Increasing Utilization of IVC POCUS for Patients with Sepsis

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INCREASING UTILIZATION OF IVC POCUS FOR PATIENTS WITH SEPSIS

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INCREASING UTILIZATION OF IVC POCUS FOR PATIENTS WITH SEPSIS

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**Abstract**

**Background:** Sepsis is the cause of death of half of all admissions in the United States (Rhee, 2019). Medicare has adopted guidelines from the surviving sepsis campaign and labeled them the “The Severe Sepsis and Septic Shock Management Bundle (SEP-1) guideline to address the care required to try to reduce mortality involving septic patients. This bundle has an all or none feature that suggests every patient presenting with septic shock receives 30 ml/kg of normal saline as a bolus. (Medicare, 2021). One must document medical reason for not providing this bolus. Inferior vena cava point of care ultrasound (IVC POCUS) can help guide the decision to continue or withhold intravenous fluids (IVF). However, most advanced practiced practitioners (APPs) are not trained to perform POCUS exams. (Huang, 2022)

**Project aim:** The aim of this evidence-based practice project was to introduce the SEP-1 guideline and educate a group of APPs on the utilization of IVC POCUS to assess fluid status in an urban emergency department.

**Approach/Method:** This nurse practitioner led project focused on one-on-one (4-hour) training on the SEP-1 bundle and POCUS training. Pre- and post- intervention surveys were implemented to assess the utilization of this guideline along with self-reported POCUS competence.

**Results:** The results of this project demonstrated improved compliance of 85% with the SEP-1 guidelines and a 65% increase APP utilization of POCUS when determining IVF therapy among adult septic patients. Implementation of SEP-1 and POCUS training has a substantial return of investment (ROI) while improving patient outcomes. This project can be easily replicated in other emergency departments, improve provider medical-decision-making, and patient outcomes while meeting the SEP-1 standards of care.

**Keywords:** Sepsis, IV fluids, POCUS, Inferior vena cava compression.
Introduction

Sepsis is one of the leading causes of death in the United States. (Rhee, 2019) CDC remarks that every year 1.7 million people in the US develop sepsis and 270,000 will die as a result. According to the World Health Organization (WHO) 1 in 5 deaths worldwide is sepsis related. Sepsis is the cause of death for half of all hospital admissions in the United States. (CDC, 2021) Septic patients are associated with severe hypotension and fluid depletion. A key part of care for a septic patient is the initial fluid resuscitation. Septic patients often require vast amounts of intravenous (IV) fluid therapy. The Surviving Sepsis Campaign, which was adopted by Medicare and included in the SEP-1 guidelines, placed a “30 ml/kg bolus” as the standard initial intervention to address this, however there has been some controversy regarding this item on the guideline. (Farkas, et al, 2021)

While aggressive fluid resuscitation is vital to the survival of septic patients, a “one size fits all” approach has been found to be detrimental to patients in emerging evidence. In one study using this approach, 46% of patient develops fluid overload in the days after admission. (Espinoza, 2020) Consider if someone was overweight at 150 kg, the current guideline suggests a 4.5 L bolus, which is likely to push anyone with any cardiac dysfunction or renal failure into overload. This is the problem with all-or-none one size fits all care.

Using point-of-care ultrasound of the inferior vena cava gives providers a tool to assess the fluid status of a body, which can guide when to not give fluids, stop fluids already being given in process, or if perhaps a person needs more. According to Xavier Filho, et al., (2021), the use of point of care ultrasound (POCUS) is the ideal method to determine if IV fluid resuscitation has reached goal. Manjri Garg, et al., (2016) suggested it to be superior as this measurement is noninvasive but comparable in efficacy to currently used but invasive methods.
such as central venous pressure (CVP) monitoring. The use of POCUS is underutilized by advanced practice providers (APPs) such as nurse practitioners (NP) and physician assistants (PA). Current practice guidelines highly support ultrasound monitoring of Inferior Vena Cava (IVC) compression to determine the fluid status of septic patients. (ACEP, 2019)

