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Pediatric Emergency Care Research Networks: A Research Agenda

Author line:

Michael J. Stoner, MD, Prashant Mahajan, MD, MPH, MBA, Silvia Bressan, MD, PhD, Samuel H. F. Lam, MD, MPH, Corrie E. Chumpitazi, MD, MS, Aaron E. Kornblith, MD, Seth W. Linakis, MD, MA, Damian Roland, BMedSci, BMBS, MRCPCH, PhD, Stephen B. Freedman, MDCM, MSc, Lise E. Nigrovic, MD, MPH, Kurt Denninghoff, MD, Paul Ishimine, MD, Nathan Kuppermann, MD, MPH

Abstract

Background: Pediatric emergency care research networks have evolved substantially over the past 2 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

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30 discussions took place on May 15, 2018 in Indianapolis, Indiana at the Academic
31 Emergency Medicine (AEM) consensus conference “*Aligning the Pediatric Emergency
32 Medicine Research Agenda to Reduce Health Outcome Gaps.*“ Here, a group of 40
33 organizers and participants met in a 90-minute “breakout” session to review and further
34 develop the initial priorities.

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

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

47 48 **Background/Introduction**

49 In a series of three seminal reports on the state of emergency services in the United
50 States, the National Academies of Science, Engineering and Medicine (NASEM)
51 concluded that the system was fragmented, overburdened and desperately in need of
52 reform.¹⁻³ Importantly, the report on the state of Emergency Medical Services for
53 Children (EMSC) identified that pediatric emergency services are particularly vulnerable
54 for several reasons including a workforce inadequate to meet the unique needs of
55 children, lack of appropriate equipment in emergency departments (EDs) and inattention
56 to research focused on critically ill and injured children.¹⁻⁴ One of NASEM’s
57 recommendations focused on the importance of improving the evidence base and
58 highlighted the fact that no single emergency medical services (EMS) agency or ED is
59 likely to have adequate numbers of critically ill or injured children to answer important

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60 clinical questions pertaining to the care of this vulnerable population. This is not only
61 seen in the United States, but is a worldwide issue.⁵

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

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

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92 **Methods**

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The consensus conference was organized by two pediatric emergency care leaders (KD & PI) who developed a steering committee that oversaw the activities of five subcommittees: emergency medical services (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 Pediatric Emergency Research Networks (PERN)²⁰. A workgroup was created consisting of 11 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, P2Network⁹, 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 acknowledgements) who contributed to the prioritization process and manuscript. A brief outline of the pediatric emergency care research networks is reported Table 1.

113

The preliminary work was completed remotely by the workgroup. Initially, open-ended input formed the 4 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.

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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

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122 agenda with a preliminary list of research priorities, which was followed by an in-person
123 meeting at the 2018 AEM Consensus conference in Indianapolis, IN.^{21,27-29} The three
124 rounds of surveys were performed using SurveyMonkey©³⁰ to rate research priorities
125 divided among the four broad themes. In the first round, we asked each survey recipient
126 to rate each of 66 research priorities (in the 4 themes) from 1-5, with 1 representing the
127 highest priority. Respondents were permitted to use each value as often as they felt was
128 warranted. The survey also allowed the participants to offer suggestions to modify and/or
129 add more topics to each theme. There was a 100% response rate from the 21 member
130 expert panel for each of the three rounds. After the first round of the survey, the highest
131 priority items (defined as being scored a 1 or 2 by at least 50% of those surveyed) were
132 included in the next round of surveys. Additionally, comments were addressed and new
133 items that were suggested were added to the subsequent survey. This resulted in 46
134 research priorities. The second round of the electronic survey proceeded in a similar
135 fashion with the 46 questions divided among the 4 themes. This time, in addition to rating
136 the 46 priorities, the participants were tasked to add to the list of clinical priorities. As in
137 the previous round, the priorities that were rated the highest in each electronic survey (i.e.
138 rated as 1 or 2 by at least 50% of the respondents) were retained on the priority list. In
139 the second round, we eliminated 9 priorities, but with the open-ended clinical additions,
140 67 priorities were considered in the third round, 47 of which were in the clinical care
141 theme. The new clinical priorities from the second round's open-ended questions were
142 ranked, and only the top 10 were kept. After the completion of the 3 rounds of surveys, a
143 list of 47 research priority topics remained, 30 of which fell into the theme of clinical
144 care. We focused the in-person AEM consensus conference on this list of 47 research
145 priority topics. The priority list was distributed prior to the conference to the registered
146 participants, allowing time for preparation.

