Clinical Practice Study

Confidence level of pediatric trainees in management of shock states

Kavita Morparia, Julie Berg, Sonali Basu

Kavita Morparia, Department of Pediatric Critical Care, Children’s Hospital of New Jersey, Newark Beth Israel Medical Center, Newark, NJ 07112, United States

Julie Berg, Department of Emergency Medicine, Children’s National Health System, Washington, DC 20010, United States

Sonali Basu, Department of Critical Care Medicine, George Washington University, Children’s National Health System, Washington, DC 20010, United States

ORCID number: Kavita Morparia (0000-0002-6170-3995); Julie Berg (0000-0002-2675-893); Sonali Basu (0000-0002-6066-3231).

Author contributions: Morparia K and Basu S designed the research methodology and survey; Morparia K and Berg J were responsible for distribution of survey and data collection; Morparia K, Berg J and Basu S contributed to writing the manuscript; Morparia K was responsible for subsequent revisions.

Institutional review board statement: The study was reviewed by the Institutional Review Board at the Children’s National Medical Center Institutional Review Board and certified as “exempt” since it was an anonymous survey sent to trainees and did not involve real patients.

Informed consent statement: The study was exempt from informed consent as it did not involve any patients.

Conflict-of-interest statement: No potential conflicts of interest relevant to this article were reported.

Open-Access: This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/

Manuscript source: Unsolicited manuscript

Abstract

AIM
To assess overall confidence level of trainees in assessing and treating shock, we sought to improve awareness of recurrent biases in clinical decision-making to help address appropriate educational interventions.

METHODS
Pediatric trainees on a national listserv were offered the opportunity to complete an electronic survey anonymously. Four commonly occurring clinical scenarios were presented, and respondents were asked to choose whether or not they would give fluid, rank factors utilized in decision-making, and comment on confidence level in their decision.

RESULTS
Pediatric trainees have a very low confidence level for assessment and treatment of shock. Highest confidence level is for initial assessment and treatment of shock involving American College of Critical Care Medicine/Pediatric Advanced Life Support recommendations. Children with preexisting cardiac comorbidities are at high risk of...
under-resuscitation.

**CONCLUSION**

Pediatric trainees nationwide have low confidence in managing various shock states, and would benefit from guidance and teaching around certain common clinical situations.

**Key words:** Fluid bolus; Shock; Medical education; Central venous pressure; Decision-making; Pediatric advanced life support guidelines

© The Author(s) 2018. Published by Baishideng Publishing Group Inc. All rights reserved.

Core tip: Pediatric trainees at all levels of training across the United States express a low degree of confidence in management of various types of shock. Children with cardiac comorbidity are at very high risk of under-resuscitation when presenting with shock. Central venous pressure is often used in isolation for decision-making regarding fluid administration and supersedes other subjective and objective measures of intravascular fluid status and shock state.

Morparia K, Berg J, Basu S. Confidence level of pediatric trainees in management of shock states. World J Crit Care Med 2018; 7(2): 31-38 Available from: URL: http://www.wjgnet.com/2220-3141/full/v7/i2/31.htm DOI: http://dx.doi.org/10.5492/wjccm.v7.i2.31

**INTRODUCTION**

Fluid resuscitation of hypovolemic shock has been hailed as acute medicine’s great triumph for children[1]. A fluid bolus is one of the most rapid ways to increase cardiac output and is central in the management of many shock states. Recognition and timely resuscitation of shock with fluid is one of the most important aspects of training in pediatrics, and one that all trainees must be empowered to feel confident managing. It has been well established that appropriate early treatment of shock is associated with improved outcomes[2,3]. Pediatric resident and fellow physicians are often the first responders at the bedside of an acutely ill child. They may be assessing the patient for the first time in the emergency room, or might be called upon to assess a patient for a change in vital signs. We were interested in exploring the grey zone in decision-making - everyone would elect to continue fluid resuscitation in the face of obvious hypotension - however, in practice, the blood pressure drops very late in the evolution of shock in children, and we were interested in finding out how trainees navigate the period before profound shock develops.

