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Pediatric Emergency Department Nurse's Knowledge and Attitudes of Pediatric Fluid Resuscitation

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Abstract

Background: Rapid fluid resuscitation is essential to the management of pediatric shock, but there are many barriers to published guideline adherence. Limited evidence describing emergency department (ED) nurse's knowledge and attitudes of fluid resuscitation exists. This study described pediatric ED nurse's knowledge and attitudes of fluid resuscitation.

Methods: This single site descriptive study used survey methodology. A 23-question survey was distributed to nurses in the ED at Boston Children's Hospital. The survey measured nurse's knowledge, attitudes, and perceived barriers to fluid resuscitation.

Results: Findings suggested gaps found between actual and perceived knowledge consistent with prior evidence. There was a 50.9% response rate to the survey, with the majority of the participants holding a bachelor's degree and a nursing certification. One of the top concerns nurses considered with each method of fluid resuscitation was the IV gauge. Thematic analysis identified the need for further education, environmental modifications, staffing consistent with patient acuity, and piloting of new devices.

Conclusion: Pediatric nurses' knowledge and attitudes varied, and improving knowledge will enhance the provision of safe and effective care. Educational interventions should incorporate a variety of modalities and reassess frequency needed to maintain competency. Education should encourage consideration of all fluid resuscitation options. Demographics provided insight into how perception, years of experience, education level, and certifications related to knowledge. Limitations included that this was a single center descriptive study with a small convenience sample. Additionally, this study took place during the COVID pandemic and social unrest which may have impacted survey response.

Keywords: Fluid resuscitation, pediatrics, nursing, education, emergency department

Pediatric Emergency Department Nurse's Knowledge and Attitudes of Rapid Pediatric Fluid Resuscitation

A reduction of intravascular volume can result from multiple etiologies in a pediatric patient such as dehydration, trauma, and sepsis (Parker & Manan, 2013). In the pediatric population, hypovolemic shock is the most common type of shock seen (Taghavi & Askari, 2020). This circulatory instability, related to a fluid volume deficit, results from impaired preload from a reduction of intravascular fluid volume, causes a decrease in peripheral tissue perfusion, which can cause ischemic injuries to vital organs and be life-threatening (Parker & Manan, 2013). In order to avoid ischemia and multisystem organ damage, rapid fluid resuscitation proves to be critical in the management of pediatric shock (de Caen et al., 2015).

Mortality related to hypovolemic shock has decreased over the years since the implementation of rapid intravenous fluid administration guidelines (de Caen et al., 2015). Guidelines developed by the American College of Critical Care Medicine (ACCM) take an aggressive approach to fluid administration recommending "rapid 20 mL/kg fluid boluses over 5 minutes" with up to 60 mL/kg of fluid provided within the first 15 minutes of resuscitative efforts, while the Society of Critical Care Medicine and the European Society of Intensive Care Medicine's (SCCM) Surviving Sepsis Campaign algorithm recommends that children should receive up to 40-60 mL/kg of fluid within the first hour of recognition of shock in the pediatric patient (Davis et al., 2017; Society of Critical Care Medicine and the European Society of Intensive Care Medicine, 2020). As each fluid bolus is administered with the goal of achieving normal perfusion and blood pressure, assessment for improved perfusion includes evaluation of the mean arterial pressure and central venous pressure (Davis et al., 2017).

While various methods of fluid resuscitation are used by healthcare providers, there are barriers to adherence to the published guidelines. These concerns include hesitance to use a small gauge IV to infuse large volumes of fluid quickly, nursing resources required for rapid infusion methods, a lack of understanding of which patients should be receiving aggressive fluid administration, concerns for fluid overload, and a gap in the understanding of the guidelines among team members (Paul et al., 2017).

Nurses play a critical role in rapid fluid resuscitation of pediatric patients. To achieve the necessary fluid replacement, various methods include manual syringe techniques such as the disconnect-reconnect method and the push-pull technique, intravenous (IV) pumps, pressure bags, and mechanical rapid infusers to administer the fluid (Stoner et al., 2007). Educating team members about the recommendations for fluid resuscitation should include the fluid volumes, timeliness, and use of fluid resuscitation devices, along with their benefits and disadvantages (Paul et al., 2017). However, nurses' attitudes towards the use of these devices may be related to the ease of use, concerns about risks associated with the different devices, maintenance of aseptic technique, and difficulty recording the actual amount of fluid infused (Stoner et al., 2007). Concerns for fluid overload are compounded in pediatric patients with underlying cardiac diagnoses or cardiogenic shock (Stoner et al., 2007).

Despite education and practice change initiatives, organizational support, enhancing the adaptability of recommendations, and committees to champion these initiatives, achieving fluid resuscitation benchmarks remains a challenge (Parker & Manan, 2013). Only one single-center study evaluated pediatric emergency department nurse's knowledge and attitudes of fluid resuscitation. A survey was administered to nurses, physicians, and subspecialty trainees

working in pediatric emergency or pediatric critical care (Parker & Manan, 2013). Results demonstrated no consensus regarding best practices to achieve pediatric fluid resuscitation goals and further study was recommended (Parker & Manan, 2013).

An attitude is "a feeling or way of thinking that affects a person's behavior" (Meriam-Webster.com, 2021). It is a "manner, disposition, feeling or position …with regard to a person or thing" (Dictionary.com). Confidence is an attitude of the "belief in one's abilities" and the "fact of feeling certain" about a person or thing (Collins Dictionary.com, 2021). A goal of this study was to measure nurse's attitudes by proposing questions related to their confidence levels with fluid resuscitation.

The purpose of this study was to describe emergency department nurse's knowledge and attitudes of fluid resuscitation, and the characteristics of the nurses who participate in the study.

Literature Review

A scoping literature review was completed to understand the current state of the evidence regarding fluid resuscitation. The databases PubMed, Google Scholar, and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) were searched for data regarding means and methods of fluid resuscitation, current guidelines for pediatric rapid fluid resuscitation, and nursing attitudes and beliefs towards fluid resuscitation. All articles were restricted to those published in English within the last seven years. Current fluid resuscitation guidelines were also included even if greater than 7 years old. Search terms included: pediatric, adolescent or child nursing, acute care nursing, emergency medicine; rapid fluid resuscitation; fluid therapy or fluid balance; shock/therapy, and pediatrics.

Administering fluids rapidly can decrease morbidity and mortality rates as the saying "time is tissue" is meant to encourage. Adhering to the current guidelines improves patient outcomes as survival odds decrease with the lack of timely fluid therapy (Parker & Manan, 2013). Although this knowledge is common, there are many challenges to protocol adherence including a lack of education about the benefits and drawbacks of each of the available devices, a gap in provider knowledge of correct device selection, and the need for education on how to operate the different devices (Rice, 2006).

Adherence to fluid resuscitation guidelines is related to the use of the correct fluid-delivery device, however the rapid rates recommended is difficult to accomplish due to a lack of understanding of device selection and the gap between what is taught and used in practice (Paul et al., 2014; 2017). Hesitance to use a small gauge IV for rapid fluid delivery, concerns regarding nursing resources for rapid infusion methods, and lack of understanding of which patients should be receiving aggressive fluid administration were barriers that demonstrated gaps in training and education (Paul et al., 2017). People often use what they are most comfortable with which can hinder using the best device.

