

Pediatric Emergency Care Research Networks: A Research Agenda

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ABSTRACT

Background: Pediatric emergency care research networks have evolved substantially over the past two decades. Some networks are specialized in specific areas (e.g., sedation, simulation) while others study a variety of medical and traumatic conditions. Given the increased collaboration between pediatric emergency research networks, the logical next step is the development of a research priorities agenda to guide global research in emergency medical services for children (EMSC).

Objectives: An international group of pediatric emergency network research leaders was assembled to develop a list of research priorities for future collaborative endeavors within and between pediatric emergency research networks.

Methods: Before an in-person meeting, we used a modified Delphi approach to achieve consensus around pediatric emergency research network topic priorities. Further discussions took place on May 15, 2018, in Indianapolis, Indiana, at the *Academic Emergency Medicine (AEM)* consensus conference “Aligning the Pediatric Emergency Medicine Research Agenda to Reduce Health Outcome Gaps.” Here, a group of 40 organizers and participants met in a 90-minute “breakout” session to review and further develop the initial priorities.

Results: We reached consensus on five clinical research priorities that would benefit from collaboration among the existing and future emergency networks focused on EMSC: sepsis, trauma, respiratory conditions, pharmacology of emergency conditions, and mental health emergencies. Furthermore, we identified nonclinical research priorities categorized under the domains of technology, knowledge translation, and organization/administration of pediatric emergency care.

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Conclusion: The identification of pediatric emergency care network research priorities within the domains of clinical care, technology, knowledge translation and organization/administration of EMSC will facilitate and help focus collaborative research within and among research networks globally. Engagement of essential stakeholders including EMSC researchers, policy makers, patients, and their caregivers will stimulate advances in the delivery of emergency care to children around the globe.

In a series of three seminal reports on the state of emergency services in the United States, the National Academies of Science, Engineering, and Medicine (NASEM) concluded that the system was fragmented, overburdened, and desperately in need of reform.^{1–3} Importantly, the report on the state of emergency medical services for children (EMSC) identified that pediatric emergency services are particularly vulnerable for several reasons including a workforce inadequate to meet the unique needs of children, lack of appropriate equipment in emergency departments (EDs) and inattention to research focused on critically ill and injured children.^{1–4} One of NASEM's recommendations focused on the importance of improving the evidence base and highlighted the fact that no single emergency medical services (EMS) agency or ED is likely to have adequate numbers of critically ill or injured children to answer important clinical questions pertaining to the care of this vulnerable population. This is not only seen in the United States, but is also a worldwide issue.⁵

Pediatric research networks focused on specific conditions/diseases (e.g., Children's Oncology Group)⁶ or populations (e.g., Neonatal Research Network)⁷ have been particularly successful in generating evidence regarding low-frequency/high-impact conditions. Several global networks pertaining to research in EMSC have developed and matured over the past two decades,^{8–15} and evidence generated by both U.S. and non-U.S.-based EMSC research networks has substantially improved the emergency care for critically ill and injured children worldwide.^{8–19} These networks share the common goal of improving care for children with emergency conditions, while individual research networks' organizational structures and research priorities are appropriately focused on regional and national needs. Recently, the Pediatric Emergency Research Networks (PERN),²⁰ a "network of pediatric emergency networks" developed a platform to conduct EMSC research on a global level. Given the number of EMSC research networks and the presence of a truly global structure (PERN), a logical next step is to develop a global research agenda to guide EMSC research.

