ARTICLE IN PRESS

Journal of Pediatric Surgery xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

An in-situ simulation-based educational outreach project for pediatric trauma care in a rural trauma system

Lilly Bayouth [a], Sarah Ashley [b], Jackie Brady [c], Bryan Lake [c], Morgan Keeter [c], David Schiller [d], Walter C. Robey III [d], Stephen Charles [e], Kari M. Beasley [f], Eric A. Toschlog [a], Shannon W. Longshore [g,*]

[a] *Department of Surgery, Brody School of Medicine at East Carolina University, 600 Moye Blvd, Greenville, NC, USA*
[b] *Department of Emergency Medicine, Brody School of Medicine at East Carolina University, 600 Moye Blvd Greenville, NC, USA*
[c] *Department of Trauma, Vidant Medical Center, 2100 Stantonsburg Road 2ED, Greenville, NC, USA*
[d] *Clinical Simulation Program, Brody School of Medicine at East Carolina University, BSOM 1L-28, Greenville, NC, USA*
[e] *Department of Bioethics and Interdisciplinary Studies, Brody School of Medicine at East Carolina University, 600 Moye Blvd, Greenville, NC, USA*
[f] *Vidant Health Center for Research and Grants, Vidant Medical Center, Greenville, NC*
[g] *Division of Pediatric Surgery, Brody School of Medicine at East Carolina University, 600 Moye Blvd MA, 207, Greenville, NC, USA*

ARTICLE INFO

Article history:
Received 9 October 2017
Accepted 9 October 2017
Available online xxxx

Key words:
Simulation education
In-situ simulation
Pediatric trauma
Rural trauma

ABSTRACT

Background: Outcome disparities between urban and rural pediatric trauma patients persist, despite regionalization of trauma systems. Rural patients are initially transported to the nearest emergency department (ED), where pediatric care is infrequent. We aim to identify educational intervention targets and increase provider experience via pediatric trauma simulation.
Methods: Prospective study of simulation-based pediatric trauma resuscitation was performed at three community EDs. Level one trauma center providers facilitated simulations, providing educational feedback. Provider performance comfort and skill with tasks essential to initial trauma care were assessed, comparing pre-/postsimulations. Primary outcomes were: 1) improved comfort performing skills, and 2) team performance during resuscitation.
Results: Provider comfort with the following improved (p-values $<$0.05): infant airway, infant IV access, blood administration, infant C-spine immobilization, chest tube placement, obtaining radiographic images, initiating transport, and Broselow tape use. The proportion of tasks needing improvement decreased: 42% to 27% (p-value = 0.001). Most common deficiencies were: failure to obtain additional history (75%), beginning secondary survey (58.33%), log rolling/examining the back (66.67%), calling for transport (50%), calculating medication dosages (50%).
Conclusions: Simulation-based education improves provider comfort and performance. Comparison of patient outcomes to evaluate improvement in pediatric trauma care is warranted.
Level of evidence rating: IV.

Traumatic injury, whether accidental, intentional, or related to violent crime remains the leading cause of death in children ages 0–17 years [1]. Despite the regionalization of trauma systems and numerous advances in the care of the injured patient, outcome disparities between urban and rural pediatric trauma patients persist [2,3]. Approximately 90% of injured children will not receive care at a pediatric trauma center or children's hospital owing to limited resources, distance, and a regional absence of pediatric surgeons and/or specialists [4]. For the aforementioned reasons, rural pediatric trauma patients are often taken to the nearest emergency department (ED) for initial workup and stabilization, rather than the ED appropriately equipped to provide the best care specific to the pediatric trauma patient's needs. For the majority of these facilities, pediatric emergency care, especially with respect to trauma, is a low-frequency event. Correspondingly, it is challenging for staff to maintain the skills necessary for efficient and successful response to pediatric trauma activations. In this high-stakes genre of emergency medicine, coordinated and effective teamwork is critical; however, the multidisciplinary teams responding to trauma activations are rarely composed of the same people. As a result of staff turnover and shift scheduling systems, it is likely

