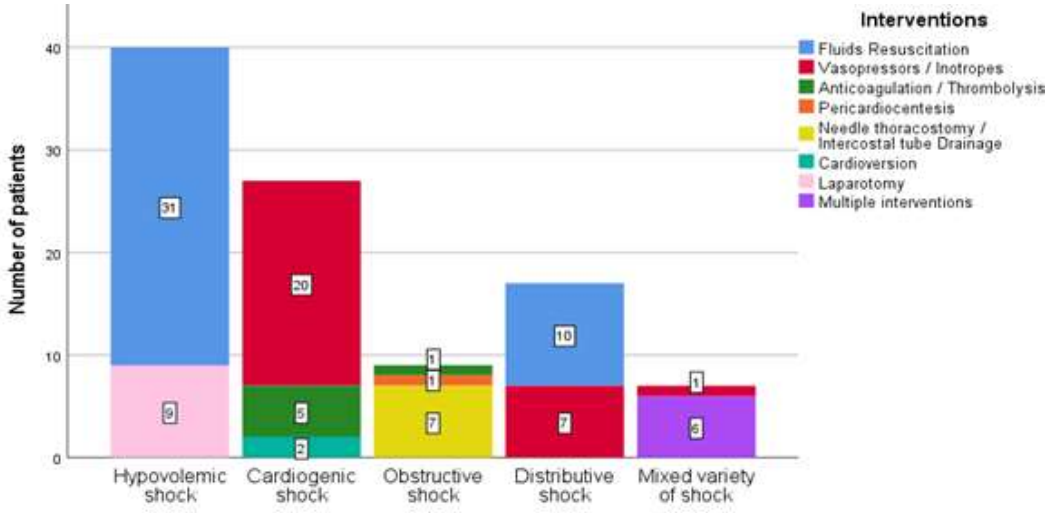


Figure 3. Interventions based on type of shock.

3. Outcome: Among hypovolemic shock patients 90% survived and 10% died as similar to obstructive shock (88.9% and 11.1%, respectively). Among distributive shock patients 70.6% survived and 29.4% died while in cardiogenic shock 48.1% survived and 51.9% died. Among mixed variety of shock patients 57.1% survived and 42.9% died. Overall, 73% of the patients survived and 27% died. This result was statistically significant (p=0.002). This is depicted in Table 4 and Figure 4.

Table 4. Outcome based in type of shock

Outcome	Hypovolemic shock	Cardiogenic shock	Obstructive shock	Distributive shock	Mixed variety of shock	Total
Survived	36(90.0%)	13(48.1%)	8(88.9%)	12(70.6%)	4(57.1%)	73(73.0%)
Dead	4(10.0%)	14(51.9%)	1(11.1%)	5(29.4%)	3(42.9%)	27(27.0%)
Total	**40(100.0%)**	**27(100.0%)**	**9(100.0%)**	**17(100.0%)**	**7(100.0%)**	**100(100.0%)**

Fisher's exact test (p=0.002)