The 2018 *Academic Emergency Medicine* (AEM) Consensus Conference on "Aligning the Pediatric Emergency Medicine Research Agenda to Reduce Health Outcome Gaps" provided a unique opportunity to bring together representatives from individual pediatric emergency care research networks and to obtain input from patient representatives to develop consensus-driven global research priorities.²¹ Research agendas have been developed independently among many of the pediatric emergency care networks, but here we strive to bring together many networks.^{22–25} In this article, we describe the development process and the finalized research priorities list. We focus on identifying research topics that are ideal for networks to address and identify barriers that need to be overcome to facilitate collaboration among various emergency research networks and develop a broad list of topics that can guide priorities for global EMSC research. This includes high-frequency illnesses without adequate evidence to support current therapies and testing novel interventions for these high-frequency illnesses. Also, exploring low-frequency but high-impact conditions that need evidence to define epidemiology, facilitate identification, and substantiate interventions.

METHODS

The consensus conference was organized by two pediatric emergency care leaders (KD and PI) who developed a steering committee that oversaw the activities of five subcommittees: EMS, multicenter network research, education, workforce development, and PEM in non-children's hospitals.²⁶ The development of research priorities for multicenter networks was the charge of the pediatric emergency care research network subcommittee led by three pediatric emergency medicine physicians and investigators (MS, PM, NK). Among them, the leaders of the subcommittee represented the Pediatric Emergency Medicine Collaborative Research Committee (PEM CRC)¹² of the American Academy of Pediatrics, the Pediatric Emergency Care Applied Research Network (PECARN),¹⁰ and the PERN.²⁰ A workgroup was created consisting of 11

Table 1
Synopsis of Represented Pediatric Emergency Care Research Networks

Network Name	Year Founded	Locale	Funding and Focus
PECARN (Pediatric Emergency Care Applied Research Network)	2001	United States	High-priority federally funded research pertaining to acutely ill and injured children and requiring substantial research infrastructure
PEM CRC (Pediatric Emergency Medicine Collaborative Research Committee of the American Academy of Pediatrics)	Early 1990's	United States	Unfunded research pertaining to acutely ill and injured children
PERN (Pediatric Emergency Research Networks)	2009	Global	Meaningful and scientifically rigorous international collaborative research in pediatric emergency care for global health problems
PERC (Pediatric Emergency Research Canada)	1995	Canada	Creating knowledge through research involving clinical and epidemiologic studies in pediatric emergency medicine
PREDICT: (Paediatric Research in Emergency Departments International Collaborative)	2004	Australia and New Zealand	High-priority federally funded multicenter pediatric emergency care research
PERUKI (Paediatric Emergency Research in the United Kingdom & Ireland)	2012	England, Ireland, Northern Ireland, Scotland and Wales	Unfunded, and federal grant-funded, multicenter pediatric emergency care research
REPTEM (Research in European Pediatric Emergency Medicine)	2006	Europe and the Middle East	Unfunded pediatric emergency care research
P2 Network		Global	Building research collaborations and offering mentorship in pediatric point-of-care ultrasound
INSPIRE (International Network for Simulation-based Pediatric Innovation Research & Education)	2011	Global	Funded multicenter and multinational researchers, educators, and clinicians examining simulation as an educational intervention and leveraging simulation as a research environment to improve the care delivered to all neonates, infants, and children
RIDEPLA (Red de Investigación y Desarrollo de la Emergencia Pediátrica de Latinoamérica)	2011	Argentina, Uruguay, and Paraguay	Unfunded multicenter pediatric emergency care research
PSRC (Pediatric Sedation Research Consortium)	2003	United States	Federally funded research, focused on improving sedation practice through sharing of prospective observational outcome data on pediatric procedural sedation encounters
TREKK (Translating Emergency Knowledge for Kids)	2011	Canada	Federally and institutionally funded, focused on pediatric emergency medicine knowledge translation

