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ORIGINAL RESEARCH

The Pediatric Emergency Research Network (PERN): A decade of global research cooperation in paediatric emergency care

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Abstract

Objectives: The Pediatric Emergency Research Network (PERN) was launched in 2009 with the intent for existing national and regional research networks in paediatric emergency care to organise globally for the conduct of collaborative research across networks.

Methods: PERN has grown from five to eight member networks over the past decade. With an executive committee comprising representatives from all member networks, PERN plays a supportive and collaborative rather than governing role. The full impact of PERN's facilitation of international collaborative research, although somewhat difficult to quantify empirically, can be measured indirectly by the observed growth of the field, the nature of the increasingly challenging research questions now being addressed and the collective capacity to generate and implement new knowledge in treating acutely ill and injured children.

Results: Beginning as a pandemic response studying H1N1 influenza risk factors in children, PERN research has progressed to multiple observational studies and ongoing global randomised controlled trials (RCTs). As a recent example, PERN has developed sufficient network infrastructure to enable the rapid initiation of a prospective observational study in response to the current COVID-19 pandemic.

Conclusions: Following its success with developing global research, the PERN goal now is to promote the implementation of scientific advances into everyday clinical practice by: (i) expanding the capacity for global RCTs; (ii) deepening the focus on implementation science; (iii) increasing attention to healthcare disparities; and (iv) expanding PERN's reach into resource-restricted regions. Through these actions, PERN aims to meet the needs of acutely ill and injured children throughout the world.

Key words: *healthcare disparities, health equity, implementation, multicentre randomised controlled trials, paediatric emergency medicine.*

Key findings

- PERN has evolved significantly from conducting retrospective case control studies to global randomised controlled trials.
- PERN has been a research-ready network that has been able to respond rapidly to study the current COVID-19 pandemic.
- The future will involve more global randomised controlled trials, implementation work, and focus on healthcare equity to ensure acutely ill and injured children around the work can benefit from new research findings.

Introduction

Conducting high-quality research in paediatric care offers unique challenges related to the nature of the population and the diseases encountered in the hospital or clinic. Serious paediatric conditions may be uncommon and require extended, consistent care (e.g. cancers or metabolic disorders), or they may be relatively common and require a patient to be seen only once (e.g. bronchiolitis, gastroenteritis, or acute injury). Regardless, generating sample sizes with sufficient statistical power to establish a clinical effect in treating any paediatric condition is difficult. Paediatric emergency care researchers have long understood the power of collaboration and multicentre studies (both retrospective and prospective) in meeting these challenges. National and regional networks have emerged in paediatric emergency care research over the past few decades, facilitating the conduct of multicentre studies. These have supported the recruitment of sufficient participants from diverse populations and resulted in research studies with adequate precision and generalisability. In spite of these advances the individual networks have made in researching how to best treat acutely ill and injured children, there was a clear need to generate and generalise research evidence beyond the possibilities afforded by the existing geographically focused networks.

In October 2009, representatives of the five existing national and regional research networks in paediatric emergency care around the globe met as part of the international standards initiative known as StaR Child Health.[1] The objectives of the meeting were (i) to learn about each network's mission, goals, infrastructure and challenges; (ii) to share important contributions each network had made to the creation of new knowledge; (iii) to discuss best practices to improve each network's effectiveness; and (iv) to explore the potential for a collaborative research project as proof of concept for the inception of a global network of networks in paediatric emergency care research.[2] This inaugural meeting of the Pediatric Emergency Research Network (PERN; https://pern-global.com/) demonstrated a common desire for high-quality research and its dissemination to improve health and outcomes of acutely ill and injured children and youth throughout the world. Beginning as a pandemic response with a high-quality retrospective case-controlled study of H1N1 risk factors for severe disease,[3] PERN research has progressed to global randomised controlled trials (RCTs)[4,5] and an invigorated network infrastructure to enable the rapid launch of a prospective observational study in response to the current COVID-19 pandemic.[6] On the occasion of Emergency Medicine Day (https://emergencymedicine-day.org/what-is-em-day/campaign-theme) and more than a decade into our existence, we review PERN's successes and challenges. Here we present a model for ongoing international collaboration in addressing global health issues in paediatric emergency care research along with a vision for the future that addresses healthcare disparities and maximises the implementation of best practices.