* Corresponding author at: 600 Moye Blvd MA 207, Greenville, NC, 27834. Tel.: +1 252 744 2832; fax: +1 252 744 3457.
E-mail addresses: bayouthl14@ecu.edu (L. Bayouth), ashleysa14@ecu.edu (S. Ashley), Jaqueline.brady@vidanthealth.com (J. Brady), james.lake@vidanthealth.com (B. Lake), morgan.keeter@vidanthealth.com (M. Keeter), schillerd15@ecu.edu (D. Schiller), robeyw@ecu.edu (W.C. Robey), charless16@ecu.edu (S. Charles), Kari.Beasley@vidanthealth.com (K.M. Beasley), toschloge@ecu.edu (E.A. Toschlog), longshores@ecu.edu (S.W. Longshore).

https://doi.org/10.1016/j.jpedsurg.2017.10.042
0022-3468/

that some providers have not worked together in the setting of a high-acuity trauma resuscitation [5].

Existing standardized resuscitation courses, such as Pediatric Advanced Life Support (PALS), offer minimal education in pediatric trauma care. Numerous studies have demonstrated the utility of in situ simulation-based training as both a tool for assessment and educational intervention with respect to trauma team function, efficacy, communication, and overall improvement in the delivery of early trauma care [6–9]. In addition, partnerships between academic and community hospitals have been shown to improve outcomes in pediatric trauma care [10].

The aims of this study were: 1) to identify targets for educational intervention at three of this academic level 1 trauma center's highest volume referral community EDs serving rural Eastern North Carolina, and 2) to increase provider experience via pediatric trauma simulations and debriefings led by our trauma care providers.

1. Materials and methods

1.1. Sample selection

The trauma registry was queried to identify which three hospitals have historically provided the highest number of pediatric trauma patient referrals to this level one trauma center. The three centers that had referred the most trauma patients were chosen with the intention of improving care delivered to the greatest number of potential future patients. These hospitals were selected from a list of nineteen, non-trauma, rural hospitals that refer to this trauma center within the Eastern designation of the North Carolina Trauma Regional Advisory Committee (NCRAC) map. Three hospitals were chosen as this represents a manageable number to pilot the simulation and allow for timely follow-up visits. Hospital representatives were contacted and contracts signed to agree to participate in the pediatric trauma simulation. In order to maintain the privacy of the providers, the participating institutions will be referred to as hospitals A, B, and C.

1.2. Pediatric trauma simulations

The trauma outreach coordinator contacted the hospital representative for each participating hospital to coordinate a planned visit. The representative subsequently arranged for two teams to each participate in one simulation per visit. Consent was obtained for video recording of the simulations. The high-fidelity mannequins utilized were SimBaby and SimJunior (Laerdal, Stravanger, Norway). In situ simulations using high fidelity mannequins were performed in the outreach hospital's ED resuscitation bay. SimView (Laerdal, Stravanger, Norway) was used to record the simulation and to perform the debrief. The participating hospitals utilized their actual equipment and potential teams they would normally have available when treating a pediatric trauma patient presenting to their facility. The same two prescripted vignettes were performed at each of the three hospitals. A second visit for reassessment was performed at a later date, during which two new prescripted vignettes were presented. Providers present and working at the time of each site visit were invited to participate at random and grouped randomly, an accurate representation of the method of assembly of a rural trauma team. For this reason, many participants from the second site visit had not participated in the simulations during the initial visit. A video debrief was performed following each scenario. This allowed participants to review their performance as a group in conjunction with visiting providers from this level one trauma center. Areas of excellence, as well as areas needing improvement, were identified.

The following clinical vignettes were presented at the initial visit:

A 5 month old boy arrived in the ED via local EMS. The mother returned from the grocery store and found him difficult to arouse. Her boyfriend had been babysitting and denied any reason for his condition. The mother describes a bruise on the right side of his head.