**Clinical Guidelines**

The Severe Sepsis and Septic Shock Management Bundle (SEP-1) was utilized for this project due to its most up to date evidence for the management of sepsis and septic shock. (CMS, 2022) The SEP-1 bundle dictates what care should be provided to patients presenting to the ER with severe septic conditions or in septic shock in an “all or none” fashion. If the icd-10 code “Severe Sepsis” is submitted to Medicare, they expect this bundle to be performed as a standard. This code defines sepsis as a “life threatening organ dysfunction caused by a dysregulated host response to infection.” (CDC, 2022). The systemic inflammatory response syndrome (SIRS) criteria used to be used to classify patients with sepsis, but not all septic patients met SIRS criteria, and not all patients meeting SIRS criteria were septic, nevertheless, it is often still used in triage to help early identification. The SIRS criteria includes; body temperature over 38 degrees Celsius or under 36 degrees; heart rate greater than 90 beats/minute; respirations greater than 20 breaths per minute; or partial pressure of CO2 less than 23 mmHg. (Chakraborty, et al. 2023).

An initial lactate level should be measured within three hours of presentation for a patient meeting criterion. Blood cultures are also to be drawn before broad-spectrum antibiotics are administered. When hypotensive patients with septic shock present themselves, a 30 ml/kg bolus is to be administered within three hours of arrival.
If the hypotension or the shock like condition does not improve, vasopressors are to be administered by the six-hour mark. Repeat, and documented, volume status and tissue perfusion assessment should be performed after these interventions. (Medicare, 2021)

The American College of Emergency Physician DART (Detect, Act, Reassess, Titrate) was also utilized for this project due to it sound evidence for the management and administration of IVF. According to Josh Farkas MD, et al, in 2021, this guideline can help prevent overloading patient with IVF. The DART tool is very similar to the Medicare guidelines except it is not “all or none” and has more grey area for patient differentiation. There are four parts: Detect, Act, Reassess, and Titrate. In the first part of the algorithm, you “detect” sepsis. They recommend having a sepsis screening tool in triage and to suspect sepsis in clear cases such as “those with fever, leukocytosis, and hypotension.” (ACEP, 2022). They also recommend considering sepsis in those with atypical findings such as having clinical instinct “something is not right” in a patient, altered mental status, or respiratory failure. The tool suggests if you are thinking sepsis may be present, start therapy quickly. They also note that patients may develop sepsis later in their stay and reassessment is paramount. ACEP also supports the use of a lactate measurement to help detect sepsis.

The “Act” portion of the algorithm recommends giving a crystalloid bolus to resolve hypotension, and gives honor to the 30 ml/kg bolus but does note that this may not fit every patient’s clinical picture and recommends ordering in 500 ml to 1000 ml increments, with revolving reassessments for clinical response. ACEP acknowledges renal and cardiac patients are sensitive to fluids but still recommends fluid resuscitation and recommends using IVC POCUS to better understand “fluid status” which can be performed before or during administration of fluids. (ACEP, 2022)
The reassessment portion of our DART tool recommends redraw of the lactate two hours after initiating treatment if they had initially had an abnormal lactate. “Persistence of elevated lactate, even in the absence of hypotension, is associated with poor outcomes. If lactate was elevated initially, try to resuscitate to a relative lactate decline of at least 10%.” (ACEP 2022)

Treatment is then “titrated” to patient response. A mean arterial pressure (MAP) of 65 should be maintained, by pressers if necessary. If vasopressors are needed, while peripheral IV can be used to initiate therapy, a central line should be eventually placed. (ACEP 2022)

**Methods**

**Study Design**

This project was an education driven project to help enact change in practice amongst a group of seven Advanced Practice Practitioners (APPs) practicing in one of the most underserved emergency departments in Southern California. The project was performed in three-part series. First, surveys were implemented among APPs to assess current practices and the use sepsis guidelines, IVC POCUS, and comfort levels in performing this task. Secondly, there was a one-on-one POCUS training with all the emergency department APPs. Lastly, a survey was implemented to reassess if the intervention was successful in improving compliance with the guidelines and if use of IVC POCUS.

