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Accuracy of rush protocol in diagnosis of septic shock

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ABSTRACT

Background: Rapid ultrasound in shock (RUSH) is the most recent emergency ultrasound protocol, designed to help clinicians better recognize distinctive shock etiologies in a shorter time frame.
Objectives: In this study, we evaluated the accuracy of the RUSH protocol in predicting septic shock among shocked patients.
Patients and Methods: RUSH protocol was performed over all patients suspected having septic shock. All patients were closely followed to determine their final clinical diagnosis. Sensitivity, specificity, positive predictive value (PPV) , negative predictive value (NPV) and accuracy of RUSH for diagnosis of septic shock were calculated.
Results: We performed RUSH protocol on 168 patients. Its accuracy for septic shock diagnosis is 77.27%,its sensitivity was 74.55%,its specificity was 84.09%,its positive predictive value was 92.13% and its negative predictive value was 56.92%.
Conclusion: This study highlights the role of the RUSH exam performed by an emergency physician, to make a rapid and reliable diagnosis of shock etiology, especially in order to rule out obstructive, cardiogenic and hypovolemic shock types in initial exam of shock patients.

Keywords: Emergency; Ultrasound; Shock,septic shock.

INTRODUCTION

Septic shock is common in the ICU and is associated with substantial mortality rates. Prompt and accurate diagnosis is a priority. The availability of portable ultrasound devices is changing the approach to the diagnosis and management of shock by offering timely diagnosis and acting to guide therapy.[1,2].

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[3,4].Rapid Ultrasound in Shock (RUSH) is a recent emergency ultrasound protocol that integrates pulmonary evaluation with cardiac, abdominal, and venous examination[5,6,7]. Perara et al., proposed this protocol to help the clinician better and faster[5,6].

The Rapid Ultrasound in Shock (RUSH exam) involves 3-parts bedside physiologic assessment. The first,is determination of cardiac status; echo examination is focused on looking for 3 main findings: the pericardial sac can be visualized to determine if the patient has a pericardial effusion that may be compressing the heart leading toobstructive shock, the left ventricle can be analyzed for global contractilityfor those patients with a cardiogenic cause of shock and the third goal-directed examination of the heart focuses on determining the relative size of the left ventricle to the right ventriclea sign of acute right ventricular strain from a massive pulmonary embolus can be detected[7-9].

The second part, is determination of effective intravascular volume status, through determination of the size of inferior vena cava (IVC) and assessment of the lung, pleural cavity, and abdominal cavities for pathology that could signal a compromised vascular volume like tension pneumothorax. The lung can also be examined for ultrasonic B lines, a potential sign of volume overload and pulmonary edema. Last, the clinician can perform a FAST exam (Focused

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Assessment with Sonography in Trauma examination), to look for source of blood loss[10-20].

The third and final part of the protocol, is evaluation of the large arteries and veins of the body specifically the abdominal and thoracic aorta for an aneurysm or dissection and the femoral and popliteal veins for compressibility which is absent in deep venous thrombosis[21-23].

Objective:

In In this study, our purpose was to evaluate the reliability of this protocol to accurately diagnose septic shock among shocked patients.

Patients and Methods

Patients

This study was carried out on 168 adult patients of both genders who were admitted to Critical Care Medicine Department in Alexandria main university hospital with a primary diagnosis of septic shock over a period of six months starting from 1/12/2014.

Approval of the Medical Ethics Committee of Alexandria faculty of Medicine and an informed consent from the patient's next of kin was taken before conducting the study.

Inclusion criteria

Any patient above 18 years old. Any shock patient in absence of trauma in the previous 24 hours.

Exclusion criteria

- Pregnant females.
- Patients aged below 18 years.
- Any hemodynamically stable patient on admission.

Presence of an obvious cause of shock that would mandate immediate specific treatment (active gastrointestinal bleeding, known drug overdose,external hemorrhage).