A 7 year old girl, who was an unrestrained backseat passenger, was found unresponsive with a GCS of 3 at the scene of a rollover, single motor vehicle crash. Per EMS, bleeding is noted from her head with fluid draining from her right ear.

The following clinical vignettes were presented at subsequent visit:

A 5 year old boy involved in a head on collision, who was appropriately restrained and found in his booster seat is brought to the ED. He has no obvious signs of injuries. He has been alert and oriented the entire time with stable vital signs.

A 7 year old boy sustained a gunshot wound to the right flank while sleeping in his bed. He is heavily crying, but alert and oriented. On arrival his SBP is 130, HR 120. He has received 300 ml of normal saline.

The teams were briefed as to the educational objectives of the session and provided an overview of simulation and the mannequin, what would be expected of the team, and the history and initial clinical presentation. The team was instructed to proceed as though it were a real pediatric trauma patient.

1.3. Evaluation

The primary outcomes of this prospective simulation-based study were: 1) improved comfort performing skills, and 2) team performance during resuscitation. Three methods of evaluation were used: 1) a pre- and postsimulation survey was administered to evaluate provider comfort with the performance of 13 resuscitative skills, 2) an assessment tool [11] was utilized to score each simulation on performance of tasks essential to initial trauma stabilization, and 3) focus groups were conducted to assess what was gained from participation in the simulation visits.

Pre- and posttest surveys using a five-point Likert scale, ranging from "1 = very uncomfortable" to "5 = extremely comfortable," assessed provider comfort performing 13 specific skills (Tables 1 and 2). The surveys were administered to each provider that participated in the simulation. Independent t-tests were performed comparing mean survey responses, pre- and postsimulation for both initial and second visits.

An assessment tool, previously used in the evaluation of more than one-third of North Carolina's EDs with respect to simulation pediatric trauma codes, was utilized to score each simulation video on thirty-six tasks essential to successful initial trauma stabilization care. The tool as previously published by Hunt et al. evaluates forty-four tasks [11]. The tasks not appropriate to the simulation vignettes used in this study were removed to create an adapted version of the assessment tool (Table 3). Simulation videos were all scored by a nurse, an ED physician, and a surgeon. A dichotomous score of "meets expectations" or "needs improvement" was recorded. Scores for each facility at initial

Table 1
Survey completed by participants to assess existing comfort level with performance of pediatric resuscitation tasks prior to simulation.

Please rate the following with your level of comfort, 1–5. 1 is no experience/very uncomfortable, 5 is extremely comfortable/expert.					
Infant Airway	1	2	3	4	5
Child Airway	1	2	3	4	5
Infant IV	1	2	3	4	5
Infant IO	1	2	3	4	5
Child IV	1	2	3	4	5
Child IO	1	2	3	4	5
Fluid Selection/Administration	1	2	3	4	5
Blood Administration	1	2	3	4	5
Infant C-Spine Immobilization	1	2	3	4	5
Pediatric Chest Tube Placement	1	2	3	4	5
Obtaining Radiographic Images	1	2	3	4	5
Initiating Transport	1	2	3	4	5
Use of Broselow Tape	1	2	3	4	5

Please cite this article as: Bayouth L, et al, An in-situ simulation-based educational outreach project for pediatric trauma care in a rural trauma system, J Pediatr Surg (2017), https://doi.org/10.1016/j.jpedsurg.2017.10.042

Table 2
Survey completed by participants to assess comfort level with performance of pediatric resuscitation tasks after simulation and educational feedback session.

Please rate the following after completion of The Rural Pediatric Trauma Simulation Program today: 1 is very uncomfortable, 5 is extremely comfortable.					
Infant Airway	1	2	3	4	5
Child Airway	1	2	3	4	5
Infant IV	1	2	3	4	5
Infant IO	1	2	3	4	5
Child IV	1	2	3	4	5
Child IO	1	2	3	4	5
Fluid Selection/Administration	1	2	3	4	5
Blood Administration	1	2	3	4	5
Infant C-Spine Immobilization	1	2	3	4	5
Pediatric Chest Tube Placement	1	2	3	4	5
Obtaining Radiographic Images	1	2	3	4	5
Initiating Transport	1	2	3	4	5
Use of Broselow Tape	1	2	3	4	5

and subsequent visits were compared to evaluate for improvement. Areas of deficiency were identified as a focus for future simulations.