147 At the AEM conference 40 total participants were involved in the pediatric
148 emergency care research network breakout. This included seven members of the
149 workgroup plus 33 new participants. Among them was a member of the International
150 Network for Simulation-based Pediatric Innovation Research & Education (INSPIRE)⁸
151 and a member of TRanslating Emergency Knowledge for Kids (TREKK)³¹. These were
152 added as experts in technology and knowledge translation, respectively, to help guide the

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153 discussions during the breakout. The participants were divided evenly into four
154 discussion groups, at separate tables, based on the four broad research themes identified
155 by the expert panel: clinical, technology, knowledge translation and
156 organization/administration of pediatric emergency care. The Consensus Conference
157 participants discussed individual priorities, further defined them, added or removed from
158 the list after discussion, and finally ranked them in order of importance. Participants were
159 given approximately 30 minutes for this process. Once these breakout subgroups
160 completed their tasks, all participants regrouped and were allowed to review, add to and
161 rank the top 5 priorities from the themes from the other groups in which they had not
162 originally been involved. Because the research priority list of clinical topics was more
163 extensive than those in the other themes, participants were asked to identify their top ten
164 priorities within this subcategory (rather than only five as in the other themes). After
165 analyzing the priority lists modified at the conference, we determined that there was
166 consensus in 3 of the 4 themes, with the exception of research priorities on clinical care
167 topics. Because of this, a 4th survey distributed among the original 21 member expert
168 panel was required to achieve consensus on research priorities for the clinical topics. This
169 was done after the conclusion of the consensus conference using REDCap electronic data
170 capture tools.³²

173 **Statement of Outcome Gaps**

174 Within pediatric emergency care, we identified several clinical areas with “knowledge
175 gaps” that could be addressed by coordinating research and collaborating to share
176 limited-resources at a global level. Examples include high frequency illnesses without
177 adequate evidence to support current therapies, or testing novel interventions for these
178 high frequency illnesses. Also included in this group of network priorities are low
179 frequency conditions that have the potential for high morbidity without adequate or
180 known therapy. During the process, we identified 4 broad areas for research prioritization
181 for pediatric emergency care research networks, which include Clinical care; Technology,
182 Knowledge Translation, and Organization/administration of pediatric emergency care.
183 Many critical childhood illnesses are uncommon events, so only through open

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184 communication and the sharing of knowledge, can these high-priority research topics in
185 EMSC be adequately addressed.

186

187 **Research Priority/Agenda Item**

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

- 192 • *Clinical:* Conditions with risk for high morbidity that lack sufficient evidence including
193 sepsis, trauma, respiratory conditions, pharmacology of emergency conditions and
194 pediatric mental health issues in the ED. Using sepsis as an example, there are limited
195 data on the optimal therapy for children with sepsis, leading to the consensus that sepsis
196 should be a multicenter research priority. Networks should collaborate on such topics as
197 sepsis, sharing knowledge and resources, so that, for example, one network can address
198 novel therapies for pediatric sepsis and others can validate another networks findings.
199 Following this, all networks can come together for global implementation of an
200 intervention.
- 201 • *Technology:* Several topics emerged under the umbrella of Technology, such as how to
202 apply new/emerging technology in the pediatric ED; how to teach technology to
203 pediatric emergency care providers; how to research the impact of technology; and how
204 to share technology. For example, point of care ultrasound (POCUS) is growing rapidly
205 in the pediatric ED, but indications for its use and its application may differ between
206 centers. In some networks POCUS may be used to study hydration and circulatory
207 volume status, which can then be validated in another network. Certain aspects of
208 POCUS may be applicable to certain networks. For example, FAST training could be of
209 value to PEM sites that care for high volumes of pediatric trauma while POCUS for
210 incision and drainage of abscesses could be needed for certain other sites. This training
211 in POCUS (education) or use of POCUS as an integral part of evaluation could be
212 incorporated in a research network as a part of a project on implementation or
213 knowledge translation.

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- 214 • *Knowledge translation*: Under the category of Knowledge Translation, several topics
215 emerged as important, including identifying differences between children’s hospital EDs
216 and community EDs in the translation of knowledge into practice; how to best
217 disseminate information and evidence to all settings in which pediatric emergency care is
218 provided; after implementing change, how best to maintain these changes.
- 219 • *Organization/administration of pediatric emergency care*: High-priority topics included
220 how to best allocate resources; how best to collaborate in this area; best practices in data
221 management; ethical issues. Examples would include organization of network steering
222 committees, best use of network infrastructure funding or lessons learned from issues
223 pertaining to data transfer or IRBs and informed consent.