Rapid fluid administration is recommended in settings where intensive care monitoring and mechanical ventilation are available, as aggressive administration of fluid replacement may lead to fluid volume overload (Davis et al., 2017; Marik et al., 2020). Fluid volume overload can cause detrimental effects within the body significantly impacting the end organs including the central nervous system, respiratory, cardiovascular, renal, gastrointestinal, and hepatic systems (Marik et al., 2020). Monitoring for these complications of fluid overload requires reassessment after each fluid bolus and access to intensive care if these issues develop.

Means and methods for fluid resuscitation

To achieve the necessary fluid replacement, various fluid delivery methods include manual syringe techniques (e.g., disconnect-reconnect method and push-pull technique), IV pumps, pressure bags, and mechanical rapid infusers (Stoner et al., 2007). With each of these techniques, there are challenges and drawbacks, including the size of the patient and the IV catheter, ease of use, availability and cost of devices, and physical and mental fatigue (Stoner et al., 2007). Each technique also has variable risk for air embolisms, ease in maintaining sterility, and ability to accurately track fluid administered to comply with the ACCM guidelines (Stoner et al., 2007).

The disconnect-reconnect method is done by preparing fluid-filled syringes, connecting them one at a time to the IV extension tubing, administering the fluid as quickly as possible, disposing of the used syringe, and repeating these steps until the desired fluid volume is achieved (Parker & Manan, 2013). This less sophisticated method requires two providers, one to draw up fluid and one to administer it. This method may be problematic if staffing resources are scarce. Additionally, there is an increased risk of a nosocomial infection as more people have contact with the syringe and it is not a closed system (Spangler et al., 2019). The benefits of this method are that it is not as cognitively challenging as others, providers can deliver an exact amount of fluid, and syringes are an easily accessible item (Parker & Manan, 2013).

The push-pull technique set-up requires a bag of sterile saline, a standard blood infusion set or gravity flow IV tubing, a 3-way stopcock, a sterile syringe attached at the free port, and a T connector (Stoner et al., 2007). The operator provides fluids by repeatedly pulling fluid from the bag, turning the stopcock, and pushing the fluid into the patient (Stoner et al., 2007). Benefits to

this method include the need for only a single healthcare provider and it avoids the need for multiple syringes and needles. However, more time is needed to administer the fluids using this method (Stoner et al., 2007). While administering fluids to children weighing more than 40 kg or through large-bore catheters, the operator may become fatigued (Stoner et al., 2007). Similar to the disconnect-reconnect method, there is an increased risk of syringe contamination. Additionally, with these two methods, nurses must be vigilant to remove air in the syringes, tubing, and bag to avoid potentially lethal air embolisms (Cook, 2013).

IV pumps are used for the administration of intravenous fluids, blood products, and medications. One provider with knowledge on how to properly program the pump is required (Parker & Manan, 2013). Fluids are hung using a standard fluid infusion set and the pump is programmed to the rate and volume to be administered. Benefits of the infusion pump include alarms to notify the team of any air embolisms, occlusions of the line, and when the bolus has finished. These pumps are commonly found in healthcare settings and providers tend to be comfortable with using them, but the maximum fluid infusion rate is 999 mL per hour which can be inadequate for fluid resuscitation unless the patient weighs less than 4.16 kg (Parker & Manan, 2013; Stoner et al., 2007).

Pressure bags are used to administer fluids rapidly. Removing air from the bag of fluid is the vital first step to avoid air embolism (Cook, 2013). To pump up the bag, the nurse turns the stopcock to allow for air to be hand-pumped, accumulating in the pressure bag to achieve the desired 300 mm Hg. The line is then opened to start fluid infusion and the flow rate is greater than gravity alone as a result of the pressure gradient (Parker & Manan, 2013). This method only requires one person but requires frequent attention to avoid under-inflation leading to slower

fluid rates or over-inflation causing herniation of the fluid bag (Stoner et al., 2007). Pressure bags should not be used on non-power central venous lines as the increased pressure can lead to mechanical damage of the catheter, such as dislodgement or rupture, which can be very harmful to the patient (Pittiruti et al., 2012). Pressure bags also make it difficult to know exactly how much fluid has been given unless an in-line scale is being used (Stoner et al., 2007). In larger children, this method may be more useful when multiple fluid boluses are required to avoid operator fatigue (Stoner et al., 2007).

Mechanical rapid infusers, such as the Level 1 Rapid Infuser generate high and consistent pressure around the bags, sustained by the machine, so providers do not have to adjust it as they do with the pressure bag (Parker & Manan, 2013). Although this method requires less manual input by the provider, the device does not allow for adjustment of the fluid flow rate which may be necessary if the patient is showing signs of fluid overload (Parker & Manan, 2013). Two bags can be placed within the chamber of the device and pressures of approximately 300 mm hg are applied, achieving flow rates of warmed fluid up to 500 mL/min (Parker & Manan, 2013). If it is not used often, poor memory may make it challenging to set up. This device also cannot be used on non-power central venous lines as there is an increased risk of mechanical damage (Pittiruti et al., 2012).

There is a dearth of research regarding barriers to best accomplish fluid resuscitation. Only one single-center study was found that evaluated pediatric emergency department nurse's knowledge and attitudes of fluid resuscitation. Using survey methodology, nursing and physician staff and subspecialty trainees working in pediatric emergency medicine or pediatric critical care medicine were surveyed (Parker & Manan, 2013). A lack of consensus was found among health

care workers regarding best practices to achieve pediatric fluid resuscitation goals and the need for further study to understand best practices was recommended (Parker & Manan, 2013).

Although this study was published in 2013 (Parker & Manan, 2013), the recommendations for rapid fluid resuscitation are still critical to outcomes, supporting the need for further research to understand nurses' attitudes and knowledge of rapid fluid resuscitation to guide the development of best practices. The sample was primarily nursing professionals (83%), with the majority (61%) working in the pediatric intensive care unit. Only 58% were able to correctly identify the resuscitation guidelines, and varying beliefs were found describing how to best meet guideline recommendations. The majority indicated infrequent use of the rapid infuser, with 47% reporting that they had not received adequate training to use the rapid infuser (Parker & Manan, 2013). Additionally, there were different opinions as to which size patients should be considered for rapid fluid resuscitation using the rapid infuser (Parker & Manan, 2013).

While there is evidence that supports the importance of rapid fluid resuscitation to improve outcomes in critically ill pediatric patients, limited evidence could be found that described registered nurses' knowledge and attitudes to achieving rapid fluid resuscitation goals in the pediatric population. Understanding nurse's knowledge and attitudes will contribute to the identification of barriers to rapid fluid resuscitation and provide critical foundational information for the development of future studies to improve outcomes for vulnerable pediatric patients.