TABLE 1. *PERN networks*

Network	PECARN	PEM CRC	PERC	PERUKI	PREDICT	REPEM	RIDEPLA	RISeuP/SPERG
Reference	PECARN[7,8]	N/A	Bialy *et al.*[9]	Lyttle *et al.*[13]	Babl *et al.*[10]	Mintegi *et al.*[11,58]	Grupo de Trabajo RIDEPLA[15]	Mintegi[14]
Established	2001	1990s	1995	2012	2004	2006	2011	2012
Joined PERN	2009	2009	2009	2013	2009	2009	2019	2018
Geographic scope (WHO regions)	United States (Americas)	United States (Americas)	Canada (Americas)	United Kingdom and Ireland (Europe)	Australia and New Zealand (Western Pacific)	Europe and Middle East (Europe, Eastern Mediterranean)	Latin America (Americas)	Spain (Europe)
Affiliations/funder	EMSC/HRSA/MCHB	American Academy of Pediatrics	Canadian Institutes of Health Research		RACP, ACEM	EUSEM	SLEPE	Spanish Society of Paediatric Emergencies (SEUP)
Member institutions	21	40+	15	63	50+	Varies	100+	53
Annual paediatric ED presentations	1.3+ million†	2 million†	0.5+ million	1.5 million	1+ million	1.5+ million	4+ million	1.5+ million

†There is considerable overlap between the networks based in the United States. ACEM, Australasian College for Emergency Medicine; EMSC, Emergency Medical Services for Children (US programme); EUSEM, European Society for Emergency Medicine; HRSA, Health Resources and Services Administration (US); MCHB, Maternal and Child Health Bureau (US); N/A, not available; PECARN, Pediatric Emergency Care Applied Research Network; PEM CRC, Pediatric Emergency Medicine Collaborative Research Committee of the American Academy of Pediatrics; PERC, Pediatric Emergency Research Canada; PERN, Pediatric Emergency Research Network; PERUKI, Paediatric Emergency Research in the United Kingdom and Ireland; PREDICT, Paediatric Research in Emergency Departments International Collaborative; REPEM, Research in European Paediatric Emergency Medicine; RACP, Royal Australasian College of Physicians; RIDEPLA, *Red de Investigación y Desarrollo de la Emergencia Pediátrica Latinoamericana*; RISeuP/SPERG, *Red de Investigación de la Sociedad Española de Urgencias de Pediatría*/Spanish Paediatric Emergency Research Group; SLEPE, *Sociedad Latinoamericana de Emergencia Pediátrica*; WHO, World Health Organization.

PERN structure and processes

The five networks represented at the inaugural meeting[2] included the Pediatric Emergency Care Applied Research Network (PECARN, USA);[7,8] the Pediatric Emergency Medicine Collaborative Research Committee of the American Academy of Pediatrics (PEM CRC, USA); Pediatric Emergency Research Canada (PERC);[9] Paediatric Research in Emergency Departments International Collaborative (PREDICT, Australia and New Zealand);[10] and Research in European Paediatric Emergency Medicine (REPEM, Europe and Middle East).[11,12] PERN has subsequently supported the creation and strengthening of regional efforts within Europe and Latin America, with the formation of Paediatric Emergency Research in the United Kingdom and Ireland (PERUKI),[13] *Red de Investigación de la Sociedad Española de Urgencias de Pediatría*/Spanish Pediatric Emergency Research Group (RISeuP/SPERG),[14] and most recently, *Red de Investigación y Desarrollo de la Emergencia Pediátrica Latinoamericana* (RIDEPLA).[15] Of note, the creation of RIDEPLA coincided with the recognition of paediatric emergency medicine as a subspecialty in several countries of the region,[16] and some years later, with the creation of the regional academic society *Sociedad Latinoamericana de Emergencia Pediátrica*, in which RIDEPLA now resides. Table 1 details PERN's current member networks.