Methods

Initial clinical evaluation, demographic data and complete medical history, immediate resuscitative interventions, all necessary therapeutic or diagnostic investigations, including supine chest X-ray, computerized tomography (CT)-scan, echocardiography, urine analysis, cultures or any other laboratory tests were carried out without delay during their hospitalization. Meanwhile, equipment for bed-side sonographic examination in ED was prepared without any delay or interruption in patients' initial care. Then, sonographic examination based on RUSH protocol was performed concurrent with patient's resuscitative care. It involves evaluation of heart (to assess tamponade, ejection fraction, and strain of right ventricle), inferior vena cava (to estimate central venous pressure), thoracic and abdominal compartments (to assess pneumothorax, pulmonary edema, pleural effusion, and peritoneal free fluid), and large arteries or veins (to assess aortic dissection or aneurysm and deep vein thrombosis).They are simplified as the pump, tank, and the pipes of a patient. Then, we suggested the shock type of the patient based on RUSH protocol findings. The time interval between the patient's arrival and the time interval to reach the conclusion using RUSH protocol was considered as duration of examination for each patient. We followed all patients to document their final diagnosis, which would be reached based on all investigations performed during their course of hospitalization and assessed the diagnostic accuracy of RUSH protocol in septic shock according to cultures results.

Results

We enrolled 168 patients consisting of 98 men and 70 women with mean age of 60 years (age range, 20-86 years) in a time interval from December 2014 up to May 2015. Mean time duration of the examination (from patient's arrival till sonographic conclusion) was about 20 minutes (range, 10-25 minutes.

Among the studied patients (168) 14(8.3%) of cases were died,septic shock was diagnosed in 95(56.5%) of cases, cardiogenic shocked in 36(21.4%) of cases, mixed septic and cardiogenic shock in 16(9.5%) of cases and other types in 7(4.2%) of cases.

Table-1. Distribution of the studied cases according to diagnosis (n=168)

Diagnosis	No.	%
Died	14	8.3
Septic shock	95	56.5
Cardiogenic shock	36	21.4
Mixed septic and cardiogenic shock	16	9.5
Others	**7**	**4.2**
Obstructive.shock,due to cardiac tamponade	1	0.6
Obstructive.shock, due to tension pneumothorax	2	1.2
Obstructive.shock, due to Pulmonary embolism	1	0.6
Obstructive.shock, due to rt atrial thrombus	1	0.6
Hypovolemic.shock due to rupture ectopic pregnancy	1	0.6
Hypovolemic.shock due to over dieresis in severely impaired left ventricular function	1	0.6

Results showed that RUSH protocol has 77.27% accuracy with a sensitivity of 74.55%,a specificity of 84.09%,a positive predictive value of 92.13% and a negative predictive value of 56.93%.

Table-2. Relation between culture and rush

	Culture							
	Negative (n=44)		Positive (n=110)		Sensitivity	Specificity	PPV	NPV	Accuracy
	No.	%	No.	%					
Rush									
Negative	37	84.1	28	25.5	74.55	84.09	92.13	56.92	77.27
Positive	7	15.9	82	74.5					
χ^2 **(p)**	4.299* (<0.001*)								

χ^2: Chi square test
*: Statistically significant at p ≤ 0.05

In our study, fever and leuckocytosis showed a high significance difference between septic shock group and non-septic shock group with sensitivity and specificity for fever 83.78 %, 66.67 % respectively and sensitivity, specificity for leuckocytosis 56.76 %, 94.74 % respectively.

Table-3. Agreement (sensitivity, specificity and accuracy) for temp to diagnose sepsis

	AUC	p	Cutoff	Sensitivity	Specificity	PPV	NPV
Temp	0.749*	<0.001*	>37	83.78	66.67	83.0	67.9

Table-4. Agreement (sensitivity, specificity and accuracy) for WBCs to diagnose sepsis

	AUC	p	Cutoff	Sensitivity	Specificity	PPV	+
WBCs	0.694*	<0.001*	>16	56.76	94.74	93.7	45.0

Table-5. Distribution of the studied cases according to cultures

	Negative		Positive	
	No.	%	No.	%
Minibal (n=154)	84	54.5	70	45.5
Urine culture (n=154)	131	85.1	23	14.9
Blood culture (n=154)	135	87.0	20	13.0
DFI (n=154)	145	94.2	9	5.8
Inf dialysis cath(n=154)	150	97.4	4	2.6
Wound (n=154)	138	89.6	16	10.3
Peritoneal fluid (n=154)	150	97.4	4	2.6

In our study, pneumonia was the most common cause of septic shock in our study with total 70 patients constituting 45.5% of studied population followed by urinary tract infection with 23 patients constituting 14.9% of studied population.klebsiella was the predominant organism presented in cultures.