Though there is some literature on level of adherence to Pediatric Advanced Life Support (PALS) guidelines and outcomes[4,5], there is a paucity of literature on the ability of pediatric trainees to correctly assess and treat shock states of varying etiologies. Variable heart rates and blood pressure thresholds for varying ages in children make it more challenging to recognize deviations from normal, often confounded by factors such as fever and beta agonist administration. While comorbid cardiomyopathy engenders a more cautious approach to fluid bolus administration, fear of fluid overload might hamper adequate resuscitation. The American College of Critical Care Medicine (ACCM) guidelines[6] recommend resuscitation end-points based on the difference between mean arterial pressure (MAP) and central venous pressure (CVP), mixed venous saturation (ScVO$_{2}$) and hemoglobin level, along with clinical exam findings. CVP has long been shown to have no utility as a marker of fluid responsiveness, yet continues to be considered as a factor in decision-making. We framed these potential stumbling blocks as clinical situations that may be widely prevalent in clinical practice as a survey for a nationwide sample of pediatric trainees. We sought to assess the confidence level of residents in the assessment and treatment of shock.

Our aim in performing this research was to assess overall confidence level of trainees in assessing and treating shock. We sought to improve awareness of recurrent biases in clinical decision-making to help address appropriate educational interventions. There is extensive literature on cognitive biases affecting decision-making in medicine[7,8], however we are not aware of any studies dealing with decision-making aspects in the management of children in the emergency room or critical care environment. There are situations where closer supervision and clinical guidance may improve earlier detection of shock in the critically ill child.

**MATERIALS AND METHODS**

We designed a survey tool using REDCap[9], an online electronic survey tool. We obtained approval from the Institutional Review Board at the Children’s National Health System and by the American Academy of Pediatrics (AAP) Section on Medical Students, Residents and Fellowship Trainees (SOMSRFT). The survey was then distributed via the AAP SOMSRFT listserv to all members currently having valid email addresses and registered with this section of the AAP, with an additional reminder email after a few weeks. Participation in the survey was voluntary and anonymous.

We collected demographic information including current role (medical student, resident or fellow), level of training based on postgraduate year (PGY-1, 2, 3, etc.) and area of specialty (for fellows). This was followed by four hypothetical case scenarios based on the recognition and management of shock. Table 1 details the clinical case presented and expected outcomes. The clinical description was followed by a set of questions including (1) Course of action the trainee would choose: fluid/
vasoactive/neither/other; (2) clinical factors taken into consideration - ranked on a Likert scale for importance; (3) level of confidence in decision ranked on a Likert scale; and (4) comments/reasoning if any. We performed additional analysis after stratification of the respondents into two groups - experts and non-experts. We classified fellows in pediatric critical care, pediatric emergency medicine and pediatric hospital medicine as experts in fluid resuscitation. All other respondents were non-experts.

Statistical analysis
Data were directly available on REDCap, and descriptive statistics were generated using this tool. Additional statistical functions were performed using SPSS v 21.0 (IBM). We used the \( \chi^2 \) test to detect differences in categorical variables among groups and the Mann Whitney U test to detect differences between the distributions among groups.

RESULTS
There were a total of 539 respondents, with demographic characteristics shown in Table 2. For the purpose of this study, we excluded responses from medical students and attending physicians, thus analyzing a total of 490 responses. There was an even distribution of residents and fellows across all levels of training. Of the fellows, pediatric critical care medicine and pediatric emergency medicine fellows accounted for the majority of respondents. Trainees’ clinical decisions in each of the four hypothetical scenarios are detailed in Table 3. Table 4 illustrates different choices selected by experts compared to non-experts for all the four scenarios.