PERN is governed by an executive committee consisting of two representatives from each of the member networks. The PERN executive meets quarterly to give regional and overall research study updates, share ideas and consider new research proposals. Annual in-person meetings have occurred when possible, coinciding with major paediatric or emergency medicine international conferences. The executive elects the Chair, who is a paediatric emergency care researcher, to a 4- to 5-year term. The intent has been to rotate the leadership between participating networks.

An important consideration of PERN's structure is that it serves a supportive and collaborative role, rather than a governing function. A PERN study is defined simply as one

in which two or more of its eight member networks collaborate. Proposals are presented to the PERN executive for the purposes of consideration and approval, followed by networking and recruitment for those proposals that are endorsed. PERN has limited sources of funding for infrastructure and regional networks are governed and managed as independent entities subject to the governing bodies within their respective nations or regions. National and regional networks consistently report that involvement with other networks through PERN has strengthened both the scope and quality of their research, to the benefit of all involved. The full impact of PERN's facilitation of international collaborative research, beyond the numbers of publications and ongoing projects, is somewhat difficult to measure empirically. However, indirectly the impact can be measured by the observed growth of the field, the nature of the increasingly challenging research questions now being addressed and the collective capacity to generate and implement new knowledge in treating acutely ill and injured children.

PERN research

The evolution of PERN research has mirrored that of other national or regional paediatric emergency care research networks, beginning with retrospective studies and moving to prospective observational studies and then RCTs.[8–10] The timing of the inaugural PERN meeting in 2009 coincided with the H1N1 influenza pandemic. The strong desire to initiate a relevant, high-quality but low-budget volunteer-based research project between global networks led to a retrospective case–control study of children (<16 years old) who presented with influenza-like illness to 79 EDs in 12 countries between 16 April and 31 December 2009.[3] At that time, the study was the largest study in paediatric emergency care as measured by the number of sites involved. The successful completion of that study formed a foundation for the international collaboration to follow. The study identified six independent risk factors for severe outcomes in children presenting to EDs with influenza-like illness during the H1N1 pandemic: chronic lung disease, cerebral palsy/developmental delay, dehydration, chest retractions, tachycardia and requirement for oxygen. These risk factors could be used by clinicians to identify those children with influenza-like illness at highest risk for severe outcomes when presenting during this and possibly future, pandemics.

Prospective observational studies further enhanced the collaborative relationships and research capacity within PERN. Following the H1N1 study, members sought to address other key globally relevant questions in paediatric emergency care, including bronchiolitis and acute poisoning. Retrospective[17] and prospective[18] observational studies as well as secondary analyses[19–22] revealed practice variations and substantial rates of non-indicated testing and inappropriate interventions in both these conditions. For infants with bronchiolitis, it was found that the use of evidence-based supportive care minimised unnecessary hospitalisations. An additional focus of PERN research has looked at professional skills and knowledge development: an online survey revealed a global knowledge gap among emergency care professionals in psychosocial care of injured children,[23] and a cross-sectional survey across six networks revealed consensus in practice frequency and modality for critical paediatric procedures.[24–26]

Even as these observational studies were ongoing, research networks were joining together to fulfil PERN's long-term vision of conducting global RCTs. To date, at least two such efforts are underway. PRagMatic Pediatric Trial of Balanced versus nOrmal saline fLUid in Sepsis (PRoMPT BOLUS)[4] is a multicentre randomised, open-label, pragmatic trial to test the comparative effectiveness and relative safety of two common fluid types in the treatment of septic shock in children. This study will recruit 8800 children from more than 44 hospitals across the United States, Canada, Australia and New Zealand. One of the unique challenges of this trial is the coordination of several regulatory bodies and funding sources. Each of the three participating networks (PECARN, PERC and PREDICT) has secured its own ethical oversight and national funding, as no single government agency has the budget to support such a large study. A second PERN RCT in process relates to the treatment of bronchiolitis with epinephrine and dexamethasone.[5] Combination therapy will be compared to placebo in this double-blinded RCT, which aims to establish any impact of such treatment on hospitalisations over a 7-day period. This study, known as Bronchiolitis in Infants Placebo versus Epinephrine and Dexamethasone (BIPED) will recruit 1616 infants from 12 hospitals across Canada, Australia and New Zealand (PERC, PREDICT). The uniqueness of this trial is the coordination of manufacture of off-patent 'old' pharmaceuticals (epinephrine and dexamethasone) across three regulatory bodies and the challenges of responding to concerns about the uncertainty of nebulisation being considered an aerosol-generating procedure during the current COVID-19 pandemic. The achievement of global recruitment into definitive RCTs represents an important milestone in PERN's development and in global paediatric emergency care research. It is expected that the current focus on interventional studies will continue, as efforts are currently underway to generate a core outcome set in acute severe paediatric asthma[27] that will serve as the basis for future RCTs in this area.