Means and Methods

Purpose

The purpose of this study was to describe emergency department nurse's knowledge and attitudes of fluid resuscitation. Information from this foundational study will inform the development of interventions to improve rapid fluid resuscitation in pediatric emergency departments. The specific aims of this study were to (1) describe pediatric ED nurses' attitudes and knowledge of fluid resuscitation, and (2) describe the characteristics of the nurses that participate in the study. The study was a descriptive study of pediatric emergency department registered nurses' knowledge and attitudes of fluid resuscitation using an on-line survey to answer the question "What are pediatric emergency nurses' knowledge and attitudes of rapid pediatric fluid resuscitation?".

Sample

The Boston Children's Hospital (BCH) Emergency Department (ED) is a Level 1 Regional Pediatric Trauma center serving about 60,000 patients each year (*Emergency Medicine | Boston Children's Hospital*., n.d.). The department cares for patients between birth and 21 years of age (*Emergency Medicine | Boston Children's Hospital*., n.d.). The BCH ED has a staff of 114 nurses, with 94 part- or full-time nurses and 20 per diem nurses. This department is the largest pediatric ED in Massachusetts (*Emergency Medicine | Boston Children's Hospital*. (n.d.)). During the study period, the department had access to equipment to provide fluid resuscitation via the disconnect-reconnect method, push-pull technique, IV pump method, pressure-bag method, and the mechanical rapid infuser method.

The population of interest and sample studied included Registered Nurses (RN) working in the ED of BCH. RNs employed in the ED who have successfully completed orientation at BCH were eligible to participate. Those on orientation were excluded. An email was sent out to the department using BCH internal email to inform them of the study with the link to the survey (Appendix 3). Additionally, a flyer was posted in the ED (Appendix 2), the study was presented at staff meetings, and nurse leaders championed the study and helped to encourage participation.

Data Collection

The survey was administered via weblink to elicit emergency department nurse's knowledge and attitudes of fluid resuscitation and was developed by the research team after the completion of a scoping literature review. The 23-question survey included attitudes and perceived barriers to fluid resuscitation and characteristics of nurses. This REDCap programmed survey link was distributed via email (Appendix 1). The items were guided by literature review and then reviewed by ED nursing experts with at least 3 years of ED experience for face and content validity (Appendix 5). The Content Validity Index Score for the questions was calculated (Emmanuel & Clow, 2017; Polit & Beck, 2006) (Appendix 6). Questions that scored a 1 or 2 were revised according to feedback from the reviewers and consensus was obtained for revised questions. The confidence questions were developed by the Level III staff nurse and used in prior fluid resuscitation QI projects (Appendix 1). An open-ended question was included in the survey to ask the participants to share any additional thoughts they had to improve fluid resuscitation.

Data Analysis

Data were analyzed using Microsoft Excel. Descriptive statistics were used to analyze the sample demographic characteristics, knowledge questions, and perceived knowledge. A thematic analysis was used to analyze the responses to the open-ended question.

Data Management and Quality Control

Throughout data collection and analysis, confidentiality was maintained. The results were reported in aggregate. The data were reviewed to determine if any data was missing. To manage missing data, a benchmark was set. If at least 75% of the survey was answered, the response was still included in the data analysis. One question, "What factors do you consider when selecting a fluid resuscitation method" was omitted from the survey due to a technical error and not included in the data analysis.

Procedures to ensure ethical considerations in research with human subjects

This study was reviewed by both Boston Children's Institutional Review Board (IRB) (IRB-P00038680) and the University of New Hampshire IRB (IRB #:8465) with both institutions determining the protocol qualified as exempt from the requirements of 45 CFR 46. The data was collected and stored in a secure REDCap database behind the BCH password-protected firewall. Only the Principal Investigator and Boston Children's Hospital mentor had access to the database. The UNH faculty advisor was granted access to a de-identified database which was stored securely in a UNH Box folder.

To preserve the subject's confidentiality, the PI requested a waiver of documentation of informed consent and instead used an information sheet to describe the study (Appendix 4). Upon opening the REDCap survey, an information sheet describing the study was provided for

review by the subjects (Appendix 4). The information sheet described that consent was implied by the taking the survey. This was a minimal risk study using survey methodology to describe nurses' knowledge and attitudes of fluid resuscitation. The risk of the study was a potential breach of confidentiality which was mitigated by the data management procedures described.

Results

Description of the Study Sample

Fifty-eight pediatric ED Registered Nurses participated in the survey. With about 114 nurses in the Emergency Department, this was a 50.9% response rate. Table 1 outlines the demographics of the participants.

The majority of the participants, 79.3% (n=46), had their bachelor's degree, 44.8% and 15.5% (n=9) held a master's degree, and 26.9 % (n=26) had six or more years of experience in the pediatric emergency department setting, while 20.7% (n=12) had less than 2 years of pediatric ED experience. For professional certifications, 8.80% (n=5) had their Certified Pediatric Nurse (CPN), 5.3% (n=3) had their Certified Emergency Nurse (CEN), 40.40% (n=23) had their Certified Pediatric Emergency Nurse, and 12% (n=7) reported they had other certifications.

When asked to describe their pediatric fluid resuscitation experience, 24.1% (n=14) reported they were very experienced, 34.50% reported they were experienced (n=20), 34.50% (n=20) reported they had some experience, and 6.9% (n=4) reported minimal to no experience. When asked to describe their knowledge of how to accurately perform pediatric rapid fluid resuscitation, 57.9% (n=33) reported they were knowledgeable or very knowledgeable with 42% (n=24) reporting no knowledge or somewhat knowledgeable.

Knowledge Based Questions

The participant's responses to the knowledge questions varied. When asked to identify the current initial dose of fluid per the Society of Critical Medicine guidelines and institutional policies for pediatric fluid resuscitation (correct answer: 10-20 mL/kg), 82.8% (n=48) participants correctly identified the recommended initial dose of fluid, and 69% (n=40) correctly selected the need for a 20 gauge IV for a Level 1 Rapid Infuser. When asked whether a pressure bag could be used on a non-power CVL or not, 48.3% (n=28) selected the incorrect answer of true.

Two knowledge questions were select all that apply and deemed correct if all of the correct options were selected and none of the incorrect. Regarding air removal from the fluid bag, the majority of nurses, 93.1% (n=54), correctly identified the need to do so with the mechanical rapid infuser, but incorrectly did not identify push-pull and pressure bag methods requiring air removal (60.3%, n=35). Overall, only 25.9% (n=15) of participants correctly identified all of the methods that require air removal. Only 3.44% (n=2) of respondents accurately choose the correct signs of fluid volume overload. Here, 89.5% (n=51) identified that third spacing of fluid indicated fluid volume overload. Table 2 provides a summary of the knowledge questions and their results and Table 6 displays the correct answers to each question.

Perceived Knowledge

Perceived knowledge questions asked participants to identify their level of knowledge with specific methods (pressure bag, push-pull, Level-1 Rapid Infuser), fluid administration risks, removal of air, and institutional guidelines. Only removing air from the IV bag (61.4%, n=35) and utilizing a pressure bag (62.1%, n=36) were aspects that the participants felt very

knowledgeable about. Some knowledge and no knowledge were the top responses for perceived knowledge of the push-pull method (64.6%, n=38), the Level-1 Rapid Infuser (70.7%, n=41), understanding the institutional guidelines (58.6%, n=34), and risks of rapid fluid resuscitation (51.7%, n=30). The perceived knowledge questions are further described in Table 3.

