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Application of Rapid Ultrasound in Shock and Hypotension (RUSH) Protocol on Patients with Shock in the Emergency Department

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ABSTRACT

Emergency ultrasound examinations should be done for a clearly defined emergency condition. RUSH (Rapid ultrasound in shock and hypotension) protocol in an emergency setting can play a vital role. The present study was conducted with the aim of applying RUSH protocol on patients with shock in the emergency department. The present cross-sectional clinical observational study was conducted in the Emergency department. Only 57 samples were selected by non-random sampling method in this study. We performed an early bedside sonographic examination for participants based on RUSH protocol. Patients received all needed standard therapeutic and diagnostic interventions without delay and were followed to document their final diagnosis. The data analysis was done with help of SPSS 18. Our study had overall sensitivity of 93% and specificity of 96% with kappa index of 0.85 which shows good agreement (85%) of our RUSH protocol with the final diagnosis. In addition, distributive shock showed the highest degree of agreement with the final diagnosis (kappa index=1) followed by hypovolemic (kappa index=0.91), cardiogenic (kappa index=0.83) and obstructive (kappa index=0.71). While, mixed variety of shock had the lowest agreement (kappa=0.70) with the final diagnosis. The RUSH protocol is significantly effective in making a rapid diagnosis of shock etiology, especially in ruling out obstructive, cardiogenic, and hypovolemic types. Moreover, the protocol can be helpful in minimizing morbidity and mortality among shock patients in the emergency department.

Keywords:-RUSH protocol, Emergency department, Rapid ultrasound in shock, Shock patient.

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INTRODUCTION

Care of the patient with shock can be one of the most challenging issues in emergency medicine. Even the most seasoned clinician, standing at the bedside of the patient in extremis, can be unclear about the cause of shock and the optimal initial therapeutic approach[1]. In shock patients, death rates are dependent upon the cause, like, mortality rate due to cardiogenic shock is between 36-56% while in septic shock mortality is 40-60%[2]. Patients in shock have high mortality rates, and these rates are correlated to the amount and duration of hypotension. Therefore, diagnosis and initial care must be accurate and prompt to optimize patient outcomes[3]. Failure to make the correct diagnosis and act appropriately can lead to potentially disastrous outcomes and high-risk situations. Ultrasound technology has been rapidly integrated into Emergency Department care in the last decade. This technology is ideal in the care of the critical patient in shock, and the most recent ACEP guidelines further delineate a new category of ‘‘resuscitative’’ ultrasound. Studies have demonstrated that initial integration of bedside ultrasound into the evaluation of the patient with shock results in a more accurate initial diagnosis with an improved patient care plan[4-5]. Instead of relying on older techniques, like listening for changes in sound coming from the patient’s body suggestive of specific pathology, bedside ultrasound now allows direct visualization of pathology or abnormal physiological states. Thus, bedside ultrasound has become an essential component in the evaluation of the hypotensive patient[6]. Physical findings of different types of shock can easily overlap each other. Since ultrasound is becoming widely available in emergency departments (ED), many ultrasonographic protocols have been introduced to evaluate pulmonary or cardiac problems in emergent settings even replacing standard imaging modalities like supine chest X-ray or echocardiography.[7-12] Specific goal directed ultrasound examinations in early evaluation of critical patients evaluating the heart, abdomen and venous system have been reported to be helpful in rapid diagnosis of non traumatic etiology of hypotension[1,13]. However, the practical efficacy of performing RUSH (Rapid ultrasound in shock and hypotension) examination in an emergency setting has not been completely evaluated yet. Hence, in this study, we tried to evaluate the accuracy of early RUSH protocol performed to predict the shock type in critically ill patients. Emergency ultrasound examinations should be done for a clearly defined emergency condition in which ultrasound has been shown to improve patient care. This includes life-threatening conditions such as ectopic pregnancy, abdominal and thoracic trauma, or abdominal aortic aneurysm; situations in which invasive procedures can be averted such as needle thoracostomy, pericardiocentesis, or culdocentesis; conditions in which ultrasound can significantly decrease the cost or time of patient evaluation such as blunt abdominal trauma or ectopic pregnancy; and indications in which ultrasound is the primary diagnostic modality such

as ectopic pregnancy, gallbladder disease, or abdominal aortic aneurysm[14]. Prompt and accurate evaluation of shock can be effective to minimize the mortality rate. The RUSH protocol is an effective approach in emergency department[15-16].