Observational studies also continue to benefit from PERN infrastructure and collaboration. An ongoing large-scale (~2600 participants) prospective cohort study of community-acquired pneumonia (CAP)[28] will result in an accurate, objective model of prognosis in paediatric CAP from a global cohort, from which adequate numbers with severe disease will ensure precision and generalisability to a worldwide population. While the COVID-19 pandemic has reduced CAP presentations internationally, the network's established CAP infrastructure, with both research ethics and data sharing in place, has allowed a nimble response to the current global health crisis, with the rapid mobilisation of a

prospective cohort study to collect data on SARS-CoV-2-positive and -negative patients presenting to PERN study sites.[6] A second ongoing observational study is examining household transmission among asymptomatic SARS-CoV-2-infected children. The relative speed with which these two studies were launched compared to the retrospective study during the previous (H1N1) pandemic over a decade ago is a testament to the level of global infrastructure and efficiency that PERN has developed over time. In contrast to the first (H1N1) PERN study, which was unfunded, these two SARS-CoV-2 PERN studies have secured over CDN$1 million (US$790 000) in research funding from the Canadian Institutes of Health Research and separate grant funding from the United States. Notwithstanding the generalisability of findings, a unique advantage of PERN's collaboration in observational studies is the ability to achieve adequate numbers of severe outcomes for frequent presentations (H1N1, bronchiolitis, CAP), or adequate numbers of infrequent presentations (intussusception). A summary of ongoing and published PERN research (also highlighted on PERN's website, http://www.pern-global.com/) can be found in Table 2.

Challenges and vision for the future

The vision shared by those in attendance at the first PERN meeting in October 2009 was focused on answering globally relevant research questions through large collaborative research studies performed internationally with large sample populations assessed in diverse emergency contexts. Since that time, global prospective observational studies and RCTs have become a reality. However, more work needs to be done to fulfil PERN's potential: to remove barriers to allow more research networks to join a study, to extend PERN's reach into all six regions of the World Health Organization with a focus on including sites from resource-poor areas and studying marginalised populations and to investigate disparities in care based on race and ethnicity to ensure that all children globally receive outstanding, evidence-based care. A further aim will be to establish and grow a permanent infrastructure including, among other objectives, a data centre and infrastructure funding to facilitate developing protocols for new prospective studies. All of these factors will increase the capacity for nimble responsiveness to the changing landscape in global paediatric emergency care.

Connected to PERN's research focus since its inception is the recognised need for translation of research knowledge into clinical practice to ensure that all children and youth who present to an ED globally will benefit from high-quality research evidence. PERN therefore strives toward the goal to improve paediatric emergency care internationally such that a child in any ED across the globe has access to the most up-to-date therapies and skills, regardless of the geographic, cultural and resource contexts.[2] To address this challenge, it is important to recognise that the leading causes of child mortality worldwide are acute conditions often requiring urgent attention: acute respiratory infection, diarrheal disease, sepsis and injury.[29] Many of these are highly treatable and the research efforts of PERN and its eight participating networks have focused on advancing best practices for these high-priority conditions. However, a coordinated, international effort to improve emergency care for children by ensuring effective implementation of best practices for common and treatable acute conditions in all ED settings is warranted.