Following completion of the two simulation visits at each hospital, a third visit was arranged to conduct focus groups. Each facility provided a minimum of four participants of the prior in vivo simulations, with at least one ED physician and one nurse, to join in the focus group session. To maintain consistency between the three referring hospitals, a written script consisting of eight questions relating to the pediatric trauma case vignettes was constructed. The questions were in relation to the following topics: provider perception of teamwork, key takeaway points from the simulations, comfort levels with assessed tasks, communication, and resultant changes in practice. The focus group sessions, which lasted between 45 and 60 min, were voice recorded for review at a later date. Analysis was performed by an independent reviewer, who identified themes present amongst the focus group responses. The frequencies of these themes were then calculated.

Table 3
Assessment form for simulation video scoring using a dichotomous scoring rubric: Meets Expectations (ME), Needs Improvement (NP), not applicable to the scenario (NA).

As you review the videos please use the following check list to grade the trauma activation: Meets Expectations (ME), Needs Improvement (NP) and not applicable to the scenario (NA). The hospitals we visited are not trauma centers and cannot admit children.			
Primary Survey	ME	NP	NA
recognizes urgency of the problem	ME	NP	NA
assumes universal precautions	ME	NP	NA
evaluates airway patency, respiratory rate, and quality of breathing	ME	NP	NA
identifies potential c-spine injury and applies collar	ME	NP	NA
applies oxygen	ME	NP	NA
assesses circulatory status using correct anatomic landmarks	ME	NP	NA
assesses level of consciousness	ME	NP	NA
exposes the patient	ME	NP	NA
applies appropriate warming measures	ME	NP	NA
uses Broselow tape during primary survey	ME	NP	NA
estimates correct weight	ME	NP	NA
Secondary Survey			
assesses vital signs, place on monitor	ME	NP	NA
obtains additional history	ME	NP	NA
begins head to toe exam	ME	NP	NA
examines head	ME	NP	NA
examines face	ME	NP	NA
examines neck	ME	NP	NA
examines shoulder	ME	NP	NA
examines chest	ME	NP	NA
examines upper extremities	ME	NP	NA
examines abdomen	ME	NP	NA
examines pelvis	ME	NP	NA
examines lower extremities	ME	NP	NA
log rolls child appropriately	ME	NP	NA
examines back	ME	NP	NA
Procedures/General Management			
obtains IV access; if unavailable within 90 s or 3 failed attempts moves to IO	ME	NP	NA
prep for IO, used landmarks and syringe for medication	ME	NP	NA
orders correct fluid bolus (20cm^3/kg)	ME	NP	NA
orders appropriate labs (CBC, type and cross)	ME	NP	NA
orders appropriate imaging (CXR and/or KUB)	ME	NP	NA
calls for transport within 5 min of patient's arrival	ME	NP	NA
recognizes indications to intubate	ME	NP	NA
intubates successfully	ME	NP	NA
places chest tube using correct size and landmarks	ME	NP	NA
uses correct weight to dose medications	ME	NP	NA
uses appropriate medications for sedation/pain/intubation	ME	NP	NA

2. Theory

Prior research has demonstrated that rural trauma patients are at risk for increased mortality when compared to urban trauma patients suffering from similar injuries. Outcome disparities between urban and rural pediatric trauma patients persist, likely secondary to limited resources, distance to appropriate pediatric trauma centers, and a lack of pediatric surgeons and/or specialists available in the rural region [2–4]. Using the 2009–2013 Nationwide Emergency Department Sample, Peng et al., reported that 21.7% of pediatric major trauma patients were under triaged; furthermore, children living in rural areas were more likely to be under triaged [12]. Less than 10% of injured children are cared for at a children's hospital or pediatric trauma center; they are most often taken to the nearest ED for initial work up and stabilization. At facilities where pediatric emergency care is a low-frequency event, staff may not have sufficient opportunities to maintain the skills necessary to provide dynamic and proficient care during pediatric trauma activations [4]. Rural physicians, when compared to urban physicians, report a greater need for continuing medical education regarding pediatric emergency procedures [13].