In scenario 1, 85% of respondents chose to continue resuscitation of shock, with an even split of respondents choosing fluid (38%) or vasoactive (47%). Most people cited the ACCM/PALS guideline cutoff of 60 mL/kg for fluid administration as the rationale for choosing vasoactives over fluid. Of the remaining 15%, 9% of respondents required additional data before determining course of action - including mental status, urine output, signs of fluid overload and ultrasound measures of fluid status. Six percent of respondents chose to halt resuscitation. The most common reason cited for stopping resuscitation was to give antipyretic and evaluate heart rate response as tachycardia could be due to presence of fever. Other reasons were “normal blood pressure”, giving IV fluids at higher than maintenance rate to treat shock and avoidance of pulmonary edema. Thirty-six percent of respondents said they had only slight confidence in their decision. There was no correlation of low confidence level with primary decision taken.

For scenario 2, 80% of respondents chose to continue resuscitation of shock, with 20% choosing fluid and 60% choosing vasoactives. The most common reason cited for not continuing resuscitation was interpretation of CVP as normal. Other reasons included awaiting chest X-ray to evaluate for pulmonary edema, echocardiogram for assessing cardiac function, and assessing adequacy of urine output. In this case, 65% of respondents were only slightly confident of their decision. Of respondents who chose to halt resuscitation or obtain additional data first, 76% (70 out of 92) expressed low confidence, compared to those who chose to give either fluid or vasoactive, where 60% expressed low confidence.

For scenario 3, 39% of total respondents choose to give additional fluid, 15% would give a vasoactive, and 46% elect to not continue resuscitation. The most common reason by far for not continuing resuscitation is the known cardiac comorbidity, with several trainees requiring an echocardiogram to evaluate for cardiac function first. The next most common factor cited is the presence of fever, and several respondents want to reevaluate the degree of tachycardia after fever has subsided. Other reasons for slowing or halting resuscitation include obtaining a chest X-ray, cultures and antibiotics, and transfer to the pediatric intensive care unit. Sixty-four percent of all respondents express poor confidence in decision. In this case, prevalence of low confidence level is the same - at 64% in all respondents regardless of whether or not they pursue to continue resuscitation or delay/halt resuscitation.

For the patient in scenario 4, 43% of respondents elected to not perform any additional intervention, 29% chose to give a fluid bolus and 20% elected to increase vasoactive support. By far the most common reason for administration of fluid or increasing vasoactive dose was the CVP value. A majority of respondents (61%) expressed low confidence in their decision.

DISCUSSION
Early identification and rapid reversal of shock has been well documented to improve outcomes. We surveyed pediatric residents and fellows to assess how they made decisions regarding treatment of shock, and uncovered some commonly prevalent biases and errors in management.

The first scenario describes a 5-year old who is clearly presenting in shock, with end-organ dysfunction manifested by altered mental status. She has already received the initial 60 mL/kg of fluid. Per the ACCM guidelines\(^6\), fluid resuscitation should be continued until signs of pulmonary overload occur or shock is reversed, defined by achieving threshold heart rate (HR) and MAP-CVP values, which were not yet achieved in this girl. In our experience, the initial 60 mL/kg is given automatically, and then there is some complacency while the patient awaits transfer to the intensive care unit (ICU). This can be thought of in terms of “premature closure” and “representativeness”, where a diagnostic category is assigned to the patient and clinical response after 60 mL/kg of fluid is taken for granted, as this amount would suffice for most patients. Ideally, central
Morparia K et al. How pediatric trainees manage shock?