Attitudes

Next, registered nurse's attitudes were measured by asking them about potential barriers to each method of fluid resuscitation available in the BCH ED and asked them to select which of the following they considered prior to using each method. Table 4 provides a summary of the participants' responses. The nurses' top two concerns for each method included:

- Disconnect-reconnect: Potential for air embolism (70.2%) and risk for contamination (70.2%)
- Push-pull: Operator fatigue (63.2%) and IV gauge (53%)
- Large-volume pump: Maximum rate of 999 mL/hr (93%) and IV gauge (54.4%)
- Pressure bag: Requires frequent attention to pressure (78.2%) and IV gauge (73%)
- Level 1 rapid infuser: IV gauge (85.5%) and staffing resources (77.3%)

Other Recommendations

The final open-ended question asked nurses for other recommendations for achieving pediatric rapid fluid resuscitation goals. Four participants (6.90%) contributed other recommendations for improving rapid fluid resuscitation in the pediatric population. Recommendations are described in Table 5. The major themes included the need for more education, physical barriers, and staffing concerns. The physical barriers identified included the

need for more space to hang the fluids and prepare all of the equipment. Staffing concerns included that all methods require additional staffing and the staff available doesn't always correlate to the acuity of patients. Additionally, there were requests for the availability of new devices to improve fluid resuscitation and decrease the risks associated with this intervention.

Discussion

The study achieved a 50.9% (n=58) response rate of staff nurses, greater than the average response rate of 33%, with nurse's response rates often low (Lindemann, 2019; VanGeest & Johnson, 2011). We anticipated there to be more correct answers for the knowledge questions, as 44.8% (n=26) of respondents had more than 6 years of experience, yet there were knowledge gaps identified in the responses to the questions. Additionally, the number of correct answers did not appear to align with the reported experience level of the participants, with 58.6% of respondents ranking themselves as experienced or very experienced with fluid resuscitation specifically. The majority of the respondents had their bachelor's degree (79.3%, n=36), with 66.8% (n=32) having certifications including CPEN, CEN, CPN, or another, showing the nurses were committed to certification and education. These demographics provided much insight regarding how perception, years of experience, education level, and certifications related to knowledge regarding pediatric rapid fluid resuscitation. With de-identification of the data and no identifying information to link the participant to their data, we were unable to compare the demographic data to knowledge, attitudes, or perceptions. Future research is needed to continue to explore these relationships. This study also supports the need for further research to understand the gap between perception of competence and knowledge.

Safety Concerns and Need for More Education

Specific educational needs and safety concerns were identified, which can be addressed in future quality improvement initiatives. Future education should include selection of an appropriate method for rapid pediatric fluid resuscitation and the use of different methods, with greater emphasis on the rapid infuser. A safety concern identified was the incorrect identification of fluid delivery methods that required the use of a power CVL. Approximately 50% (n=28) did not correctly answer that a pressure bag cannot be used on a non-power CVL. This is concerning as pushing fluids with a pressure bag through a non-power CVL can result in catheter damage and adverse outcomes such as catheter embolisms (Plumb & Murphy, 2011). This finding suggests a need for more education to proactively prevent a serious safety event as 57.9 % (n=33) participants perceived that they were knowledgeable or very knowledgeable, but 50% incorrectly answered regarding non-power CVLs. Further research and education are consistent with the BCH commitment to high reliability to prevent patient harm through proactive identification of risks, including routinely understanding knowledge gaps. Other focal points for an educational initiative are methods that require the air be removed from the IV bags and signs of fluid volume overload.

The knowledge questions responses indicated a variability in the accuracy of these responses, especially when in light of self-reported experience levels and perceived knowledge. Here as 57.9 % (n=33) participants perceived that they were knowledgeable or very knowledgeable with the various methods and guidelines for rapid fluid resuscitation, the responses to the knowledge questions suggested knowledge gaps related to the use of pressure bags and non-power CVLs with approximately 50% of respondents answering this question correctly. A need for educational refreshment to align with the gaps identified in this study was

recognized. Other areas to include in an educational initiative included signs of fluid volume overload, perceived knowledge gaps with specific rapid fluid resuscitation methodology, fluid resuscitation guidelines and institutional policies, and factors that should be considered when selecting fluid resuscitation methodology. The findings also suggest a need to further understand not only what types of additional education is needed (e.g., didactic, simulation, or a combination of both), but to also understand the "dose" of the educational interventions needed (e.g., annual competencies or more frequent mock competency opportunities).

Attitudes Can Impact Method Choices

The responses to the rapid infuser questions were consistent with the findings of the only study found that investigated rapid fluid resuscitation in pediatric EDs and ICUs (Parker & Mannan, 2013). This single-center study done in Canada aligned with our findings that most people consider IV gauge which is critical to achieving fluid resuscitation goals, especially with limited vascular access in the pediatric population. Attitudes about each device identified IV-gauge, potential for complication (infections or air embolisms), and devices where participants need some reinforcement. Additional education should encourage nurses to consider all options, weighing barriers and drawbacks that could be safety concerns if not evaluated.

The thematic analysis of open-ended questions describing nurses' recommendations for opportunities for improvement of rapid fluid resuscitation suggest the need for more resources within the department, both fluid resuscitation resources and staffing resources, as well as further education on this topic, especially with the mechanical rapid infusers. The Level 1-Rapid infuser is not used very often within the department which is a strong topic for research on if this is due to the staff not feeling confident in their ability to use it.

Limitations

Limitations of this study include that it is a single-center study with a small convenience sample of pediatric emergency department RNs which limits the generalizability. Additionally, as this was a descriptive study, the design of this study does not permit understanding relationships or correlation through higher-level analyses. The questions, while evaluated for content and face validity, need further analysis to determine whether they truly captured the intended information or whether single answer responses may have provided more clarity to the responses. Limitations of the knowledge questions could include the participants' individual interpretation of the question suggesting a need for further validation of the question. Additionally, as this study took place during the COVID pandemic and social unrest, time constraints and other situations factors such fatigue and multiple competing priorities may have rushed completion of the survey.

Research Recommendations for Practice and Education

There is a lack of literature surrounding the topic of knowledge and attitudes of pediatric rapid fluid resuscitation from the nurse's perspective. The survey findings suggest that a gap may exists in the knowledge of fluid resuscitation guidelines and the choice of and use of the different fluid resuscitation methods. This was a descriptive study which provides foundational information and research.

Results from this study support the need for further nursing education and evaluation of the emergency department's fluid resuscitation benchmarks. This research suggests a need to describe and compare sample demographics and clinical characteristics, including of patient's fluid resuscitation efforts on a case-by-case basis. A retrospective descriptive study to analyze both demographic and clinical characteristics of the patients, including guidelines, is

recommended to provide a baseline measure for future studies. Once baseline data are obtained, a prospective study will allow both metrics that align the benchmark fluid recommendations with actual fluid resuscitation goals and identification of situational barriers through debriefing after resuscitative efforts. Future research is needed to continue to explore these relationships. This study also supports the need for further research to understand the gap between the perception of competence and the response to knowledge-based questions.