**Study Setting**

The emergency department in this community can be described as a level 4 trauma center that provides basic emergency medicine in a rural area to a largely Hispanic community. It is noted be in the most underserved area of southern California. This emergency department serves and average of 50,000 patients annually.
Study Protocol

Surveys were dispersed to the APPs and were collected anonymously. Nurse practitioner then provided a four-hour one-on-one training on how to perform IVC POCUS and discussed the implications of its use. All the APPs who participated in this training demonstrated competency by performing at least 10 sonograms. At this time the APPs were also trained and educated to follow the SEP-1 and DART guidelines. Three-month post intervention date was collected using the same survey to reassess for changes in clinical practice.

Measurements

There were seven APPs that took part in the training and pre- and post- surveys. Surveys included eight questions that can be appreciated in Figure 1. These questions measured data regarding current practices, guidelines used, IVF selection, use of POCUS for IV compression, and average number of septic patients seen.

Data Analysis

The data analysis done for this project was done with Intellectual Statistics. Percentages, means, and medians were used to analyze the frequency of compliance in using IVC POCUS, SEP-1 Guidelines, and DART tools among APPS. Pre intervention data was compares to post intervention data including: number of patient’s seen, comfort levels in using POCUS, and current practices.

Surveys were collected before and after every training session to assess for practice change. Responses were logged for comparison. The intervention had a clinically significant improvement in the selection of an evidenced based sepsis bundle and IVF replacement therapy following the SEP-1 and ACEP-DART tool. There was documented 85% improvement in the utilization of the recommended guidelines along with a 60% increment use of IVC POCUS.
compression to determine the amount of IVF. Overall comfort in the use of IVC POCUS increased.

**Findings**

This project included and evaluation of APP demographics in the emergency department including the following: number of nurse practitioners, physician assistants, experience, certification, etc. This can be found in Figure 2.

The initial surveys revealed that all APPs were using sepsis guidelines in accordance with standard procedures. However, none of the APPs were using either the DART tool or the SEP-1 guidelines that are recommended by Centers of Medicare and Medicaid Services (CMS). It was also noted that IVC POCUS was not being utilized to identify and guide fluid resuscitation therapy. Rather abnormal vital signs and/or electrolyte imbalances in lab values were being utilized instead. This is problematic and not evidenced-based as vital signs do not always reflect accurate fluid status. Often time, patients with sepsis may be fluid overloaded and remain hypotensive and tachycardic. Lab values are always helpful to add a better clinical image and representation of the patients’ statue. Nevertheless, abnormal lab values do not always interpret fluid status of septic patients. Abnormal renal function, electrolyte imbalance, or elevated hemoglobin and hematocrit lab values do not always represent hypovolemia. The Initial survey identified that some were not aware of IVC POCUS while most of them were not comfortable performing IVC POCUS.

The post-intervention survey identified: Compliance with SEP-1 guidelines and the DART tool rose to 100%; use of labs/vital signs for assessing fluid status dropped to 25%, and APPs reporting they would use IVC POCUS on septic patients rose to 100%. These findings can be found in Figure 3 and 4.
Limitations

The first and biggest limitation of this project was not being able to obtain data from the electronic medical records (EHR) due to hospital regulations. This would have been ideal to accurately assess the number of times that IVF were appropriately and inappropriately delivered among the APPs in the project. Secondly, many of the APPs did not manage septic patients on regular basis. This limited the number of opportunities for them to perform IVC POCUS. Lastly, IVC POCUS is a skill the requires high level competency to perform accurately. Therefore, it was noted that many APPs deferred the IVC POCUS to the attending physician.

Ethical Considerations

This study was approved by the Institutional Review Board from a local university. The project did not involve any human subjects and was deemed except.

Potential Cost Savings Analysis

Medical management for septic patients is very costly no matter the stage. It requires extensive resources and often prolonged hospital length of stay. The average septic patient is hospitalized for 7 to 15 days. (Paoli, et al. 2018) According to the hospital finance department the emergency department bills an average of $18,000 dollars per septic patient. This is just the emergency services fees not including the admission billing. However, it was made clear that reimbursement by CMS, and private insurance may vary regardless of what the hospital is billing.