Table 1  Clinical case scenarios and outcomes studied

| Case | Scenario description | Clinical questions | Key clinical features | Expected interventions | Outcomes studied |
|------|----------------------|--------------------|----------------------|------------------------|------------------|
| 1    | A 5 yr-old girl is brought into the emergency department with fever, diarrhea and vomiting. She is drowsy and does not answer questions appropriately. Her vitals are as follows: Temp 38.4 °C, HR 168/min, RR 36/min, BP 90/45 (MAP 60) mmHg. She seems dehydrated with dry mucous membranes, is warm, flushed and has flash capillary refill. You diagnose septic shock and after getting two good IV lines for access, begin rapid fluid administration. You give her 60 mL/kg crystalloids over a period of 60 min, and one dose of antibiotics. At the end of this time, her vitals are as follows: Temp 38.4 °C, HR 165/min, RR 32/min, BP 96/40 (MAP 59) mmHg, capillary refill unchanged. What would be your next plan of action? | What would be your next plan of action? (1) Do nothing at this point; (2) give an additional 20 mL/kg fluid bolus; (3) start a vasoactive medication; (4) need additional data to decide- please specify; (5) Other | Severe shock with altered mental status | Continue resuscitation with either fluid or vasoactive administration | Rationale in choosing fluid vs vasoactive, or vice versa |
|      |                      |                    |                      |                        |                  |
| 2    | You are caring for a 4 yr old in the PICU with severe septic shock due to lobar pneumonia. His first night of admission he received 60 mL/kg of crystalloids and 20 mL/kg of 5% albumin. When you see him this morning, he is barely arousable and has a cap refill time of 5 s. You insert an internal jugular line and a radial arterial line. His vitals at this time are as follows: Temp 37.5 °C, HR 152/min, RR 35/min, BP 100/45 (MAP 63) mmHg. His CVP is 8 mmHg. You obtain a blood gas from the A-line, and his lactate is 4.5 mmol/L. You decide to intubate to reduce oxygen consumption related to work of breathing. Despite adequate sedation, he persists to have tachycardia; vitals after intubation are as follows: Temp 37.5 °C, HR 168/min, BP 110/40 (MAP 63) mmHg, CVP 10 mmHg, cap refill time 5 s. You immediately have to escalate to very high ventilator settings with pressure control of 34 and PEEP of 10 to achieve acceptable oxygenation and ventilation. What would your next intervention be? | What would be your next plan of action? (1) Do nothing at this point; (2) give an additional 20 mL/kg fluid bolus; (3) start a vasoactive medication; (4) need additional data to decide- please specify; (5) Other | Worsening hemodynamics after initiation of positive pressure ventilation | Resuscitate shock with fluid or vasoactives | Recognition of decrease in preload caused by initiating of positive pressure ventilation |
|      |                      |                    |                      |                        |                  |
| 3    | While rotating through the Hematology Oncology unit, you are called to the bedside of a 12-yr old receiving maintenance chemotherapy for AML. She has developed a temperature of 39.3 °C. On exam she has a HR of 160/min, RR 32/min, BP 110/40 (MAP 63) mmHg, and cap refill of 3 s. She is known to have anthracycline-induced cardiomyopathy. You palpate her abdomen and notice that her liver is 3-4 cm, similar to earlier, she has no murmur or gallop, and a CVP transduced through her broviac is 6 mmHg. In the last 4 h, her urine output has reduced from 1.5 mL/kg h to 0.3 mL/kg h. You decide to cautiously give her a 10 mL/kg fluid bolus over half an hour to see the response. At the end of the bolus, her HR is now 154/min, BP is 106/46 (MAP 66) mmHg, CVP has increased to 8 mmHg. What would your next step be? | What would be your next plan of action? (1) Do nothing at this point; (2) give an additional fluid bolus; (3) start a vasoactive medication; (4) need additional data to decide- please specify; (5) Other | Known cardiomyopathy with onset of shock | Continue fluid resuscitation | Rationale for halting or slowing resuscitation |