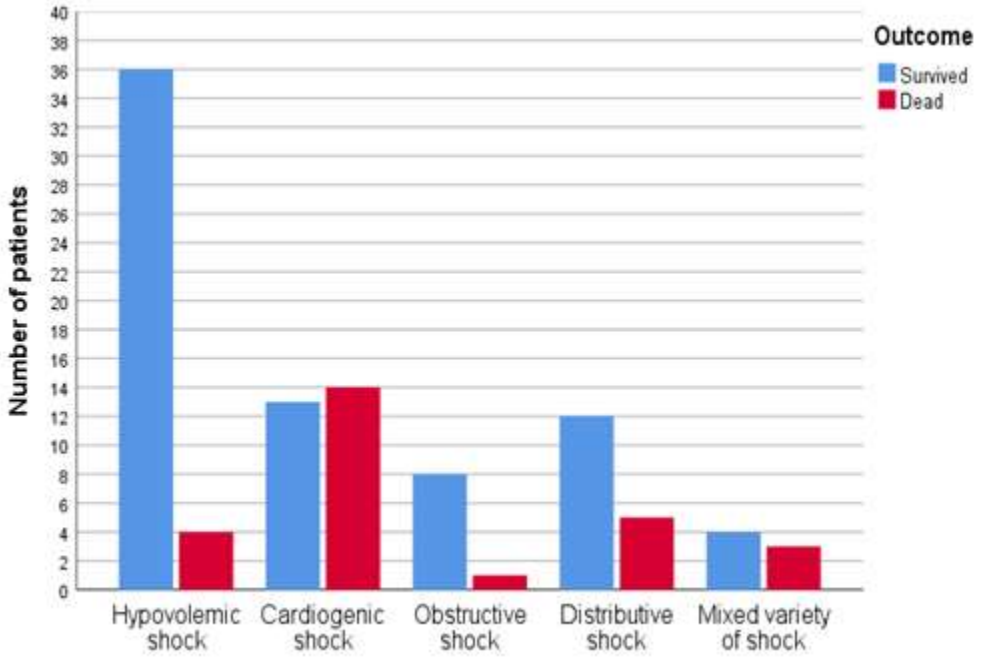


Figure 4. Outcome among different types of shock

Discussion

RUSH is the most recent emergency ultrasound protocol, designed to detect the type of shock at the bedside in a shorter time frame. Appropriate identification of the etiology of shock in early few minutes of patients arrival to emergency room is the essence of the discipline of emergency medicine [6,14]. This study adds to the evidence that a goal-directed point-of-care ultrasound will help emergency physicians (EPs) correctly identify the cause of

symptomatic undifferentiated hypotension [6,15]. In this prospective observational study conducted on 100 patients presenting with undifferentiated hypotension as per the inclusion and exclusion criteria, we applied the RUSH protocol, performed by an emergency physicians in predicting the type of shock in critical patients.

The demographic profile was comparable to a study conducted by Javali et al. [16]. The vitals and clinical characteristics are comparable with studies done by Ginoya et al, which showed similar results [17].

1. RUSH findings

a. Pump: RUSH findings of the heart such as LV contractility and RV size but not cardiac tamponade were able to effectively rule in cardiogenic shock. It had only hypercontractile LV in hypovolemic shock and distributive shock in which the pump cannot be solely used for these diagnosis. Although cardiac tamponade could be easily picked up by RUSH, but was only present in only one of total 8 patients with obstructive shock and was not statistically significant (p=0.159). LV contractility and RV size were statistically significant in determining the type of shock. (p=0.001, p=0.001 respectively)

b. Tank: IVC was effective in diagnosing hypovolemic shock as a direct measure of central blood volume (p=0.001). It was also true in the presence of hemoperitoneum (p=0.010). In cardiogenic, obstructive and distributive shocks, IVC can only help as an associated finding in with the main underlying pathology in the respective conditions.

The presence of pneumothorax, hemothorax were the causes for obstructive shock predominantly in the category. Pulmonary edema in cardiogenic shock was only found in 29.6% of cardiogenic shock and 5.9% of Distributive shock. In distributive shock, the presence of pulmonary edema attributing to the late stage of septic shock with compromised cardiac function. Although lungs consolidation is not included as a finding in RUSH protocol, it was found in lung ultrasound in patients of Hypovolemic shock (17.5%) and Distributive shock(17.6%) which indicates source of sepsis which led to hypovolemia and distribution of central blood volume. Pleural effusion which was bilateral, was present in Hypovolemic shock (2.5%), although it might not solely determine as a cause of shock, as it was reactive pleural effusion. Shock due to pleural effusion which is massive, could lead to obstructive shock rather than hypovolemic shock. Lungs findings were statistically significant in determining the type of shock (p=0.001)

c. Pipes: Abdominal aorta aneurysm/dissection was only in Hypovolemic shock (2.5%) and Deep vein thrombosis causing pulmonary thromboembolism was present in only Obstructive shock (11.1%). Both abdominal aortic aneurysm/dissection and deep vein thrombosis were statistically not significant in determining the type of shock (p=1.000 and p=0.159, respectively) as both of them were present in very less number of patients.

In our study, there were 7 patients which were determined as having mixed variety of shock. The possible reasons for this mixed presentation were due to mixed etiologies, advanced disease states, multiple comorbidities, immune compromised states, etc. While the RUSH findings effectively ruled in the different categories of shock, but for the mixed variety of shock, when there were multiple etiologies resulted in unstable hemodynamic conditions of the patient (for example: cardiogenic and distributive shock, obstructive and cardiogenic shock, hypovolemic and cardiogenic shock), the protocol had the least sensitivity and agreement with the final diagnosis in a study conducted by Ghane et al. [18]. Thus, we strongly suggest that physicians interpret results of this exam with more caution, when they have high clinical suspicion for mixed etiologies.