Further research to understand the relationship between nurses' years in practice and certifications and fluid resuscitation knowledge are needed. Research regarding the effects of teaching modalities (e.g., didactic, simulations, mock emergency events) including the staff's preferred learning style and retention of the information is needed to inform improvement of educational initiatives, and retention of information. As the literature also recommends that nurses are taught best via in-person discussion-based classes, clinical implications and further research of this method of education is warranted. Clinically, there is a need for further education including reinforcement of key information, and research to understand the "dose "of the educational intervention. To address the gaps in knowledge demonstrated by the results of this study, an online module has been developed to educate the nurses and address each of the topics discussed within the survey, making sure to focus on areas that were identified as concerns. This module will utilize a pre and post-test approach to evaluate the effectiveness of an educational module and provide further data for areas that need further education and improvement. A 6-month follow-up of giving the same questions to the participants can test for retention of knowledge and also provide insight on how often education regarding fluid resuscitation should take place. Combining the didactic education with hands-on experience is recommended to improve retention of information and practice change. Finally, development of subject matter

experts to champion the initiative and provide real time support during the event is recommended.

In order to sustain changes in practice, the current evidence indicated that a new process involves significant pre-planning and consideration regarding the impact new interventions will have on the staff and the facility. This delay in the development of innovations and their adaption to the clinical setting is difficult to mitigate as it takes time to adhere to even simple practices despite there being compelling evidence on reasons to do so (Hall et al., 2016). Through promotion of the initiative and support from management and other senior leadership, sustainability can be achieved.

Management support is beneficial because quality improvement is a main focus of theirs and what they deem as relevant and important is what happens on the unit (Fleiszer et al., 2016). Managerial involvement and strengthened ties between unit level leadership is important for enhancing a culture of accountability that the new initiative survives in order to provide the highest level of quality care to the patients (Fleiszer et al., 2016).

Recruiting members of the staff to be champions of the initiative is also recommended. These groups of people or "champions" of the initiative not only educate the staff about the changes being implemented, but also enhance competency, treatment capacity, and therefore, patient outcomes (Barker et al., 2018; Block et al., 2018). Strong leadership is one of the most common influencers of sustainability (Fleiszer et al., 2015). Cohesive leadership is identified as possibly one of the most pertinent influencers of organizational performance (Fleiszer et al., 2015). Champion leaders also become responsible for this initiative which enhances adherence and long-term sustainability (de Veer et al., 2020). Peer to peer knowledge is common within the practice of nursing too (Barker et al., 2018). Nursing is a team profession and nurses rely on one

another. By implementing a champion approach to disseminate knowledge and promote understanding and adherence to new initiatives, colleagues are more likely to utilize the evidence-based practice recommendations which promotes a sustainable practice change (Barker et al., 2018).

Finally, ensuring the initiative is adaptable, and well-integrated with other initiatives will support sustaining practice change. In regard to adaptability of new initiatives, making sure there is a good fit between the institutional resources and the new protocol is an important step to take (de Veer et al., 2020). For example, if there is a recommendation for utilizing a new device, such as a rapid infuser, for fluid resuscitation and the facility does not own the specific device, this recommendation is not adaptable to the facility. Making sure the new initiatives are also not straining the existing resources is important too as it can be difficult to promote adherence if staff feels it cannot be integrated into current workflow (Block et al., 2018). If staff feel that the change in practice is achievable and that it can be adapted to their work, it is more likely to be sustained (Block et al., 2018; de Veer et al., 2020). The issues raised in the thematic analysis suggest a need to understand how acuity is measured in the ED and to further understand how measures of acuity aligns with staffing needs and schedule. Evaluating and addressing environmental barriers of the ED, especially during critical emergency situations, needs further study. Barriers to documenting fluid delivery accurately should be considered including barriers with the use of electronic medical records. Further studies should also be considered to understand how to best standardize practices and identify appropriate tools, such as checklists and algorithms, to eliminate human factor errors in alignment with high reliability principles. Additionally, as new tools to improve fluid resuscitation emerge, these should be considered for implementation at the point of care.

Conclusion

In conclusion, despite evidence supporting the need for rapid implementation of fluid resuscitation intervention in alignment with standardized guidelines, fluid resuscitation benchmarks are often not met. Despite a body of evidence, the literature continues to identify the failure to meet fluid resuscitation benchmarks remains a concern across institutions and both nationally and internationally. Pediatric nurses' knowledge and attitudes of this topic varied, and in order to provide safe and effective care, improving knowledge is the first step to enhancing compliance with the various guidelines. Evidence-based practice is best for improving patient outcomes, but it is not always implemented into practice. Nursing professionals are life-long learners and are expected to stay up to date with the ever-changing recommendations for practice. In many cases, nurses fall back on what they feel is most comfortable for them and the practices that they are used to because ‘that is how they’ve always done it’. Further study to assess how often nurses should be re-educated about the means and methods of fluid resuscitation, as well as the guidelines for achieving fluid resuscitation goals is warranted.

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Tables

Table 1. Participant Demographics (N=58)

Variable Name	n	Percentage
Years of Experience		
< 2 years	12	20.70%
2-5 years	20	34.50%
6-10 years	8	13.80%
>10 years	18	31.00%
Fluid Resuscitation Experience		
None/minimal	4	6.90%
Some	20	34.50%
Experienced	20	34.50%
Very Experienced	14	24.10%
Knowledge to Perform Fluid Resuscitation		
No knowledge	3	5.30%
Some Knowledge	21	36.80%
Knowledgeable	20	35.10%
Very Knowledgeable	13	22.80%
Highest Nursing Education Degree		
AD	3	5.20%
BSN	36	79.30%
MS	9	15.50%
PhD/DNP	0	0%
Professional Certification		
CPN	5	8.80%
CEN	3	5.30%
CPEN	23	40.40%
Other	7	12%
None	25	43.90%

Table 2. Participant's Knowledge (N=58)

Variable Name	n	Percentage
Recommended Initial Dose Fluid		
30ml/kg	4	6.90%
10-20 mL/kg	48	82.80%
40 mL/kg	6	10.30%
25 mL/kg	0	0%
Pressure Bag and Non-power CVL		
TRUE	28	48.30%
FALSE	30	51.70%
Level 1 Infuser and IV Gauge		
24g	1	1.70%
22g	17	29.30%
18g	0	0%
20g	40	69%
Methods Requiring Air Removed from Bag		
Mechanical Infuser	54	93.10%
Push-Pull	23	39.70%
Pressure Bag	36	62. 1%
Large volume pump	8	13.80%
Total Percentage Correct	15	25.90%
Signs Fluid Overload		
Increase WOB	56	98.20%
Capillary Refill < 3 sec	8	14%
Hypoxemia	29	50.90%
Distention jugular veins	52	91.20%
Pulses 2+	15	26.30%
3rd spacing	51	89.50%
Total Percentage Correct	2	3.44%

Note: Underline indicates correct answer

Table 3. Participant's Perceived Knowledge (N=58)