| Rationale for choice of fluid bolus or vasoactive | Rationale for choice of fluid bolus or vasoactive | Rationale for choice of fluid bolus or vasoactive |
|------------------------------------------------|------------------------------------------------|------------------------------------------------|
| Recognition of decrease in preload caused by initiating of positive pressure ventilation | Interpretation of CVP in conjunction with higher intrathoracic pressures | Recognition of decrease in preload caused by initiating of positive pressure ventilation |
| Rationale in choosing fluid vs vasoactive, or vice versa | Rationale for halting or slowing resuscitation | Rationale in choosing fluid vs vasoactive, or vice versa |
| Recognition of decrease in preload caused by initiating of positive pressure ventilation | Interpretation of CVP in conjunction with higher intrathoracic pressures | Recognition of decrease in preload caused by initiating of positive pressure ventilation |
venous access should be obtained and vasoactive medications made available to be started immediately if needed, while assessment of shock should proceed with the same urgency as at initial presentation, especially in the presence of ongoing losses. We found that most respondents were appropriately aggressive, opting to continue either fluid or vasoactive. While most respondents explicitly cited that they were basing their decision on ACCM guidelines, most also interpreted the blood pressure as normal, although the MAP was below the threshold recommended in the ACCM guidelines. It would be interesting to study how prevalent is this departure from the guidelines while treating shock, and whether the thresholds recommended by the ACCM are actually achieved in practice.

Scenario 2 dealt with a more complex situation where positive pressure ventilation had just been initiated. While advanced cardiopulmonary interactions are beyond the scope of general pediatric training, the ACCM guidelines mention that fluid loading might be necessary with the initiation of positive pressure ventilation due to a resultant reduction in the preload. The scenario describes florid shock with altered mental status, tachycardia despite adequate sedation, a heart rate of 168 and a diastolic blood pressure of 40 mmHg in a 4-year old child. The CVP of 10 mmHg in the face of very high intrathoracic pressures does not reflect in any way on intravascular volume status. The most common reason for inadequate resuscitation was the CVP value. Interestingly, a low confidence level was correlated with inaction in this scenario. This can be seen as a form of “omission bias”—one of the commonest biases in clinical medicine, where events occurring through the natural progression of a disease are more acceptable than those that may be directly attributed to the action of the physician.

In the third scenario, though the patient is known to have chemotherapy-induced cardiomyopathy, her liver size is not enlarged from baseline, CVP is low, and heart rate improves with an initial 10 mL/kg bolus. The probability that fluid administration will be harmful given these clinical attributes is inflated, and the far more likely possibility that there is ongoing shock in an immunocompromised host is minimized. This is a form of “base rate neglect”—clinicians conflate probabilities to rule out the worst case scenario.

---

Table 2  Demographics of respondents

| Demographics of respondents | n (%) |
|-----------------------------|-------|
| Total respondents           | 539 (100) |
| Medical students            | 37 (7) |
| Residents                   | 393 (73) |
| Fellows                     | 97 (18) |
| Attending physicians        | 12 (2) |
| Level of training- residents| 367 (100) |
| PGY-1                       | 120 (33) |
| PGY-2                       | 110 (30) |
| PGY-3                       | 121 (33) |
| PGY-4                       | 16 (4) |
| No response                 | 26 |
| Level of training- fellows  | 901 (100) |
| PGY-4                       | 25 (28) |
| PGY-5                       | 32 (35) |
| PGY-6                       | 29 (32) |
| PGY-7                       | 4 (4) |
| No response                 | 7 |
| Pediatric fellows’ specialty| (97) |
| Pediatric critical care medicine | 25 (26) |
| Pediatric emergency medicine | 22 (23) |
| Neonatology 14 (14) |
| Pediatric hospital medicine | 5 (5) |
| Pediatric cardiology 4 (4) |
| Other 27 (28) |

*Total number of respondents to this question from all survey takers.

ACCM: American college of critical care medicine; PALS: Pediatric advanced life support; MAP: Mean arterial pressure; CVP: Central venous pressure.
In scenario 4 - the patient has required a fair amount of fluid and vasopressor, but has an adequate urine output and normal vitals. Again in this case, CVP of 3 mmHg takes precedence in decision-making and half of all respondents elect to give additional fluid or increase vasoactives.