Additionally, patient with septic shock may rise billing up to $36,000 if admitted to the intensive care unit or transferred for higher level of care. The cost of IVC POCUS training for APPs was $400. This included four hours of one-on-one training. The average nurse practitioner is paid $80-100 per hour. The total labor cost to train all APPs was $2400. The cost of supplies
(e.g., gel, pamphlets, cleaning supplies, etc.) was $200. According to the finance and billing department, the average revenue for IVC POCUS is $300. The average hospital cost for every normal saline (NS) bag is $11. The average patient billing for NS IVF bag is $160.

If reimbursement is tied to the guideline adherence during this project period, the potential cost savings and revenue for every APP performing IVC POCUS per everyone septic patient went from $600 to $3600. The total return of investment (ROI) after deducting all the training fees was $1200. However, this is only the revenue for a three-month period. If the trend of IVC POCUS continues utilizing a one-hour yearly in-service training, the ROI will be $13,700 per year.

**Implications for Nursing Practice**

Implementation of this nurse practitioner lead education project led to improved adherence to guidelines set by CMS, improved medical decision making, and created a return on investment. This demonstrates that nurse practitioners are able to lead practice change within the emergency department in order to improve outcomes. It also helps resolve a safety issue revolving around the avoidance of heart failure and pleural effusion in septic patients.

**Conclusion**

The use of the SEP-1 guideline along with the ACEP recommended DART tool facilitates the management of sepsis while improving patient outcomes. Providing APPs with education regarding these guidelines helps improve compliance with these guidelines that are shown to reduce mortality in vulnerable septic patients.

The use of IVC POCUS compression among APPs helps early identification of fluid depletion, and fluid overload while reducing unnecessary cost and potential patient harm from
fluid overload. This project shows that given this training, this tool in providing care to septic patient is more likely to be utilized as opposed to when APPs have not received training.

This project can be easily replicated in similar rural emergency departments wanting to introduce these EBP guidelines and the use of POCUS for the management of sepsis.
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Tables and Figures

**Figure 1**

ER Sepsis Survey

Assess current practice among the clinic providers with a 8-question survey.
1. Do you follow any specific guideline when managing septic patients?
   a. Yes
   b. No
   c. If yes, which one:____________________________________

2. How do you usually determine fluid depletion in your patients?
   1. Lab work (e.g., BNP, CMP)
   2. Central Venous Pressure (CVP)
   3. Vital Signs (e.g., hypotension, tachycardia)
   4. Point of Care Ultrasound Inferior Vena Cava Compression

3. Do you give 30 ml/kg normal saline bolus to patients with sepsis?
   a. Yes
   b. No

4. How do you determined enough fluid have been provided?
   1. Lab work (e.g., BNP, CMP)
   2. Central Venous Pressure (CVP)
   3. Vital Signs (e.g., hypotension, tachycardia)
   4. Point of Care Ultrasound Inferior Vena Cava Compression

5. Do you use Point of Care Ultrasound (POCUS) to assess fluid status?
   a. Yes
   b. No

6. From 0 to 10 how comfortable do you feel in using POCUS to assess Inferior Vena Cava compression? Circle your best answer. 0= not comfortable at all; 10= Very comfortable

   1  2  3  4  5  6  7  8  9  10

7. In the last 3-months, estimate how many patients with sepsis have you treated?
   a. 0-25
   b. 25-50
   c. >50

8. In the last 3-months, estimate how many times you have used POCUS to assess fluid status in septic patients?
   a. 0-25
b. 25-50

c. >50

**Figure 2**

*Er Provider Demographics*

![Bar chart showing provider demographics](chart.png)
Figure 3

Pre- and Post-Intervention Results

Results (Sepsis Management/POCUS)

Figure 4

Pre- and Post-Intervention Compliance Statistics

<table>
<thead>
<tr>
<th></th>
<th>Pre-Intervention</th>
<th>Post-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follows SEP-1</td>
<td>14.28% (n = 1)</td>
<td>100% (n = 7)</td>
</tr>
<tr>
<td>IVF based on POCUS</td>
<td>42.85% (n = 3)</td>
<td>100% (n = 7)</td>
</tr>
<tr>
<td>IVF 30 ml/kg based on DART/POCUS</td>
<td>100% (n = 7)</td>
<td>100% (n = 7)</td>
</tr>
<tr>
<td># of patients treated w/ POCUS</td>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>