Table 2
Research Priorities for Nonclinical Topics by Themes

Top 5 Ranked From Preconference Modified Delphi	Final Top 5 Ranked From AEM Consensus Conference
<i>Technology</i>	
<ol style="list-style-type: none"> 1. Study the use of telemedicine as a means of providing ED care to areas lacking PEM expertise, including impact on outcomes and cost effectiveness 2. Investigate the best methods of knowledge translation via use of the electronic health record 3. Study how to best use the electronic health record for predictive analytics 4. Investigate impact of bedside ultrasound on clinical outcomes of specific diseases (e.g., blunt abdominal trauma, resuscitation for intravascular volume status) 5. Investigate how do use precision medicine for emergency care through the use of electronic health record data 	<ol style="list-style-type: none"> 1. Study how to best use the electronic health record for predictive analytics 2. Machine learning 3. Telemedicine (provider to provider) 4. Simulation training 5. Clinical decision support via the electronic health record
<i>Knowledge Translation</i>	
<ol style="list-style-type: none"> 1. Evaluate how to identify priority topics for knowledge translation (KT) 2. Investigate how to use shared patient/parent decision making in network research 3. Develop KT strategies—how to use PEM research networks to best disseminate and implement evidence-based practice to all emergency care settings 4. Role of social media for KT 5. Exploring patient and family acceptance of medical practices across different cultures to anticipate barriers/success of implementation of new practices 	<ol style="list-style-type: none"> 1. Dissemination and implementation of evidence-based practice 2. Changing provider behavior—motivations and metrics 3. Evaluate how to identify priority topics for KT 4. Develop KT strategies—how to use PEM research networks to best disseminate and implement evidence-based practice to all emergency care settings 5. Investigate how best to use shared patient decision making in network research
<i>Organizational Research Topics (Regulatory, Administrative, and Collaboration)</i>	
<ol style="list-style-type: none"> 1. Network resource utilization and economies of scale between networks (Should we duplicate research studies to validate each other or “divide and conquer” pressing new research questions among networks?) 2. Exception from informed consent (EFIC) for time-sensitive enrollment of patients in the ED (when should we use EFIC, when is it not needed, can we do EFIC studies across networks across countries?) 3. Ethical considerations for multicenter studies within and across international boundaries 4. Research into cost efficiency of network research 5. Development of a standard PEM research training that can be shared among networks 6. Globalization—how to efficiently improve care in resource poor/constrained settings 	<ol style="list-style-type: none"> 1. Barriers to reporting clinical data, building diverse registries 2. Research collaboration between PEM, EMS, and non-PEM providers and dissemination of evidence from research 3. Network resource utilization and economies of scale between networks 4. Global identification of “top 5” research questions and collaboration to answer those questions 5. Exception from informed consent (EFIC) for time-sensitive enrollment of patients in the ED

Left column = Subcommittee priorities from the preconference modified Delphi; right column = final priorities developed at the AEM Consensus conference by the participants (participants had the results of the preconference modified Delphi prior to initiating. PEM = pediatric emergency medicine.

members who represented eight pediatric emergency care multicenter research networks around the globe including the PEM CRC, PECARN, PERN, Pediatric Emergency Research in the United Kingdom & Ireland (PERUKI),¹³ Pediatric Emergency Research Canada (PERC),¹⁴ P2Network,⁹ Pediatric Sedation Research Consortium (PSRC),¹¹ and Research in European Pediatric Emergency Medicine (REPEM).¹⁵ In addition, the main workgroup collaborated closely with many other members of global pediatric emergency care research networks (mentioned in the acknowledgments) who contributed to the

prioritization process and manuscript. A brief outline of the pediatric emergency care research networks is reported Table 1.

The preliminary work was completed remotely by the workgroup. Initially, open-ended input formed the four broad themes for the future direction of pediatric emergency care multicenter network research. These included 1) clinical care, 2) technology, 3) knowledge translation, and 4) organization/administration of pediatric emergency care.