High quality trauma care significantly improves mortality. Given the need for coordinated and timely execution of care during trauma resuscitation, the high-stakes nature of this field, minimal opportunities for pediatric trauma education within currently offered resuscitative courses, and the lower number of pediatric patients seen in nonpediatric facilities and rural settings, implementation of team-training and pediatric trauma care concepts as well as an opportunity to review this procedure is of utmost importance [14–16].

3. Results

3.1. Study population

Vidant Medical Center is the only pediatric trauma center within the Eastern North Carolina RAC. Out of 310 total pediatric trauma encounters for 2016, 189 pediatric trauma patients were received in transfer to this level one trauma center. Participating hospitals A, B, and C provided 14.3%, 9.5%, and 3.2% of these pediatric trauma transfers, respectively. Ninety-nine emergency medicine ED health care providers from hospitals A, B, and C participated in this study. The study cohort consisted of 19 MDs, 65 RNs, 5 RRTs, and 10 other providers (including nursing students, nursing assistants, and advanced practice practitioners). There were no resident physician participants. All MD participants were fully credentialed in their specialties. While levels of provider experience vary by a wide range of individual years of practice and prior work environments, none have had recent or formal pediatric trauma education, outside of residency training and practitioner schooling. There was no additional pediatric trauma education provided between visits and during enrollment of this study.

3.2. Survey analysis by stabilization task

The initial site visits at all three facilities produced higher mean responses postsimulation, demonstrating a perceived improvement in

Please cite this article as: Bayouth L, et al, An in-situ simulation-based educational outreach project for pediatric trauma care in a rural trauma system, J Pediatr Surg (2017), https://doi.org/10.1016/j.jpedsurg.2017.10.042

comfort level for all assessed skills. Results of the independent t-test analysis of the pre- and postsimulation survey responses for all site visits are reported with corresponding p-values at 95% confidence intervals for the thirteen skills evaluated (Table 4). Comfort performing the following eight tasks showed statistically significant improvement: management of the infant airway, infant IV access, blood product administration, infant C-spine immobilization, pediatric chest tube placement, obtaining indicated radiographic images, identifying need for a higher level of care and initiating transport to this level one trauma center, and appropriate use of the Broselow tape.

3.3. Simulation video evaluation

Analysis of the scored videos, with respect to team performance, found that the proportion of tasks that needed improvement per simulation was initially 42%. This value improved to 27% during a second visit. A Chi-Square test of independence indicated a significant association between the visits and simulation score categories ($p\text{-value} = 0.001$). The frequency that a task needed improvement amongst simulation sessions is reported in Table 5. Deficiencies most common amongst all simulations were as follows: failure to obtain additional history (75%), beginning the secondary survey exam (58.33%), log rolling appropriately and examining the back (66.67%), calling for transport within 5 min (50%), and calculating appropriate medication dosages (50%).

3.4. Postsimulation focus group

Analysis of forty-three comments taken from focus group discussions demonstrate an emergence of the following dominant themes in order of descending frequency: (1) participants used the simulation scenarios to improve teamwork (23.26%), (2) participant confidence levels increased in handling pediatric traumas (16.28%), (3) participants changed their behavior based upon reflection of performance during simulation scenarios (13.95%), (4) communication between the level one trauma center and regional hospitals has improved (13.95%), (5) participants remembered their mistakes made during the simulation (4.65%). Samples of the participant comments reflective of the corresponding themes are as follows: (1) "Teamwork has improved, especially with people you haven't worked with before," (2) "I feel more confident [in pediatric trauma care]. Some of the new RNs also feel the same;" (3) "I've been able to use the pediatric imaging study information;" (4) "Putting a face to who we talk to really helps and is very beneficial. This helps build trust with the ER team and the trauma team. It's made it easier and more comfortable to reach out;" (5) "I made a mistake by not using the stylet with the ET tube and didn't use a c-collar." "I remember lack of communication and forgetting to talk to the patient."