We uncovered some common themes across the scenarios. The presence of fever can act as a confounding factor in the attribution of tachycardia to the shock state. This leads to delay in treatment for shock while treating with antipyretics and awaiting fever to subside before assessing degree of tachycardia. It is important to emphasize to trainees that while awaiting antipyretics to take effect, it is vital to continue resuscitative measures for shock. Myocardial depression often coexists with septic shock, yet these children need to be resuscitated with either fluid or vasopressors, and clinical exam for response to fluid, hemoptoemegaly and rales is usually the only tool available at bedside. As such, it is not appropriate to await results of echocardiographic imaging to make decisions on fluid resuscitation. Experts were more likely than non-experts to prefer vasoactive medication to fluid in all instances except for scenario 4, and were uniformly more confident.

Our study has several limitations. Answering questions on a survey does not replicate the experience of examining a patient and assessing the evolution of disease in real time. In practice, each patient is immeasurably complex and there are multiple sources of clinical input - both conscious and subconscious. For sake of keeping the question stem at a reasonable length, we had to handpick what we considered the most relevant information. There is also the inevitable introduction of the Hawthorne effect here-respondents are aware that they are completing a survey on fluid management practices and this knowledge might further add to the 

### Table 3 Responses to clinical scenarios

| Scenario                                      | Fluid bolus (%) | Vasoactive (%) | No further intervention/need more data/other (%) | Factors cited as important for decision-making | Percentage with low confidence |
|-----------------------------------------------|-----------------|----------------|-----------------------------------------------|-----------------------------------------------|-------------------------------|
| 1-septic shock s/p 60 mL/kg fluid             | 38              | 47             | 15                                           | Capillary refill, response to fluid            | 36                            |
| 2-hemodynamic instability s/p initiation of positive pressure ventilation | 20              | 60             | 20                                           | CVP, lactate                                  | 65                            |
| 3-shock with comorbid cardiomyopathy          | 39              | 15             | 46                                           | HR, BP                                       | 64                            |
| 4-anaphylaxis with resolved shock             | 29              | 20             | 51                                           | CVP                                          | 61                            |

s/p: Status post; CVP: Central venous pressure; HR: Heart rate; BP: Blood pressure.

### Table 4 Preferences of non-experts vs experts

| Scenario                                      | Role           | Bolus (% of total) | Vasoactive (% of total) | Other (% of total) | P value |
|-----------------------------------------------|----------------|-------------------|-------------------------|--------------------|---------|
| 1-septic shock with ongoing loss              | Non-experts    | 40                | 47                      | 13                 | 0.02    |
|                                              | Experts        | 25                | 50                      | 25                 |         |
| 2-worsening hemodynamics after intubation     | Non-experts    | 21                | 59                      | 20                 | 0.08    |
|                                              | Experts        | 11                | 73                      | 16                 |         |
| 3-shock in a child known to have cardiomyopathy | Non-experts | 39                | 15                      | 46                 | 0.77    |
|                                              | Experts        | 42                | 17                      | 41                 |         |
| 4-recovering anaphylactic shock with low CVP  | Non-experts    | 29                | 21                      | 50                 | 0.01    |
|                                              | Experts        | 25                | 8                       | 67                 |         |

1. Experts: Fellows in pediatric critical care, pediatric emergency medicine, and pediatric hospital medicine; Non-experts: All other respondents.
inaccuracy of survey responses compared to actual decisions made. Thus the survey-based methodology is far less rigorous than conducting a prospective study and debriefing pediatric trainees in real time.

To conclude, while pediatric trainees are most confident when following ACCM guidelines to treat shock, they face a high degree of decisional conflict and lack of confidence when encountering alternative etiologies and comorbidities. Educational interventions targeting the biases outlined in our study could be of benefit.

ARTICLE HIGHLIGHTS

Research background
Pediatric trainees are often the first responders at the bedside for evaluation and ongoing management of children presenting with various shock states, yet there is little data on how they navigate through these decisions or how confident they feel in making these decisions. We conducted a survey of pediatric trainees all over the United States. Our study is the first study to survey the literature studying fluid administration practices of trainees.