After we achieved consensus around the above-mentioned four themes, we formed an expert panel that

included the 11 members of the workgroup and 10 other members of the PERN executive committee, representing many global pediatric emergency care research networks. We used the modified Delphi consensus method, which consisted of three rounds of electronic surveys to arrive at the preconference agenda with a preliminary list of research priorities, which was followed by an in-person meeting at the 2018 AEM consensus conference in Indianapolis, Indianapolis.^{21,27–29} The three rounds of surveys were performed using SurveyMonkey³⁰ to rate research priorities divided among the four broad themes. In the first round, we asked each survey recipient to rate each of 66 research priorities (in the four themes) from 1 to 5, with 1 representing the highest priority. Respondents were permitted to use each value as often as they felt was warranted. The survey also allowed the participants to offer suggestions to modify and/or add more topics to each theme. There was a 100% response rate from the 21-member expert panel for each of the three rounds. After the first round of the survey, the highest priority items (defined as being scored a 1 or 2 by at least 50% of those surveyed) were included in the next round of surveys. Additionally, comments were addressed and new items that were suggested were added to the subsequent survey. This resulted in 46 research priorities. The second round of the electronic survey proceeded in a similar fashion with the 46 questions divided among the four themes. This time, in addition to rating the 46 priorities, the participants were tasked to add to the list of clinical priorities. As in the previous round, the priorities that were rated the highest in each electronic survey (i.e., rated as 1 or 2 by at least 50% of the respondents) were retained on the priority list. In the second round, we eliminated nine priorities, but with the open-ended clinical additions, 67 priorities were considered in the third round, 47 of which were in the clinical care theme. The new clinical priorities from the second round's open-ended questions were ranked, and only the top 10 were kept. After the completion of the three rounds of surveys, a list of 47 research priority topics remained, 30 of which fell into the theme of clinical care. We focused the in-person AEM consensus conference on this list of 47 research priority topics. The priority list was distributed prior to the conference to the registered participants, allowing time for preparation.

At the AEM conference 40 total participants were involved in the pediatric emergency care research

network breakout. This included seven members of the workgroup plus 33 new participants. Among them was a member of the International Network for Simulation-based Pediatric Innovation Research & Education (INSPIRE)⁸ and a member of TRanslating Emergency Knowledge for Kids (TREKK).³¹ These were added as experts in technology and knowledge translation, respectively, to help guide the discussions during the breakout. The participants were divided evenly into four discussion groups, at separate tables, based on the four broad research themes identified by the expert panel: clinical, technology, knowledge translation, and organization/administration of pediatric emergency care. The consensus conference participants discussed individual priorities, further defined them, added or removed from the list after discussion, and finally ranked them in order of importance. Participants were given approximately 30 minutes for this process. Once these breakout subgroups completed their tasks, all participants regrouped and were allowed to review, add to, and rank the top 5 priorities from the themes from the other groups in which they had not originally been involved. Because the research priority list of clinical topics was more extensive than those in the other themes, participants were asked to identify their top 10 priorities within this subcategory (rather than only five as in the other themes). After analyzing the priority lists modified at the conference, we determined that there was consensus in three of the four themes, with the exception of research priorities on clinical care topics. Because of this, a fourth survey distributed among the original 21-member expert panel was required to achieve consensus on research priorities for the clinical topics. This was done after the conclusion of the consensus conference using REDCap electronic data capture tools.³²

STATEMENT OF OUTCOME GAPS

Within pediatric emergency care, we identified several clinical areas with “knowledge gaps” that could be addressed by coordinating research and collaborating to share limited resources at a global level. Examples include high-frequency illnesses without adequate evidence to support current therapies or testing novel interventions for these high-frequency illnesses. Also included in this group of network priorities are low-frequency conditions that have the potential for high morbidity without adequate or known therapy. During the process, we identified four broad areas for research

prioritization for pediatric emergency care research networks, which include clinical care, technology, knowledge translation, and organization/administration of pediatric emergency care. Many critical childhood illnesses are uncommon events, so only through open communication and the sharing of knowledge can these high-priority research topics in EMSC be adequately addressed.