Table 5
The percentage of simulations from all site visits, both pre- and postsimulation, where the video evaluated simulation task scored as "needs improvement" is reported.

Simulation Task	(%) Needs Improvement
recognizes urgency of the problem	33
assumes universal precautions	16.67
evaluates airway patency, respiratory rate, and quality of breathing	8.33
identifies potential c-spine injury and applies collar	8.33
applies oxygen	16.67
assesses circulatory status using correct anatomic landmarks	33
assesses level of consciousness	8.33
exposes the patient	8.33
applies appropriate warming measures	8.33
uses Broselow tape during primary survey	16.67
estimates correct weight	16.67
assess vital signs, place on monitor	0
obtains additional history	75
begins head to toe exam	58.33
examines head	33.33
examines face	58.33
examines neck	75
examines shoulder	66.67
examines chest	50
examines upper extremities	66.67
examines abdomen	33.33
examines pelvis	66.67
examines lower extremities	66.67
log rolls child appropriately	66.67
examines back	66.67
obtains IV access; if unavailable within 90 s or 3 failed attempts moves to IO	16.67
prep for IO, used landmarks and syringe for medication	0
orders correct fluid bolus (20 cm^3/kg)	25
orders appropriate labs (CBC, type and cross)	33.33
orders appropriate imaging (CXR and/or KUB)	25
calls for transport within 5 min of patient's arrival	50
recognizes indications to intubate	41.67
intubates successfully	8.33
places chest tube using correct size and landmarks	8.33
uses correct weight to dose medications	25
uses appropriate medications for sedation/pain/intubation	50

4. Discussion

Recent studies targeting improvement in pediatric trauma care using in situ trauma simulations followed by a debriefing, have demonstrated positive results. Our data corroborate these prior findings, by showing that providers perceive individual improvement postsimulation. These studies report successful translation of team-oriented skills including effective communication and efficiency [17–19]. Our data show that participants reported improvement in communication both within the immediate members of the emergency care team, as well as between hospital systems; specifically, this level one trauma center and the corresponding referral hospitals. Community

Table 4
T-test analysis of mean survey responses with respect to both pre- and postsimulation provider task comfort levels at all site visits is reported with the corresponding task listed. Tasks that demonstrated statistically significant improvement in provider comfort level following simulation are highlighted with p-value <0.05.

Simulation Task	Degrees of freedom (df)	Presimulation mean	Postsimulation mean	t-statistic t(df)	p-value
Infant Airway	10	2.43	3.27	−1.872	**0.046**
Child Airway	10	2.55	3.27	−1.515	0.080
Infant IV	10	2.78	3.53	−1.911	**0.043**
Infant IO	10	2.33	3.29	−1.684	0.062
Child IV	10	3.34	3.68	−1.096	0.150
Child IO	10	2.47	3.33	−1.604	0.070
Fluid Selection/Administration	10	3.31	3.8	−1.293	0.113
Blood Administration	10	2.98	3.7	−2.010	**0.036**
Infant C-Spine Immobilization	10	2.96	3.91	−2.394	**0.019**
Pediatric Chest Tube Placement	10	1.93	3.02	−2.101	**0.031**
Obtaining Radiographic Images	10	2.83	3.67	−2.234	**0.025**
Initiating Transport	10	3.29	3.95	−1.925	**0.042**
Use of Broselow Tape	10	3.48	4.22	−2.341	**0.021**