2. **Interventions**

After the diagnoses of the category of shock were determined using RUSH protocol, interventions were performed. Hypovolemic shock required fluids resuscitation predominantly and but also required blood transfusion and laparotomy for those patients with hemoperitoneum to control the source of internal hemorrhage. Though majority of the Cardiogenic shock patients required Vasopressors/Inotropes, Anticoagulation/Thrombolysis was done for those patients with acute coronary syndrome as the cause of cardiogenic shock and in only two cases (7.4%), cardioversion was done to reverse the tachyarryhthmias with persistent compromised perfusion. Needle thoracostomy (for pneumothorax) and Intercostal tube drainage (for pnemothorax and hemothorax) were done for majority of the obstructive shock patients. An ultrasound guided pericardiocentesis was done for one case of cardiac tamponade which was due to blunt chest trauma. Anticoagulation and Thrombolysis was done for one case of massive pulmonary thromboembolism with shock. Majority of the distributive shock patients either fluids resuscitation or Vasopressors and Inotropes and a very few required both fluids and vasopressors/inotropes as guided by the IVC caliber. Majority of the mixed variety of shock patients required multiple interventions (85.7%) such as fluids replacement, Vasopressors, inotropes and anticoagulation

Use of POCUS in emergency room gives provides information about both abnormal pathology and physiology in a critically ill patient if it is done by expert hands. Thus, emergency physicians with expertise of emergency ultrasound can use this protocol at the bedside and subsequently administer earlier, more goal-directed therapies for these critical patients at the ED. In addition, it will also help them to monitor the effects of interventions performed and if necessary make appropriate adjustments by using RUSH protocol [12,19-21].

3. Outcome

Among hypovolemic shock and distributive shock patients, majority survived owing to its reversibility of shock state if adequate fluid replacement done in early phase of the illness which was done in the current study. Among cardiogenic shock and mixed variety shock patients, the outcomes were equivocal as these patients

which deteriorate rapidly than any other shock types. Most (88.9%) of the obstructive shock patients survived as the interventions done to relieve the obstruction were in time but we lost one patient with cardac tamponade which was due to delayed presentation and overall decreased myocardial contractility. The results of the type of shock and the outcome were statistically significant (p=0.003) which indicates effective implementation of RUSH protocol in the early diagnosis and appropriate interventions as per the type of shock decided by the use of RUSH protocol. We should note that the goal of early use of RUSH protocol in a patient with shock state is to detect the underlying problems that led to shock in shorter time frame or at least to exclude certain life-threatening conditions.

Conclusion

RUSH protocol used for undifferentiated hypotension and shock is an effective tool at the bedside as an early approach to diagnose the type of shock. It will aso help in determining and guiding the early definitive intervention in shock states and thereby having better patient outcomes.

Limitations

This was a single-center study which included only 100 patients. We have considered only consolidation of lungs which was found in lungs ultrasound as foci of sepsis. Other organs with infection were not made an attempt to find it as source of sepsis at the bedside.

Acknowledgements

We would like to acknowledge all the participating patients for allowing us to include them in this study.

Statements and Declarations

Conflicts of interest

The authors declares that they do not have conflict of interest.

Funding

No funding was received for conducting this study.

Ethical Clearance

Institutional Ethical clearance approved.

References

1. Russell JA, Rush B, Boyd J: Pathophysiology of septic shock. Crit Care Clin 2018;34:43.
2. Biering-Sørensen F, Biering-Sørensen T, Liu N, Malmqvist L, Wecht JM, Krassioukov A. Alterations in cardiac autonomic control in spinal cord injury. Auton Neurosci. 2018;209:4-18. doi:10.1016/j.autneu.2017.02.004.
3. Ashruf JF, Bruining HA, Ince C: New insights into the pathophysiology of cardiogenic shock: the role of the microcirculation. Curr Opin Crit Care 2013;19:381.
4. Wacker DA, Winters ME. Shock. Emerg Med Clin North Am. 2014;32(4):747 58.
5. Wongwaisayawan S, Suwannanon R, Prachanukool T, Sricharoen P, Saksobhavivat N, Kaewlai R. Trauma