RESEARCH PRIORITY/AGENDA ITEM

Consensus was achieved around the four broad themes/topics below that would benefit from collaboration between the current multicenter research networks. The following high-priority research themes were defined for each broad category and discussed with participants at the AEM consensus conference:

Clinical

Conditions with risk for high morbidity that lack sufficient evidence including sepsis, trauma, respiratory conditions, pharmacology of emergency conditions, and pediatric mental health issues in the ED. Using sepsis as an example, there are limited data on the optimal therapy for children with sepsis, leading to the consensus that sepsis should be a multicenter research priority. Networks should collaborate on such topics as sepsis, sharing knowledge and resources, so that, for example, one network can address novel therapies for pediatric sepsis and others can validate another networks findings. Following this, all networks can come together for global implementation of an intervention.

Technology

Several topics emerged under the umbrella of technology, such as how to apply new/emerging technology in the pediatric ED; how to teach technology to pediatric emergency care providers; how to research the impact of technology; and how to share technology. For example, point-of-care ultrasound (POCUS) is growing rapidly in the pediatric ED, but indications for its use and its application may differ between centers. In some networks POCUS may be used to study hydration and circulatory volume status, which can then be validated in another network. Certain aspects of POCUS may be applicable to certain networks. For example, FAST training could be of value to PEM sites that care for high volumes of pediatric trauma while POCUS for incision and drainage of abscesses

could be needed for certain other sites. This training in POCUS (education) or use of POCUS as an integral part of evaluation could be incorporated in a research network as a part of a project on implementation or knowledge translation.

Knowledge Translation

Under the category of knowledge translation, several topics emerged as important, including identifying differences between children's hospital EDs and community EDs in the translation of knowledge into practice; how to best disseminate information and evidence to all settings in which pediatric emergency care is provided; and after implementing change, how best to maintain these changes.

Organization/Administration of Pediatric Emergency Care

High-priority topics included how to best allocate resources, how best to collaborate in this area, best practices in data management, and ethical issues. Examples would include organization of network steering committees, best use of network infrastructure funding or lessons learned from issues pertaining to data transfer or institutional review boards, and informed consent.

A final list of nonclinical research priorities was created based on the preconference modified Delphi process and from input from participants at the AEM consensus conference as reported in Table 2. Five priorities were designated in each of the three nonclinical themes (technology, knowledge translation, and organization/administration of pediatric emergency care). A final electronic survey after the AEM conference with the 21 network members further refined the priorities within the clinical care category (Table 3). In addition, a list of 10 research priority topics was also ranked from a larger pool of miscellaneous topics proposed by both pediatric emergency care research network members and participants at the AEM consensus conference (Table 4).

CHALLENGES

In this document we describe the consensus process used to generate a priority list of pediatric emergency care research gaps that would benefit from research within and collaboration between pediatric emergency care research networks. Our aim is for these results to help focus the research agenda of pediatric emergency care networks globally. However, there are substantial

Table 3
Research Priorities of Clinical Topics

Sepsis
<ol style="list-style-type: none"> 1. Improving early identification of sepsis (age specific screening tool) 2. Working definition of sepsis in the emergency department 3. Does fluid choice (e.g., lactated Ringer's, Plasma-Lyte, 0.9% NS) impact sepsis outcomes? 4. Effectiveness of protocol-driven sepsis care 5. Effectiveness of "rules/criteria" embedded into electronic health records to improve care and outcomes (e.g., identification tools, order sets, and guidelines)
Trauma
<ol style="list-style-type: none"> 1. Head <ol style="list-style-type: none"> a. Severe head injury evaluation and treatment (penetrating trauma, skull fracture, intracranial hemorrhage) b. Concussion evaluation and treatment 2. Cervical spine <ol style="list-style-type: none"> a. Effect of immobilization on outcomes b. Radiologic assessment 3. Blunt torso trauma assessment
Respiratory emergencies
<ol style="list-style-type: none"> a. Pneumonia <ol style="list-style-type: none"> i. Evaluation and severity assessment ii. Management b. Bronchiolitis <ol style="list-style-type: none"> i. Management ii. Evaluation and severity assessment c. Asthma <ol style="list-style-type: none"> i. Best medications for acute exacerbation ii. Effectiveness/impact of asthma score/protocol driven care iii. Effectiveness of early non-invasive positive pressure
Pharmacology/sedation in pediatric emergency care
<ol style="list-style-type: none"> 1. Procedural sedation in the ED 2. Safety outcomes of medications 3. Pain and anxiety—acute treatment
Mental health
<ol style="list-style-type: none"> 1. Telemedicine for remote evaluation and treatment of adolescent mental health issues 2. Media effects on adolescent suicide risk 3. Impact of peer support on victims of violence