Variable Name	n	Percentage
Perceived Knowledge Pressure Bag		
Very knowledgeable	36	62.10%
Some Knowledge	21	36.2
None	1	2%
Perceived Knowledge Level I Infuser		
Very Knowledgeable	17	29.30%
Some Knowledge	36	62.10%
None	5	8.60%
Perceived Knowledge Push-Pull		
Very Knowledgeable	20	34.50%
Some Knowledge	27	46.60%
None	11	19%
Perceived Knowledge Remove Air from IV Bag		
Very Knowledgeable	35	61.40%
Some Knowledge	22	38.60%
None	0	0
Perceived Knowledge Risks Rapid Fluid Resuscitation		
Very Knowledgeable	28	48.30%
Some Knowledge	30	51.70%
None	0	0
Understand Fluid Resuscitation Guidelines/Policies		
Very Knowledgeable	24	41.40%
Some Knowledge	34	58.60%
None	0	0%

Table 4. Factors Participants Consider When Using Each Device (N=58)

Variable Name	n	Percentage
Factors Considered w/ Disconnect- Reconnect Method		
Staffing Resources	31	54.40%
Risk Contamination	40	70.20%
IV Gauge	28	49.10%
Potential Air Embolism	40	70.20%
Not Enough Knowledge	18	31.60%
None	0	0%
Other	1	1.80%
Other	large of syringes needed 10,20,30 cc syringes easier to push, High risk of contamination	
Factors Considered w/ Push-Pull		
Too Slow to Administer	21	37%
Operator Fatigue	36	63.20%
IV Gauge	30	53%
Risk Contamination	25	49.30%
Not Enough Knowledge	11	19.30%
None	1	1.80%
Other	2	3.50%
	hand fatigue w/ 60 cc syringe, contamination of syringe plugger, stop cock lock position confusion if it is a neonate/ or cardiac patient and there is a more specific amount of fluid that would be required for the administration.	
Factors Considered w/ IV Pump		
Maximum Rate of 999mL/hr	53	93.00%
Can't Meet Guidelines Unless < 16,5kg	20	35.10%
IV Gauge	31	54.40%
Not Enough Knowledge	1	1.80%
None	1	1.80%
Other	1	1.80%

	one could have two PIV's and two pumps infusing at the same time to get fluid in fast	
Factors Considered w/ Pressure Bag		
Req Frequent Attention to Bag Inflation	43	78. 2%
Difficult to Know Amount Fluid Infused	35	63.60%
Difficult to use IO	13	24%
IV Gauge	40	73%
Limited to Power Lines	8	14.50%
Not Enough Knowledge	2	3.60%
None	1	1.80%
Other	1	1.80%
	never forget to remove air from the IV bag, the bigger the IV the faster	
Factors Considered w/ Mechanical Rapid Infuser		
No Adjustment Fluid Rate	29	52.70%
Fluid Overload	38	69.10%
Staffing Resources	44	80.00%
IV gauge	47	85.50%
Pt. Weight	41	74.50%
Challenge to Set-Up	36	65.50%
Not Enough Knowledge	6	10.90%
None of the Factors	0	0
Not Enough Knowledge	0	0
Other	1	1.80%
	not used often at all and one can forget how to set up and use, may need two people to set it up if you forget how to use it. Need 1:1 on the machine, cannot transport while infusing	

Table 5. Participant Recommendations for Achieving Rapid Fluid Resuscitation Guidelines

Variable Name	n	Percentage
Other Recommendations	4	6.90%

- All of these skills require additional staffing and additional availability of nurses. Staffing to demand does not take into account critical patient needs. Space in the rooms is an issue, with monitors and equipment making it difficult to get to the bedside and to the IV access site. There is a challenge with locating space to hang the fluids from and bulky IV poles inhibiting bedside space and being difficult to transfer a patient. We need ceiling-mounted hangers and more poles attached to beds. Tubing length can also be a barrier for longer patients. There can also be competing demands on IV sites: for labs, for fluids, and for medications.

- I think we could use the rapid infuser much more than we do. I am definitely less comfortable with push-pull method as I didn't have much training with it.

- Love to see the new handheld Lifeflow device used in our ED, no batteries, any size PIV, minimizes CLABSI and the line contamination, and can infuse blood with them now!

- For infants or small child can use multiple 10cc NS syringes for rapid infusion.

Table 6. Knowledge Questions- Correct Responses

Variable Name	n	Percentage
Recommended Initial Dose		
10-20 mL/kg	48	82.8%
Pressure Bag and Non-Power CVL		
FALSE	30	51.7%
Level 1 Rapid Infuser IV gauge		
20g	40	69.0%
Methods Requiring Air Removal from IV Bag (Mechanical Infuser, Push-Pull, Pressure Bag)		
Total % Correct	15	25.9%
Signs Fluid Volume Overload (Increased work of breathing, hypoxemia, distention jugular vein)		
Total % Correct	2	3.44%

Appendices

Appendix 1: Survey Questions:

Demographic Questions:

1. How many years of experience do you have working in the pediatric ED setting?

a. <2 years

b. 2-5 years

c .6-10 years

d. >10 years

2. How would you describe your pediatric fluid resuscitation experience?

a. None or minimal

b. Some

c. Experienced

d. Very experienced

3. How would you describe your knowledge of how to accurately perform pediatric rapid fluid resuscitation?

a. Not knowledgeable

b. Somewhat knowledgeable

c. Knowledgeable

d. Very knowledgeable

4. What is your highest nursing educational degree obtained?

a. Associate's degree

b. Bachelor’s degree

c. Master’s degree

d. Doctorate degree

5. Do you have a professional certification (check all that apply)?

a. CPN

b. CEN

c. CPEN

d. Other

Knowledge Questions

6. According to the Society of Critical Care Medicine and the policies at BCH, the recommended initial dose of fluid that should be administered to a pediatric patient requiring rapid fluid resuscitation is:

a. 30 mL/kg

b. 10-20 mL/kg

c. 40 mL/kg

d. 25 mL/kg

7. What factors do you consider when selecting a fluid resuscitation method (i.e., pressure bag, push-pull, Level 1)? Select all that apply:

a. Comfort level with the method

b. Availability of equipment

c. ease of device use

d. Staffing

e. Fluid resuscitation guidelines (ACCM, SCCM, PALS, etc.)

f. IV gauge

g. Patient's weight

g. None of the above

h. Other: please explain

8. True or False: A patient with a non-power central venous line (CVL) can receive fluid resuscitation via a pressure bag?

a. True

b. False

9. For a Level 1 rapid infuser to be utilized, the patient must weigh greater than 20 kg AND have at least a _____ gauge IV placed.

a. 24 gauge

b. 22 gauge

c. 18 gauge

d. 20 gauge

10. Before using which methods of fluid resuscitation is it required that the air is removed from the bag of fluid? (select all that apply)

a. Mechanical rapid infuser

b. Syringe push-pull with 3 way stop cock connected to IV tubing

c. Pressure bag

d. Large-volume pump

11. Which of the following signs would indicate the patient is experiencing fluid volume overload? (select all that apply)

a. an increase in work of breathing

b. capillary refill less than 3 seconds

c. Hypoxemia

d. Jugular vein distention

e. Pulses +2

f. Third spacing of fluid

Please rate how knowledgeable you are with the following:

1= Very knowledgeable 2=Some knowledge 3=No knowledge

	1	2	3
12. I know how to properly use a pressure bag for rapid fluid resuscitation.			
13. I know how to use the Level 1 Rapid Infuser.			
14. I know how to use the push-pull method of fluid administration.			
15. I know how to remove air from an IV bag prior to pressure infusion.			
16. I understand the risks associated with rapid fluid resuscitation.			
17. I understand our institution's guidelines based on the PALS and SCCM fluid resuscitation guidelines.			