Research motivation
The motivation for performing this research was to uncover common situations where pediatric trainees faced a significant decisional conflict when treating shock. We also aimed to uncover some common situations where under-resuscitation was common and to highlight cognitive biases and fallacies of trainees while assessing and treating children with shock.

Research objectives
One of the study objectives was to assess level of adherence and confidence level with American College of Critical Care Medicine (ACCM) guidelines which are universally followed in the United States for treatment of septic shock. Additionally, we wanted to assess degree of reliance on central venous pressure, resuscitation in children with ongoing cardiac comorbidity. We also sought to discover if there were significant differences in treatment practices of more advanced level trainees such as pediatric critical care, hospital medicine and emergency medicine fellows. All these objectives were realized, and can help in training and supporting pediatric residents for management of shock.

Research methods
We conducted a nationwide survey of all pediatric trainees in the United States. This included residents at all levels of training, and fellows training in one of the subspecialties of pediatrics. The survey was voluntary and anonymous. Statistics were primarily descriptive, and SPSS was used for performing additional statistical testing.

Research results
We found that pediatric trainees across all levels of training faced a high degree of uncertainty and lack of confidence while they were making decisions regarding fluid administration in children presenting with shock. ACCM guidelines are frequently cited, yet blood pressure goals cited in the ACCM guidelines are often not met, nor is a suboptimal blood pressure recognized. Children with coexisting cardiac comorbidities may be prone to severe under-resuscitation for fear of cardiac failure causing pulmonary edema. Fever is an important confounding factor often delaying recognition of shock. This study sheds light on these important observations, and further prospective observational studies are warranted which study decision-making of trainees.

Research conclusions
This study is the first study on how trainees in pediatrics make decisions for treatment of shock. It is vital that shock be recognized and treated rapidly, yet there are no studies looking at how confident trainees feel in their judgment. This study points to a very low level of confidence when treating shock, and some common situations which should be highlighted to trainees while caring for patients or in simulated scenarios.

Morpia K et al. How does pediatric trainees manage shock?

Research perspectives
Pediatric trainees should be supported adequately and provided focused teaching related to treatment of shock states in children. Children with malignancy and cardiac comorbidity who present with septic shock are a uniquely vulnerable population prone to under-resuscitation and should be managed by expert physicians. Central venous pressure should be interpreted with caution and not used in isolation without entire clinical picture.

REFERENCES

1. Carcillo JA, Tasker RC. Fluid resuscitation of hypovolemic shock: acute medicine’s great triumph for children. *Intensive Care Med* 2006; 32: 958-961 [PMID: 16791656 DOI: 10.1007/s00134-006-0189-3]

2. Carcillo JA, Davis AL, Zaritsky A. Role of early fluid resuscitation in pediatric septic shock. *JAMA* 1991; 266: 1242-1245 [PMID: 1870250 DOI: 10.1001/jama.1991.03470090076035]

3. Han YY, Carcillo JA, Dragotta MA, Bills DM, Watson RS, Westerman ME, Orr RA. Early reversal of pediatric-neonatal septic shock by community physicians is associated with improved outcome. *Pediatrics* 2003; 112: 793-799 [PMID: 14523168 DOI: 10.1542/peds.112.4.793]

4. Oliveira CF, Nogueira de Sá FR, Oliveira DS, Gottschald AF, Moura JD, Shibata AR, Troster EJ, Vaz FA, Carcillo JA. Time- and fluid-sensitive resuscitation for hemodynamic support of children in septic shock: barriers to the implementation of the American College of Critical Care Medicine/Pediatric Advanced Life Support Guidelines in a pediatric intensive care unit in a developing world. *Pediatr Emerg Care* 2008; 24: 810-815 [PMID: 19050666 DOI: 10.1097/PEC.0b013e3181e9f3a]

5. Paul R, Neuman MI, Monuteux MC, Melendez E. Adherence to PALS Sepsis Guidelines and Hospital Length of Stay. *Pediatrics* 2012; 130: e273-e280 [PMID: 22753559 DOI: 10.1542/ peds.2012-0094]