Ultrasound. Ultrasound Med Biol. 2015;41(10):2543–61.
6. Jones AE, Tayal VS, Sullivan DM, et al. Randomized, controlled trial of immediate versus delayed goal directed ultrasound to identify the cause of nontraumatic hypotension in emergency department patients. Crit Care Med 2004;32:1703–8.
7. Jones AE, Aborn LS, Kline JA. Severity of emergency department hypotension predicts adverse hospital outcome. Shock 2004;22:410–4.
8. Ahn JH, Jeon J, Toh H-C, Noble VE, Kim JS, Kim YS, et al. Search 8Es: a novel point of care ultrasound protocol for patients with chest pain, dyspnea or symptomatic hypotension in the emergency department. Brakenridge S, ed. PLOS ONE 2017;12(3): e0174581. DOI: 10.1371/journal.pone.0174581.
9. Atkinson PRT, McAuley DJ, Kendall RJ, Abeyakoon O, Reid CG, Connolly J, et al. Abdominal and cardiac evaluation with sonography in shock (ACES): an approach by emergency physicians for the use of ultrasound in patients with undifferentiated hypotension. Emerg Med J 2009;26(2):87–91. DOI: 10.1136/emj.2007.056242.
10. Rose JS, Bair AE, Mandavia D, Kinser DJ. The UHP ultrasound protocol: a novel ultrasound approach to the empiric evaluation of the undifferentiated hypotensive patient. Am J Emerg Med 2001;19(4):299–302. DOI: 10.1053/ajem.2001.24481.
11. Lichtenstein DA, Mezière GA. Relevance of lung ultrasound in the diagnosis of acute respiratory failure*: the BLUE protocol. Chest 2008;134(1):117–125. DOI: 10.1378/chest.07-2800.
12. Perera P, Mailhot T, Riley D, Mandavia D. The RUSH exam: rapid ultrasound in shock in the evaluation of the critically ill. Emerg Med Clin North Am 2010;28(1):29–56. DOI: 10.1016/j.emc.2009.09.010.
13. M. Ikbal Sasmaz et al. Effect of Focused Bedside Ultrasonography in Hypotensive Patients on the Clinical Decision of Emergency Physicians. Hindawi Emergency Medicine International Volume 2017. https://doi.org/10.1155/2017/6248687
14. Rosen's Emergency Medicine: Concepts and Clinical Practice - 9th Edition. Available from: https://www.elsevier.com/books/rosens-emergency-medicine-concepts-andclinical-practice/walls/978-0-323-35479-0.
15. Sasmaz MI, Gungor F, Guven R, Akyol KC, Kozaci N, Kesapli M. Effect of focused bedside ultrasonography in hypotensive patients on the clinical decision of emergency physicians. Emerg Med Int 2017;2017:1–8. DOI: 10.1155/2017/6248687.
16. Javali RH, Loganathan A, Srinivasarangan M, Akkamahadevi P, Ganesha BS, Nisarg S, et al. Reliability of Emergency Department Diagnosis in Identifying the Etiology of Nontraumatic Undifferentiated Hypotension. Indian J Crit Care Med 2020;24(5):313–320.

17. Ginoya S. et al. Rapid Ultrasound in Shock in Patients of Undifferentiated Hypotension. GCSMC J Med Sci Vol (XI) No (II) July-December
18. Ghane MR et al. Accuracy of Rapid Ultrasound in Shock (RUSH) Exam for Diagnosis of Shock in Critically Ill Patients.. Trauma Mon. 2015;20(1):e20095. DOI: 10.5812/traumamon.20095
19. Hernandez C, Shuler K, Hannan H, Sonyika C, Likourezos A, Marshall J. C.A.U.S.E.: Cardiac arrest ultra-sound exam--a better approach to managing patients in primary non-arrhythmogenic cardiac arrest. Resuscitation. 2008;76(2):198–206.
20. Seif D, Perera P, Mailhot T, Riley D, Mandavia D. Bedside ultrasound in resuscitation and the rapid ultrasound in shock protocol. Crit Care Res Pract. 2012;2012:503254.
21. Volpicelli G, Lamorte A, Tullio M, Cardinale L, Giraudo M, Stefanone V, et al. Point-of-care multiorgan ultrasonography for the evaluation of undifferentiated hypotension in the emergency department. Intensive Care Med. 2013;39(7):1290–8.