MATERIALS AND METHOD

The cross sectional observational study was conducted with aim to assess the effect of RUSH protocol among patients with shock in the emergency department. The population of the current study consisted of 57 adults both male and females, who were more than 18 years and attending the emergency department with shock & hypotension at/ within 24 Hours of presentation and with a Shock Index (Pulse Rate/Systolic Blood pressure) of >1.0. The patients with CCF, Renal Failure, Portal hypertension with ascites, Hypoproteinemias, pleural effusion and tuberculosis were excluded from the study. Detailed clinical examination of all systems (Cardiovascular, Respiratory, abdominal and central nervous) was done. Then Initial Resuscitation was started and at same time the patient was subjected to Ultrasound examination according to RUSH protocol to find out the cause of shock. Then immediate diagnosis was made according to RUSH protocol and immediate treatment measures were decided accordingly. The initial diagnosis is then compared with the final diagnosis and on the basis of this a general degree of agreement was made (Sensitivity, Specificity, Positive Predictive value, Negative predictive value and kappa index). The subjects were selected by a Non-probability convenient sampling technique for this study. RUSH examination was performed using standard ultrasound (Mindray) equipment using a curvilinear probe (7.5-10) MHz for the required examinations. Ethical permission was taken from the ethical committee and well informed written consents were taken from the subjects. Anonymity and confidentiality of the subjects was maintained while carrying out the study. The statistical analysis was done using SPSS 18 software.

RESULTS AND DISCUSSION

Out of total 57 patients, 31(54.3%) patients came between the age group of 18-30 years whereas; mostly young patients came in our study. Mostly patients (61.4%) were males and 22(38.59%) patients were females in our study. The mortality rate in our study was 11.29%. The most common type of shock in our study was Hypovolemic (64.9%) followed by Mixed variety of shock (15.7%). Hypovolemic shock showed the great degree of agreement with the final diagnosis with excellent sensitivity (97%) and good specificity (86.36%) with kappa index =0.91 (p value<0.001). Cardiogenic shock showed low sensitivity (66.6%) but very good specificity (100%). This result may be due to the small sample size of patients with cardiogenic shock. Obstructive shock showed excellent sensitivity (100%) and good specificity (96.29%) with kappa index=0.71. Distributive shock showed the highest degree of agreement with the

final diagnosis among all the types of shock with sensitivity (100%), specificity (100%) and kappa index= 1. Mixed variety of shocks showed the lowest degree of agreement (kappa=0.7) with the final diagnosis. Our study had an overall sensitivity of 93% and specificity of 96% with kappa index of 0.85 which shows good agreement (85%) of our RUSH protocol with the final diagnosis. All patients who were included in our study were followed for the final diagnosis. Out of 57 patients enrolled in our study, 12 (21.05%) patients were diagnosed as acute gastroenteritis, 6 (10.52%) patients were diagnosed with Hemoperitoneum, 4 (7.01%) patients each were diagnosed to have left ventricular failure and Dengue fever, 3(5.2%) patients each were diagnosed to have Head injury, sepsis of abdomen, sepsis of lung, severe hemorrhage and shock of unknown origin respectively. 2(3.5%) patients each were diagnosed to have Hepatic encephalopathy and Pneumothorax.

In recent era, diagnostic procedure like ultrasound is a crucial technique in the critical care and emergency department to evaluate and provisionally diagnose the patient. The current technique is noninvasive, rapid and possible on the patient's bedside[17-18]. The current study was conducted on 57 adults, who were attending the emergency department with shock & hypotension at/ within 24 Hours of presentation and with a Shock Index (Pulse Rate/Systolic Blood pressure) of >1.0.