challenges to pursuing this agenda. Meaningful and impactful multicenter research requires federal research funding as well as private sector support. In the current fiscal environment of many countries, funding is a challenge to current and future pediatric emergency care research priorities

The inherent organization, infrastructure, and support of individual networks vary, posing barriers to collaboration among networks. Furthermore, aligning global networks with a common goal and bringing them together to address common conditions remains challenging, as each has unique goals and objectives. By aligning networks on overlapping priorities, similar

Table 4
Miscellaneous Research Priority Topics

<ol style="list-style-type: none"> 1. Delivery of evidence based medicine to the ED provider at the point of care. 2. Caring for the pediatric patient in a general ED setting. 3. Shared decision making and culturally related differences. 4. Reduction in inappropriate diagnostic imaging (e.g., Choosing Wisely). 5. Impact of scoring systems (e.g., asthma, sepsis) on outcomes. 6. Patient safety using multicenter quality improvement initiatives—effects on outcomes. 7. How to improve diagnosis/care of uncommon but severe conditions. 8. How do differences in health care systems impact care? Investigate methods to reduce variation and optimize care. 9. Disposition appropriateness—how best to study. 10. Individual studies using "omics" for advanced diagnosis and tailored therapies in the ED.
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to what PERN has done, will bridge this gap to better focus the research agenda and provide definitive answers to high-priority questions of global importance to the PEM community. Another challenge is sustaining interest by investigators in multicenter research given competing responsibilities and the limited funding and support each participating network investigator receives. Finally, we must determine how to enhance the interest and participation in pediatric emergency care research at non-children's hospitals and general EDs, where most acutely ill and injured children are evaluated and managed. Key to this will be the interest and engagement of local champions at each hospital and resources to enhance pediatric emergency care. While it is true that non-children's hospitals see the majority of pediatric patients nationally and globally, the number of pediatric patients at each individual ED is small. With limited resources available, alignment of electronic health records to populate databases that can be used and shared by networks and embed pediatric emergency care decision support are options. Another barrier is dissemination of information to these hospitals, which is an ongoing problem of knowledge translation. Again, use of the electronic health record for dissemination research is but one avenue for multicenter research in this area.

LIMITATIONS

Although the conference participants developed an important list of research priorities for pediatric emergency care research networks, the consensus process included a somewhat limited number of perspectives and individuals. We closely adhered to modified Delphi techniques, but this process has some inherent

variability and lack of formal structure. Attempts were made to represent as many pediatric emergency care research networks as possible by including investigators from around the globe, but it was not possible to capture input from every possible source of information or network. Research networks and priorities for EMSC research in non-/underrepresented geographical regions such as South America, Africa, or Asia were also not included.

CONCLUSION

We developed consensus around topics in pediatric emergency care that would benefit from multicenter collaborative research, with the top five clinical conditions being sepsis, trauma, respiratory conditions, pharmacology of emergency conditions, and mental health. Furthermore, we identified high-priority nonclinical issues categorized under the domains of technology, knowledge translation, and organization/administration of pediatric emergency care that should be explored by EMSC researchers, policy makers, and other stakeholders to advance the global research agenda.

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