224

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

234

235 **Challenges**

236 In this document we describe the consensus process used to generate a priority list
237 of pediatric emergency care research gaps that would benefit from research within and
238 collaboration between pediatric emergency care research networks. Our aim is for these
239 results to help focus the research agenda of pediatric emergency care networks globally.
240 However, there are substantial challenges to pursuing this agenda. Meaningful and
241 impactful multicenter research requires federal research funding as well as private sector
242 support. In the current fiscal environment of many countries, funding is a challenge to
243 current and future pediatric emergency care research priorities

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244 The inherent organization, infrastructure and support of individual networks vary,
245 posing barriers to collaboration among networks. Furthermore, aligning global networks
246 with a common goal and bringing them together to address common conditions remains
247 challenging, as each has unique goals and objectives. By aligning networks on
248 overlapping priorities, similar to what PERN has done, will bridge this gap to better focus
249 the research agenda and provide definitive answers to high-priority questions of global
250 importance to the PEM community. Another challenge is sustaining interest by
251 investigators in multicenter research given competing responsibilities and the limited
252 funding and support each participating network investigator receives. Finally, we must
253 determine how to enhance the interest and participation in pediatric emergency care
254 research at non-children's hospitals and general EDs, where most acutely ill and injured
255 children are evaluated and managed. Key to this will be the interest and engagement of
256 local champions at each hospital and resources to enhance pediatric emergency care.
257 While it is true that non-children's hospitals see the majority of pediatric patients
258 nationally and globally, the number of pediatric patients at each individual ED is small.
259 With limited resources available, alignment of electronic health records to populate
260 databases that can be used and shared by networks, and embed pediatric emergency care
261 decision support are options. Another barrier is dissemination of information to these
262 hospitals, which is an ongoing problem of knowledge translation. Again, use of the
263 electronic health record for dissemination research is but one avenue for multicenter
264 research in this area.

266 **Limitations**

267 Although the conference participants developed an important list of research priorities for
268 pediatric emergency care research networks, the consensus process included a somewhat
269 limited number of perspectives and individuals. We closely adhered to modified Delphi
270 techniques, but this process has some inherent variability and lack of formal structure.
271 Attempts were made to represent as many pediatric emergency care research networks as
272 possible by including investigators from around the globe, but it was not possible to
273 capture input from every possible source of information or network. Research networks

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274 and priorities for EMSC research in non/under-represented geographical regions such as
275 South America, Africa, or Asia were also not included.

276

277 **Conclusion**

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

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Affiliations:

- 380 • The Division of Emergency Medicine, Department of Pediatrics, Nationwide Children's
381 Hospital, The Ohio State University College of Medicine; Columbus (M.J.S. & S.W.L.)
- 382 • Department of Emergency Medicine, CS Mott Children's Hospital of Michigan,
383 University of Michigan Medical School, Ann Arbor (P.M.)
- 384 • Division of Pediatric Emergency Medicine, Department of Women's and Children's
385 Health, University of Padova, Italy (S.B.)
- 386 • Department of Emergency Medicine, Sutter Medical Center Sacramento, Sacramento
387 (S.H.F.L.)
- 388 • Section of Emergency Medicine, Baylor College of Medicine, Houston (C.E.C.)
- 389 • Department of Emergency Medicine and Pediatrics, University of California, San
390 Francisco (A.E.K.)
- 391 • SAPPHERE Group, Health Sciences, Leicester University, Leicester, UK & Paediatric
392 Emergency Medicine Leicester Academic (PEMLA) group, Children's Emergency
393 Department, Leicester Hospitals, UK (D.R.)
- 394 • Sections of Pediatric Emergency Medicine and Gastroenterology, Department of
395 Pediatrics, Alberta Children's Hospital and Alberta Children's Hospital Research
396 Institute, Cumming School of Medicine, University of Calgary (S.B.F)

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- 397 • Division of Emergency Medicine, Boston Children's Hospital; Boston (L.E.N.)
- 398 • Department of Emergency Medicine, University of Arizona College of Medicine; Tucson
- 399 (K.D.)
- 400 • Departments of Emergency Medicine, University of California, San Diego School of
- 401 Medicine; San Diego (P.I.)
- 402 • Departments of Emergency Medicine and Pediatrics, University of California, Davis,
- 403 School of Medicine, and UC Davis Health, Sacramento (N.K.)