DISCUSSION

The results of this study showed that RUSH protocol has 77.27% accuracy with a sensitivity of 74.55%,a specificity of 84.09%,a positive predictive value of 92.13% and a negative predictive value of 56.93%.

In agreement to our study study, Mohammad Reza Ghane1 et al in 2015 had done RUSH protocol over 52 shocked patients then sensitivity, specificity, positive predictive value and negative predictive value were calculated for each type of shock where septic shock had 100% specificity and positive predictive value, 75%sensitivity and 94.4% negative predictive value. Hypovolemic shock had 100%sensitivity, 94.6% specificity, 80% positive predictive value and 100%negative predictive value. Cardiogenic shock had 91.7% sensitivity, 97% specificity, 91.7% positive predictive value and 97%negative predictive value. Obstructive shock had 75%sensitivity, 97% specificity, 87.5% positive predictive value and 100% negative predictive value[24] .

Also, Shahram Bagheri –Hariri et al.in 2015[25], have reported the same index of agreement between shock type diagnosed based on a similar protocol and final clinical diagnosis of patients.

Volpicelli et al.in 2013[26], have reported the same index of agreement between shock type diagnosed based on a study enrolled over 108 shocked patients where he had gotten the same sensitivity, specificity, positive predictive value and negative predictive value results as those of previous two studies.

The explanation of the difference in results in our study and the other three studies is the difference in methodology, prevalence of specific type of shock in each search: in our study septic shock was predominant (56.5%),in Mohammad Reza Ghane study:cardiogenic shock was predominant (26%) and in Shahram Bagheri–Hariri study: hypovolemic shock was predominant (68%).

Another explanation is ultrasound is operator dependant so there may be some difference in results as from the pathophysiological point of view, a transition occurs in the body from systemic inflammatory response syndrome (SIRS) to severe sepsis and septic shock, and accordingly indices of circulation change accordingly in a dynamic manner. Thus, a patient with septic shock may demonstrate a myriad of complex findings in a RUSH examination and does not demonstrate the straight forward findings of a distributive shock.[27,28]

Conclusion

From this study, we can conclude that:

- RUSH protocol has good sensitivity and specificity and diagnostic accuracy for septic shock identification.
- The routine use of ultrasound appears as a very

effective: it is fast, radiation free, low cost, non-invasive, safely done in difficult to transfer patients, and provides an accurate evaluation of different pathologies in critically ill patients.

- 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. This would guide the physician to begin a more specific life-saving resuscitative intervention earlier and more confidently.
- This protocol enabled our clinician to plan his therapeutic strategies more efficiently.

RECOMMENDATION

From the study, we can recommend:

- RUSH protocol can be used as an effective tool in diagnosis of septic shock.
- Planned training programs of point of care ultrasonography for intensive care units (ICU) staff should be held.

STUDY LIMITATIONS

- There is an important consideration for using any type of ultrasonic protocol, which is the amount of required expertise to reach the desired evaluation (here, to outline the shock type of a critical patient).
- In addition, US limitations include its difficulty to use it in obese patients with thick chest wall, patients having subcutaneous emphysema, the probe may contribute to the dissemination of multi-resistant strains in the ICU and increase the incidence of nosocomial infections, its low availability in remote areas, presence of drain or dressings can interfere with appropriate placement of the probe. Also, ICU patients often lie in non optimal positions which limit exploration of certain areas.

Conflict of Interests:

Authors declare that there is no conflict of interests regarding the publication of this paper.

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