Please cite this article as: Bayouth L, et al, An in-situ simulation-based educational outreach project for pediatric trauma care in a rural trauma system, J Pediatr Surg (2017), https://doi.org/10.1016/j.jpedsurg.2017.10.042

outreach projects to provide specialty education to local healthcare providers have been shown to have a positive impact on interaction and collaboration between care providers [20]. Participants cite a potential for early and improved communication with our trauma center in the future when caring for the infrequent pediatric trauma patient. As this level one trauma center is the only tertiary referral center available to the participating hospitals, the mean number of referrals is not expected to change with study participation, but overall communication between providers at participating referring hospitals and this trauma center will improve. Immediate improvement in provider comfort with respect to communication with our trauma providers is evident in the aforementioned focus group responses.

Overall, the simulation-based outreach to the three participating community EDs was well received by our study subjects. In addition to reporting individual improvement in comfort level when caring for pediatric trauma patients, our study participants cited changes in their medical practice and improvement in teamwork, implemented between site visits. Of the nineteen hospitals that refer pediatric trauma patients, these three participating hospitals provide nearly 30% of our total annual transfer patients. The rationale for targeting the three hospitals that provided the largest percentage of our referred pediatric trauma patients, was to increase the quality of care provided prior to transfer and to decrease the greatest number of performance improvement errors seen. While these numbers would be too small to measure a significant difference at this time, outcomes measures will be followed as participation in the study is opened to other hospitals within the Eastern North Carolina RAC.

As this study is partially survey based, our data are subject to researcher and response bias. While simulation is increasingly becoming a popular tool in medical education for infrequent and high-risk events such as trauma resuscitation, we are unable to conclude whether these simulations are sufficiently realistic. Furthermore, we cannot say whether a participant's performance during a simulation reflects how he/she would perform during a real pediatric trauma resuscitation. Another limitation of this study lies in the selection of participants. Given the volume of providers in the emergency departments, their varying schedules, and turnover of locum tenens providers at these facilities, we were unable to assemble the same participants for both site visit simulations. Specifically, one institution had no return participants. The other two hospitals each had three return participants; both facilities had two returning RNs and one returning MD. Although a significant limitation of the study that may skew the data, it is an accurate representation of the rural trauma team. The effectiveness of simulation education in a setting with high provider turnover is evident in the improvement in perceived comfort level with an overall increase in mean response when comparing the pre- and postsimulation surveys for the first and second site visits. We postulate that this improvement is a result of participants practicing and sharing their new skills/knowledge obtained at simulation. Upon review of the focus group responses, some of the participants reported circulating through their emergency departments and amongst colleagues the practice management guidelines and PowerPoint presentation previously reviewed by the level one trauma center staff during the educational postsimulation debriefing. It is important to note that participants underwent no other formal pediatric trauma education outside of these site visits.

5. Conclusions

This study used simulation to identify and correct deficiencies in stabilization of children presenting to referring rural EDs. Our data show that simulation-based education improves both provider comfort and performance. Community education and outreach improves relationships and communication with local health providers. Expansion of this project to include participation of the remaining sixteen referring rural hospitals should be pursued. Educational opportunities should be expanded via additional simulation vignettes based upon performance gaps identified and distinguished as critical errors and those simply needing improvement. Additional instruction and simulation should be provided to participants based on these distinctions. We postulate that this simulation-based training project will improve future pediatric trauma patient care and potentially help to reduce the cost of care in Eastern North Carolina. A follow up study comparing patient outcomes and healthcare costs, prior to and after implementation of this simulation project, is warranted.

Funding

This work was supported by The Childress Institute for Pediatric Trauma.