Please answer the following questions based on your knowledge about each method of fluid resuscitation. (Select all that apply)

18. Please indicate which of the following factors you consider when using the disconnect-reconnect method for rapid fluid resuscitation are:

a. Staffing resources since this method requires two nurses

b. Risk for contamination and infection

c. IV gauge

d. Potential for air emboli

e. I don't have enough knowledge about this method

f. No concerns

g. Other: please explain

19. Please indicate which of the following factors you consider when using the push-pull technique for rapid fluid resuscitation are:

a. Too slow to administer fluids
b. Operator fatigue
c. IV gauge
d. Risk for contamination and infection
e. I don't have enough knowledge about this method
f. No concerns
g. Other: please explain

20. Please indicate which of the following factors you consider when using IV pumps for rapid fluid resuscitation are:

a. The maximum rate of 999 ml/hr
b. Can't achieve necessary guidelines unless patient weighs less than 16 kg
c. IV gauge
d. I don't have enough knowledge about this method
e. No concerns
f. Other: please explain

21. Please indicate which of the following factors you consider when using the pressure bag method for rapid fluid resuscitation are:

a. Requiring frequent attention to ensure the bag is not over or underinflated
b. Difficult to know exactly how much fluid is given
c. Difficult to use on intraosseous (IO) access

d. IV gauge
e. Can only be used on power central venous access lines/devices
f. I don't have enough knowledge about this method
g. No concerns
h. Other: please explain

22. Please indicate which of the following factors you consider when using a mechanical rapid infuser for rapid fluid resuscitation are:

a. No adjustment of fluid rate
b. Fluid overload
c. Staffing resources-usually requires two people to set it up
d. IV gauge
e. Patient weight
f. Challenge to set-up
g. I don't have enough knowledge about this method
h. No concerns
i. Other: please explain

23. Are there any recommendations you have regarding how to best accomplish pediatric rapid fluid resuscitation?

_____

_____

Appendix 2-Recruitment Flyer

Emergency Department Nurse's Knowledge and Attitudes of Rapid Pediatric Fluid Resuscitation

What is the purpose of this survey?: There is currently limited evidence evaluating nurse's knowledge and attitudes of rapid pediatric fluid resuscitation. This study aims to describe this and the demographics of participating nurses.

Who can participate?: Any ED RNs who have successfully completed orientation

What am I asked to do?: Participants will complete a 23 question survey which will take approximately 20-25 minutes to complete. Please check your email for the survey link and more information,

What do we gain?: Participation in this foundational study will help us understand nurses knowledge and attitudes of fluid resuscitation

**This study is being completed by Tannah O'Brien, a student nurse for partial fulfillment of UNH Nursing Honors Program. For more information: Contact Katie Sultan, Denise Downey, Allison Ivers, or Tannah O'Brien*

Appendix 3- Email sent to nurses

Hello Nurses!

My name is Tannah O'Brien and I am in my last semester of nursing school at the University of New Hampshire. I am completing my honors research study here in the ED and I would really appreciate your participation in my project titled Emergency Department Nurse's Knowledge and Attitudes of Rapid Pediatric Fluid Resuscitation. Any registered nurse in the BCH ED who has completed orientation may participate. This study has been reviewed by the Nursing Science Review Committee at BCH and has been approved by the BCH and UNH IRBs. This study is being mentored by Debra Lajoie JD, PhD, MSN, RN, Katie Sultan BSN, RN, CPEN, Denise Downey, MSN, RN-BC, CPEN, and Allison Ivers, MSN, RN, CNL.

The purpose of this study is to understand and describe emergency department nurse's knowledge and attitudes of fluid resuscitation and describe the characteristics on aggregate of the nurses who participate in the study. Information from this foundational study will inform the development of interventions to improve rapid fluid resuscitation in pediatric emergency departments.

If you would like to participate in my research, please click the link below to access the REDCap survey. This 23-question survey was developed to evaluate nursing's knowledge, attitudes and perceived barriers to rapid pediatric fluid resuscitation as well as to collect information to describe the sample of nurses who participated. It will take approximately 20-25 minutes to complete. Any answers provided will be confidential and responses will be reported in aggregate. We will not attempt to identify individual nurses.

(INSERT LINK)

Thank you for your consideration and if you have any questions, please don't hesitate to reach out to Katie Sultan BSN, RN, CPEN, Denise Downey, MSN, RN-BC, CPEN, Allison Ivers, MSN, RN, CNL, or Tannah O'Brien.

Sincerely,

Tannah O'Brien

Tannah.obrien@childrens.harvard.edu

508-231-7002

Appendix 4- Research Information Sheet

Boston Children's Hospital

RESEARCH INFORMATION SHEET

Protocol Title: **Pediatric Emergency Department Nurse's Knowledge and Attitudes of Pediatric Fluid Resuscitation**

Principal Investigator:
Tannah O'Brien SN
Debra Lajoie, JD, PhD, MSN, RN

What is the purpose of the study?

- This study will describe emergency department nurse's knowledge and attitudes of fluid resuscitation, and the characteristics of the nurses who participate in the study. We will use this foundational information to guide the development of future studies and to inform practice.

How are individuals selected for this research study? How many will participate?

- Any ED nurse at BCH who has successfully completed orientation is eligible to participate in this research study.

What do I have to do if I'm in the study?

- If you wish to participate, please click on the study link received by email.
- Participation in this study will take approximately 20-25 minutes.
- By entering the study, you are consenting to use data for analysis and dissemination.
- All of the data collected will be summarized and reported in aggregate.

What are the risks of this research study?

- We anticipate that the only risk would be a minimal risk of a breach of confidentiality. This risk will be mitigated by storing the de-identified data behind the BCH firewall on a password protected computer.

What are the benefits of this research study?

- Participation in this study helps to understand nurse's knowledge and attitudes of rapid fluid resuscitation to inform practice and guide future studies.

What will happen with the information obtained as part of this research study? What about confidentiality?

- Any information that is collected will be de-identified and reported in aggregate.
- The information we collect will be stored in a password protected database behind the BCH firewall. Only members of the research team will know the password to the protected database.

If I do not want to take part in this research study, what are the other choices?

- This study is voluntary. You may withdraw from this study anytime.
- However, once we collected the completed survey, we will not be able to remove this from the study because we will not be able to identify the individual.
- Refusal to participate will not interfere with your work at Children's Hospital.

Who should I contact if I have questions?