6. Brierley J, Carcillo JA, Choong K, Cornell T, Decaen A, Dyemann A, Doctor A, Davis A, Duff J, Dugas MA, Duncan A, Evans B, Feldman J, Felmet K, Fisher G, Frankel L, Jeffries H, Greenwald B, Gutierrez J, Hall M, Han YY, Hanson J, Hazelzet J, Hernan L, Kiff J, Kissoon N, Kon A, Irazuza J, Lin J, Lorts A, Mariscalco M, Mehta R, Nadel S, Nguyen T, Nicholson C, Peters M, Okhuyzen-Cawley R, Poulton T, Relves M, Rodriguez A, Rozenfeld R, Schnitzler E, Shanley T, Kache S, Skippen P, Torres A, van Dessauer B, Weingarten J, Yeh T, Zaritsky A, Stojadinovic B, Zimmerman J, Zuckerberg A. Clinical practice parameters for hemodynamic support of pediatric and neonatal septic shock: 2007 update from the American College of Critical Care Medicine. *Crit Care Med* 2009; 37: 666-688 [PMID: 19323539 DOI: 10.1097/ CC9.0b013e3181932b36]

7. Blumenthal-Barby JS, Krieger H. Cognitive biases and heuristics in medical decision making: a critical review using a systematic search strategy. *Med Decis Making* 2015; 35: 539-557 [PMID: 25145577 DOI: 10.1177/0727480614547740]

8. Crowley RS, Legowski E, Medvedova O, Reitmeyer K, Tseytin E, Castine M, Jukic D, Mello-Thoms C. Automated detection of heuristics and biases among pathologists in a computer-based system. *Adv Health Sci Educ Theory Pract* 2013; 18: 343-363 [PMID: 22618855 DOI: 10.1007/s10459-012-9374-z]

9. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)–a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009; 42: 377-381 [PMID: 18929636 DOI: 10.1016/j.jbi.2008.08.010]

10. Shippy CR, Appel PL, Shoemaker WC. Reliability of clinical monitoring to assess blood volume in critically ill patients. *Crit Care Med* 1984; 12: 107-112 [PMID: 6697726]

11. Mark PE, Baram M, Vahid B. Does central venous pressure predict fluid responsiveness? A systematic review of the literature and the tale of seven mares. *Chest* 2008; 134: 172-178 [PMID: 18628220 DOI: 10.1378/chest.07-2331]

12. Arikan AA, Zappittelli M, Goldstein SL, Naipaul A, Jefferson
Morparia KG et al. How pediatric trainees manage shock?

LS, Loftis LL. Fluid overload is associated with impaired oxygenation and morbidity in critically ill children. Pediatr Crit Care Med 2012; 13: 253-258 [PMID: 21760565 DOI: 10.1097/PCC.0b013e31822882a3]

De Backer D, Vincent JL. Should we measure the central venous pressure to guide fluid management? Ten answers to 10 questions. Crit Care 2018; 22: 43 [PMID: 29471884 DOI: 10.1186/s13054-018-1959-3]

De Backer D, Vincent JL. Should we measure the central venous pressure to guide fluid management? Ten answers to 10 questions. Crit Care 2018; 22: 43 [PMID: 29471884 DOI: 10.1186/s13054-018-1959-3]

Morparia KG, Reddy SK, Olivieri LJ, Spaeder MC, Schuette JJ. Respiratory variation in peak aortic velocity accurately predicts fluid responsiveness in children undergoing neurosurgery under general anesthesia. J Clin Monit Comput 2018; 32: 221-226 [PMID: 28299589 DOI: 10.1007/s10877-017-0013-3]

Raj S, Killinger JS, Gonzalez JA, Lopez L. Myocardial dysfunction in pediatric septic shock. J Pediatr 2014; 164: 72-77. e2 [PMID: 24144393 DOI: 10.1016/j.jpeds.2013.09.027]