Accuracy of RUSH protocol among shock patients:

Hypovolemic shock

Ghane *et al*[19]. and Volpicelli *et al*[20]. showed a great degree of agreement between RUSH and final diagnosis (kappa index=0.86) and (kappa value=0.71) respectively which shows that RUSH protocol is successful in diagnosing hypovolemia in patients and necessary immediate resuscitative measures can be taken accordingly. Shahram BH *et al*[21] had sensitivity of 60%, specificity of 100%, Positive predictive value of 100, Negative predictive value of 95.5 and kappa index of 0.71 which is almost in accordance with our study. Ghane *et al*.[19] had sensitivity of 91.7%, specificity of 97%, Positive predictive value of 91.7, Negative predictive value of 97 and kappa index of 0.89 which is slightly high as compared to our study as maximum number of patients in our study were of hypovolemic shock.

Cardiogenic shock

Ghane *et al*.[19] had sensitivity of 75%, specificity of 100%, Positive predictive value of 100, Negative predictive value of 94.9 and kappa index of 0.83 which is almost in accordance with our study. Shahram BH *et al*.[21] had sensitivity of 75%, specificity of 100%, Positive predictive value of 100, and Negative predictive value of 95.5 and kappa index of 0.83 which is almost in accordance with our study.

Obstructive shock

Our study showed good agreement with the final diagnosis (kappa index=0.71) with Sensitivity - 100%, Specificity - 96.29%, Positive predictive value (PPV) - 60%, Negative predictive value (NPV) - 100%.

Distributive shock:

Our study showed good agreement with the final diagnosis with Sensitivity - 100%, Specificity - 100%, Positive predictive value(PPV) - 100%, Negative predictive value(NPV) - 100% and kappa index=0.71. In this context, Ghane *et al.*[19] had sensitivity of 75%, specificity of 100%, Positive predictive value of 100, Negative predictive value of 94.9 and kappa index of 0.83 which is almost in accordance with our study. Shahram BH *et al.*[21] had sensitivity of 75%, specificity of 100%, Positive predictive value of 100, Negative predictive value of 95.5 and kappa index of 0.83 which is almost in accordance with our study.

Mixed shock

In addition to mixed shock, our study showed good agreement with the final diagnosis (kappa index=0.70) with Sensitivity - 100%, Specificity – 94.11%, Positive predictive value (PPV) – 66.66%, Negative predictive value (NPV) - 100%. Ghane *et al.*[19] had sensitivity of 70%, specificity of 100%, Positive predictive value of 100, Negative predictive value of 92.1 and kappa index of 0.74 which is almost in accordance with our study.

Final outcomes of the patient

Our results have a low mortality rate (11.29%) which showed the effectiveness of applying RUSH protocol on patients with shock. By Rapid ultrasound we were able to diagnose the type of shock early and accordingly patients received the treatment which resulted in the overall reduction in mortality. R Ghane *et al*[19] had a mortality rate of 13.5% which is in accordance with our study. The most common type of shock in our study was Hypovolemic (64.9%) followed by a mixed variety of shock (15.7%). Shahram BH *et al*[21] also mentions the most common type of shock in their study as Hypovolemic shock (68%).

Rahul kumar HH et al[22] conducted a study on 130 shock patients using RUSH protocol. The protocol was effective to diagnose 100% of obstructive shock, 96.3% of cardiogenic shock, 94.4% of hypovolemic shock, 80.9% of mixed type of shock, and 75% of distributive type of shock. Furthermore, the study showed significant accuracy with all shocks except distributive shock. Our study results were also consistent with the study. In addition to the final diagnosis, our study had an overall sensitivity of 93% and specificity of 96% with kappa index of 0.85 which shows good agreement (85%) of our RUSH protocol with the final diagnosis. In this context, Keikha M et al[23] and Bagheri Hariri et al[21] highlighted the Kappa correlation coefficient for comparison of the RUSH protocol and the final diagnosis by 84%. Dezfuli Seyed et al[24] highlighted that Kappa index for agreement between shock types was defined by the RUSH protocol and final diagnosis was 0.85 for the subjects. The study also communicated

that hypovolemic shock has excellent agreement, good sensitivity, specificity and accuracy and highest agreement with final diagnoses. Whereas, low agreement, excellent specificity, sensitivity and accuracy were seen in distributive shock. Our study findings were in context to the study.