References

[1] Centers for Disease Control and Prevention. Ten leading causes of death and injury. Centers for Disease Control and Prevention; 2016[Web. 02 Feb. 2017].
[2] Petrosyan M, Guner YS, Emami CN, et al. Disparities in the delivery of pediatric trauma care. J Trauma 2009;67(2 Suppl.):S114–9. https://doi.org/10.1097/TA.0b013e3181ad3251.
[3] Jarman MP, Castillo RC, Carlini AR, et al. Rural risk: geographic disparities in trauma mortality. Surgery 2016;160(6):1551–9. https://doi.org/10.1016/j.surg.2016.06.020 [Epub 2016 Aug 6].
[4] Densmore JC, Lim HJ, Oldham KT, et al. Outcomes and delivery of care in pediatric injury. J Pediatr Surg 2006;41:92–8.
[5] Snyder CL, Jain VN, Saltzman DA, et al. Blunt trauma in adults and children: a comparative analysis. J Trauma 1990;30:1239–45.
[6] Steinemann S, Berg B, DiTullio A, et al. Assessing teamwork in the trauma bay: introduction of a modified "NOTECHS" scale for trauma. Am J Surg 2012;203:69–75.
[7] Amiel I, Simon D, Merin O, et al. Mobile in situ simulation as a tool for evaluation and improvement of trauma treatment in the emergency department. J Surg Educ 2016;73:121–8.
[8] Falcone Jr RA, Daugherty M, Schweer L, et al. Multidisciplinary pediatric trauma team training using high-fidelity trauma simulation. J Pediatr Surg 2008;43:1065–71.
[9] Steinemann S, Berg B, Skinner A, et al. In situ, multidisciplinary, simulation-based teamwork training improves early trauma care. J Surg Educ 2011;68:472–7.
[10] Kelley-Quon LI, Crowley MA, Applebaum H, et al. Academic-community partnerships improve outcomes in pediatric trauma care. J Pediatr Surg 2015;50:1032–6.
[11] Hunt EA, Hohenhaus SM, Luo X, et al. Simulation of pediatric trauma stabilization in 35 North Carolina emergency departments: identification of targets for performance improvement. Pediatrics 2006;117(3):641–8.
[12] Peng J, Wheeler K, Groner JI, et al. Undertriage of pediatric major trauma patients in the United States. Clin Pediatr (Phila) 2017. https://doi.org/10.1177/0009922817709553 [9922817709553, Epub ahead of print].
[13] Curran V, Rourke L, Snow P. A framework for enhancing continuing medical education for rural physicians: a summary of the literature. Med Teach 2010;32(11):e501–8.
[14] Sethi D, Racioppi F, Baumgarten I, et al. Reducing inequalities from injuries in Europe. Lancet 2006;368(9554):2243–50.
[15] Esposito TJ, Sanddal ND, Dean JM, et al. Analysis of preventable pediatric trauma deaths and inappropriate trauma care in Montana. J Trauma 1999;47(2):243–53.
[16] Patterson MD, Blike GT, Nadkarni VM. In situ simulation: challenges and results. In: Henriksen K, Battles JB, Keyes MA, et al, editors. Advances in patient safety: new directions and alternative approaches. Performance and toolsRockville (MD): Agency for Healthcare Research and Quality (US); 2008.
[17] Lehner M, Heimberg E, Hoffmann F, et al. Evaluation of a pilot project to introduce simulation-based team training to pediatric surgery trauma room care. Int J Ped 2017;2017. https://doi.org/10.1155/2017/9732316.
[18] Burke RV, Demeter NE, Goodhue CJ, et al. Qualitative assessment of simulation-based training for pediatric trauma resuscitation. Surgery 2017;161(5):1357–66.
[19] Lin Y, Cheng A. The role of simulation in teaching pediatric resuscitation: current perspectives. Adv Med Educ Pract 2015;6:239–48.
[20] Luckstead-Gosdin A, Vinson L, Greenwell C, et al. Caring for kids bridging gaps in pediatric emergency care through community education and outreach. Crit Care Nurs Clin North Am 2017;29:143–55. https://doi.org/10.1016/j.cnc.2017.01.002.

Please cite this article as: Bayouth L, et al, An in-situ simulation-based educational outreach project for pediatric trauma care in a rural trauma system, J Pediatr Surg (2017), https://doi.org/10.1016/j.jpedsurg.2017.10.042