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Table 1: Synopsis of Represented Pediatric Emergency Care Research Networks

Network Name	Year Founded	Locale	Funding & Focus
<u>PECARN:</u> (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
<u>PEM CRC:</u> (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
<u>PERN:</u> (Pediatric Emergency Research Networks)	2009	Global	Meaningful and scientifically rigorous international collaborative research in pediatric emergency care for global health problems
<u>PERC:</u> (Pediatric Emergency Research Canada)	1995	Canada	Creating knowledge through research involving clinical and epidemiological studies in pediatric emergency medicine
<u>PREDICT:</u> (Paediatric Research in Emergency Departments International Collaborative)	2004	Australia and New Zealand	High-priority federally funded multicenter pediatric emergency care research

Table 1: Synopsis of Represented Pediatric Emergency Care Research Networks

<u>PERUKI:</u> (Paediatric Emergency Research in the United Kingdom & Ireland)	2012	England, Ireland, Northern Ireland, Scotland & Wales	Unfunded, and federal grant funded, multicenter pediatric emergency care research
<u>REPEM:</u> (Research in European Pediatric Emergency Medicine)	2006	Europe and the Middle East	Unfunded pediatric emergency care research
<u>P2 Network:</u>		Global	Building research collaborations and offering mentorship in pediatric point-of-care ultrasound
<u>INSPIRE:</u> (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.
<u>RIDEPLA:</u> (Red de Investigación y Desarrollo de la Emergencia Pediátrica de Latinoamérica)	2011	Argentina, Uruguay and Paraguay	Unfunded multicenter pediatric emergency care research
<u>PSRC:</u> (Pediatric Sedation	2003	United States	Federally-funded research, focused on improving sedation

Table 1: Synopsis of Represented Pediatric Emergency Care Research Networks

Research Consortium)			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

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Table 2 – Research priorities for non-clinical topics by themes

Technology	
Top 5 ranked from Pre-conference modified-Delphi	Final Top 5 ranked from AEM Consensus Conference
<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, etc.) 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
Knowledge Translation	
Top 5 ranked from Pre-conference modified-Delphi	Final Top 5 ranked from AEM Consensus Conference
<ol style="list-style-type: none"> 1. Evaluate how to identify priority topics for knowledge translation (KT) 	<ol style="list-style-type: none"> 1. Dissemination and implementation of evidence-based practice

<ol style="list-style-type: none"> 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"> 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
Organizational Research Topics (Regulatory, Administrative and Collaboration)	
Top 5 ranked from Pre-conference modified-Delphi	Final Top 5 ranked from AEM Consensus Conference
<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 	<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

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
5. Globalization - how to efficiently improve care in resource poor/constrained settings

5. Exception from informed consent (EFIC) for time-sensitive enrollment of patients in the ED

- Left column - Subcommittee priorities from the pre-conference modified-Delphi.
- Right column - Final priorities developed at the AEM Consensus conference by the participants.
 - Participants had the results of the pre-conference modified-Delphi prior to initiating.

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Table 3 – Research priorities of clinical topics

Clinical Research Priorities
1. 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 (ex. identification tools, order sets & guidelines)
2. 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
3. Respiratory emergencies
<ol style="list-style-type: none"> a. <u>Pneumonia</u> <ol style="list-style-type: none"> a) Evaluation and severity assessment b) Management b. <u>Bronchiolitis</u> <ol style="list-style-type: none"> a) Management b) Evaluation and severity assessment c. <u>Asthma</u> <ol style="list-style-type: none"> a) Best medications for acute exacerbation

b) Effectiveness/impact of asthma score/protocol driven care c) Effectiveness of early non-invasive positive pressure
4. Pharmacology/Sedation in pediatric emergency care
1. Procedural sedation in the emergency department 2. Safety outcomes of medications 3. Pain and anxiety – acute treatment
5. Mental Health
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

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Table 4 – Miscellaneous Research Priority Topics

Miscellaneous Research Priorities
<ol style="list-style-type: none">1. Delivery of evidence based medicine to the ED provider at the point of care2. Caring for the pediatric patient in a general ED setting3. Shared decision making and culturally related differences4. Reduction in inappropriate diagnostic imaging (e.g. Choosing Wisely)5. Impact of scoring systems (ex. asthma, sepsis) on outcomes6. Patient safety using multicenter quality improvement initiatives – effects on outcomes7. How to improve diagnosis/ care of uncommon but severe conditions8. How do differences in health care systems impact care? Investigate methods to reduce variation and optimize care.9. Disposition appropriateness – how best to study10. Individual studies using “omics” for advanced diagnosis and tailored therapies in the ED