In context to final diagnosis, Stickles Sean et al[25] highlighted in their study that RUSH protocol is significantly effective to rule out the causes of shock like we found in our study. There exist certain considerations that need to be emphasized. The first issue is that in practice, we should not expect early RUSH protocol just to provide the patient's exact final diagnosis. Instead, the main role of this protocol should be to elucidate the most probable diagnosis among all potential etiologies and rule out certain life threatening diagnosis in the initial precious time interval. In addition, we should bear in mind that findings on this goal directed ultrasonography often require further interpretation to define whether they are significant. In this way, the involved clinician could be the best candidate to use this protocol.

Table 1: Sociodemographic profile of the subjects.

S.No.	Variables		Frequency	Percentage
1	Age	18-30 years	31	54.3%
		31-40 years	10	17.54%
		41-50 years	08	14.03%
		51-60 years	03	5.2%
		61-70 years	05	8.77%
2	Gender	Male	35	61%
		Female	22	39%
3	Chief complaints	Fever	21	36.84%
		Loose stools & vomiting	11	19.29%
		Road traffic accidents	7	12.2%%
		Generalized weakness	4	7.01%
		Altered consciousness	3	5.2%
		Fall from height	3	5.2%
		Chest pain	2	3.5%
		Blood in vomit	2	3.5%
		Abdominal pain	2	3.5%
		Difficulty in breathing	2	3.5%
4	Final outcome	Death	7	12.2
		Discharged	43	75.4
		Discharge against medical advice (DAMA)	2	3.5
		Discharge on request (DOR)	5	8.77
5	Contractility of Heart	Hyperdynamic	34	59.64
		Normal	13	22.8
		Decreased	10	17.54
6	Inferior vena cava	Collapsible/Small IVC	42	73.68
		Non-Collapsible/Large IVC	15	26.31
7	Types of shock	Hypovolemic	37	64.9
		Cardiogenic	2	3.5
		Obstructive	5	8.77
		Distributive	2	3.5

Mixed	9	15.7
Indefinate	2	3.5

N=57

Table 2: Shock type based on clinical diagnosis

Shock type based on RUSH criteria	Hypovolemic	Cardiogenic	Obstructive	Distributive	Mixed	Not defined	Total
Hypovolemic	34	0	0	1	0	2	37
Cardiogenic	0	2	0	0	0	0	2
Obstructive	0	0	3	0	0	2	5
Distributive	0	0	0	2	0	0	2
Mixed	1	1	0	0	6	1	9
Not defined	0	1	0	1	0	0	2
Total	35	4	3	4	6	5	57

Table 3: Diagnostic accuracy of RUSH and final diagnosis. N= 55

S.No.	Reliability indices	Hypovolemic Shock (n=37)	Cardiogenic Shock (n=02)	Obstructive Shock (n=05)	Distributive Shock (n=02)	Mixed type Shock (n=09)
1	Sensitivity	97%	66.66%	100%	100%	100%
2	Specificity	86.36%	100%	96.29%	100%	94.11%
3	PPV	91.89%	100%	60%	100%	66.66%
4	NPV	95%	98.18%	100%	100%	100%
5	Kappa index	0.91(<0.001)	0.83(<0.001)	0.71(<0.001)	1(<0.001)	0.70(<0.001)

Kappa- index of agreement between diagnosis of shock type based on RUSH criteria and final diagnosis.

CONCLUSION

Our study shows that RUSH protocol can effectively diagnose the most life threatening causes of shock (Hypovolemic, cardiogenic and distributive) with ease which helps us to intervene early. In Addition, we also highlighted the role of early RUSH examination in the care of an emergency physician to make a rapid and acceptable accurate diagnosis of the shock type in a hypotensive patient, especially to rule out obstructive (due to pneumothorax or tamponade), distributive and hypovolemic shock types. This would guide the physician to begin a more specific lifesaving resuscitative intervention earlier and more confidently.

Limitations of our study

This study was done at the emergency department of a tertiary hospital and included a limited number of patients. Another limitation of our study was initial ultrasonographic findings were compared with the final diagnosis made by the expert panel.

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