If you have general questions about this research, you can contact Debra Lajoie (Debra.Lajoie @ childrens.harvard.edu.)

If you have questions about your rights as a research subject, any research-related concerns or complaints, or if you want to speak with someone other than the researchers, you can call the Institutional Review Board (IRB) Office at (617) 355-7052.

If you have questions about your rights as a research subject, you can contact Melissa McGee in UNH Research Integrity Services at 603-862-2005 or melissa.mcgee@unh.edu to discuss them

How will the Confidentiality of my study records be reported?

The confidentiality of all data associated with your participation in this study will be maintained as described above. There are, however, rare instances when we may be required to share information with the following

- People from agencies and organizations that provide regulatory and ethical oversight of research (Including officials at the University of New Hampshire, where the PI is a student).
- Sponsors or others involved in funding the research.

You should be aware that the federal privacy rule does not cover all of these possible uses. This means that once some of the above-mentioned users receive your information, they do not have to follow the same rules. Other laws may or may not protect sharing of private health information. If you have a question about this, you may contact the Children's Hospital Privacy Officer at (617) 355-5502.

To help protect the confidentiality of your information, as described above, any information that is collected will be de-identified and reported in aggregate, including as part of the PI's UNH Honors' Thesis. The information we collect will be stored in a password protected database only accessible to members of the research team.
The data will be destroyed per the BCH study records retention policy.

You have the right to withdraw from this study at any time before de-identified information is collected. At that time, we will not be able to identify the nurse who has completed the pre/posttests or the demographic data.

Acknowledgement of Information Sheet and Data Use

Language to be attached to REDCap survey link:

I understand that by clicking this button to enter the survey, I consent to participate in this study.

Appendix 5- Content Validity Index Table sent to ED Nursing Experts

Dear ED Nursing Fluid Resuscitation Experts,

Thank you for agreeing to help with my pre- and post-test questions.
I have developed pre- and post-test questions guided by the literature, representative of the relevant population using Katie Sultan's previous work (used with permission), and expert recommendations. I am asking your expert input to complete a Content Validity Index to determine whether the questions are relevant to the topic of interest, are clear to the reader, are simple, and lack ambiguity

Please score each question using the Likert scale provided in the table. With the information you provide, an analysis will be performed to determine the content validity index (CVI). Thank you for your time and support.

Sincerely,

Tannah O'Brien, SN UNH

Fluid Resuscitation Questions: Content Validity Index (Polit & Beck, 2006)

Content validity measure the variables of interest. Content validity is obtained from three sources: the literature, representatives of the relevant population, and experts.
Please score each of the pre-post questions using the scoring guide for relevance, clarity, simplicity, and ambiguity.

For each item rate:

Relevance:

1. **Not relevant**
2. **Item needs some revision**
3. **Relevant but needs minor revision**
4. **Very relevant**

Clarity

1. **Not clear**
2. **Item needs some revision**
3. **Clear but needs minor revision**
4. **Very clear**

Simplicity

1. **Not simple**
2. **Item needs some revision**
3. **Simple but needs minor revision**
4. **Very simple**

Ambiguity

1. **Doubtful**
2. **Item needs some revision**
3. **No doubt but needs minor revision**
4. **Meaning is clear**

Pre-post test questions:

Fluid Resuscitation

1. How many years of experience do you have working in the pediatric ED setting?

a. <2 years
b. 2-5 years
c .6-10 years
d. >10 years

2. How would you describe your pediatric fluid resuscitation experience?

a. None or minimal
b. Some
c. Experienced
d. Very experienced

3. How would you describe your confidence in your understanding of how to accurately perform pediatric rapid fluid resuscitation?
a. Not confident
b. Somewhat confident
c. Confident
d. Very confident

4. What is your highest nursing educational degree obtained?
a. Associate's degree
b. Bachelor's degree
c. Master's degree
d. Doctorate degree

5. Do you have a professional certification (check all that apply)?
a. CPN
b. CEN
c. Other

6. According to the American College of Critical Care Medicine, the recommended amount of fluid that should be administered to a pediatric patient requiring rapid fluid resuscitation is:
a. 30 mL/kg
b. 20 mL/kg
c. 25 mL/kg
d. 40 mL/kg

7. The goal when treating pediatric shock is to administer:
a. 20 mL/kg within 30 minutes
b. 30 mL/kg within 60 minutes
c. 40 mL/kg within 40 minutes
d. 60 mL/kg within 60 minutes

8. With a large volume pump's maximum rate being 999 ml/hour, and the ACCM guideline recommending infusing fluid boluses of 20 mL/kg over 5 minutes, which patient would NOT be able to receive fluid boluses via the large volume pump?
a. A patient weighing 3.7 kg
b. A patient weighing 4.1 kg
c. A patient weighing 2.9 kg
d. A patient weighing 5.2 kg

9. For a Level 1 rapid infuser to be utilized, the patient must weigh greater than 20 kg AND have at least a _____ gauge IV placed.
a. 24 gauge
b. 22 gauge
c. 18 gauge

d. 20 gauge

10. Before using which methods of fluid resuscitation is it required that the air is removed from the bag of fluid? (select all that apply)
a. Mechanical rapid infuser
b. Push-pull
c. Pressure bag
d. disconnect-reconnect
e. Large-volume pump

11. When administering fluids rapidly, the patient should be reassessed for signs of adequate perfusion and for signs of fluid volume overload. Which of the following signs would indicate the patient is experiencing fluid volume overload? (select all that apply)
a. an increase in work of breathing
b. capillary refill less than 3 seconds
c. Hypoxemia as a result of pulmonary edema
d. Jugular vein distention
e. Pulses +2

12. Please rate your confidence level with the following questions:
I understand how to properly use a pressure bag for rapid fluid resuscitation.
1= Always 2=Sometimes 3=Never

13. I feel confident in my understanding of using the Level 1 Rapid Infuser.
1= Always 2=Sometimes 3=Never

14. I feel confident in my understanding of using the push-pull method of fluid administration.
1= Always 2=Sometimes 3=Never

15. I feel confident in my understanding of how to remove air from an IV bag prior to pressure infusion.
1= Always 2=Sometimes 3=Never

16. I understand the risks associated with rapid fluid resuscitation.
1= Always 2=Sometimes 3=Never

17. I understand the PALS and ACCM fluid resuscitation guidelines.
1= Always 2=Sometimes 3=Never

Appendix 6- Content Validity Index

Question	Relevance	Clarity	Simplicity	Ambiguity
1	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0
6	0.5	0.5	0.5	0.5
7	0.75	0.75	0.75	0.75
8	0.5	0.5	0.5	0.5
9	1.0	1.0	1.0	1.0
10	0.75	0.75	0.75	0.5
11	1.0	0.75	0.75	0.75
12	1.0	1.0	1.0	1.0
13	1.0	1.0	1.0	1.0
14	1.0	1.0	1.0	1.0
15	1.0	1.0	1.0	1.0
16	1.0	1.0	1.0	0.5
17	0.75	0.75	0.5	0.5

Overall CVI- 0.82
portion of items scoring >0.75 out of all items- 56/68=0.82