The path to this goal is not straightforward. As an example, the fluid-based resuscitation question being addressed by the PRoMPT BOLUS study[4] seeks to establish best practices for the type of fluid used in fluid resuscitation for the treatment of paediatric sepsis globally. Even within resource-rich contexts, however, disparities exist in paediatric emergency care that can have devastating outcomes.[30] Unfortunately, what is likely an infrequent event that warrants investigation in a resource-rich country is a common, daily occurrence elsewhere and the worldwide rate of death from sepsis in children is likely grossly underestimated.[31] Although the estimated mortality rate for neonatal sepsis is 11–19% in middle- to high-income countries,[32] it is as high as 31% in Latin America,[33] in great part due to inadequately prepared providers.[34] In addition to variation in fluid type and mortality, management of paediatric sepsis is also complicated by the question of the amount of fluid resuscitation required. The highest-quality evidence that is available comes from the Fluid Expansion as Supportive Therapy (FEAST) study, an RCT of 3141 children presenting to hospitals in sub-Saharan Africa with sepsis randomised to receive fluid boluses or no fluid boluses.[35] Despite the no-bolus arm showing a benefit in terms of mortality, overall and in the subgroups with and without malaria, clinicians in resource-rich settings have struggled to integrate these findings into clinical practice, relying more on lower-quality evidence from settings similar to their own. If we are going to improve emergency care for children by increasing the use of evidence-based therapies, evidence needs to flow bi-directionally between resource-rich and resource-restricted settings.

The movement of research-derived evidence into clinical practice has been addressed over the past two decades by advances in knowledge translation (KT), which seeks to close the gap between what is known from scientific evidence and what is done in clinical practice. National knowledge mobilisation initiatives such as Translating Emergency Knowledge for Kids (TREKK; https://trekk.ca) in Canada and the Emergency Medical Services for Children Innovation and Improvement Center (EIIC; https://emscimprovement.center/) in the United States have had some success in connecting general EDs across the country with expertise and best practices available through paediatric emergency care specialists. Furthermore, this established infrastructure has already been shown to shorten the process of moving research knowledge into the clinical setting

TABLE 2. *PERN research*

Reference	Study design	Number of sites/ countries	Date of data collection, *n*	Topic of study	Major finding
H1N1					
Dalziel *et al.*, 2013[3]	Retrospective case-controlled	79 sites, 12 countries	Apr–Dec 2009, $n = 265$ children (<16 years)	H1N1, influenza-like disease	Identified six risk factors for severe outcomes
Bronchiolitis					
Schuh *et al.*, 2017[17]	Retrospective cohort	38 EDs, 8 countries	Jan–Dec 2013, $n = 3725$ infants (<12 months)	Practice variation in acute bronchiolitis	Evidence-based supportive therapies minimise potentially unnecessary hospitalisations
Freire *et al.*, 2018[19]	Secondary analysis	38 EDs, 8 countries	Jan–Dec 2013, $n = 3725$ infants (<12 months)	Escalated care in infant bronchiolitis	Risk score derived to stratify risk of escalated care for hospitalised infants
Zipursky *et al.*, 2020[21]	Secondary analysis	38 EDs, 8 countries	Jan–Dec 2013, $n = 3725$ infants (<12 months)	Practice patterns of antibiotics and lab tests in infant bronchiolitis	Significant rates of non-indicated testing outside UK and Ireland, increased antibiotic use associated with chest X-ray; international benchmarks, guidelines, quality initiatives are needed
Plint *et al.*, 2020[5]	RCT 'BIPED'	12 sites, 3 countries	In process, $n = 1616$ infants (<12 months)	Comparative effectiveness of dexamethasone and epinephrine *versus* placebo in infant bronchiolitis	Hypothesis: fewer hospitalisations over 7 days with treatment compared to placebo
Poisoning					
Mintegi *et al.*, 2017[18]	Prospective cross-sectional	105 EDs, 20 countries	2013–2014, $n = 1688$	Practice variation in GID after acute poisoning	<50% of GID interventions are appropriate
Mintegi *et al.*, 2019[20]	Secondary analysis	105 EDs, 20 countries	2013–2014, $n = 1688$	Epidemiology of acute poisonings	Regional and national differences in means and demographics

TABLE 2. *Continued*

Reference	Study design	Number of sites/ countries	Date of data collection, *n*	Topic of study	Major finding
Gonzalez-Urdiales *et al.*, 2020[22]	Secondary analysis	105 EDs, 20 countries	2013–2014, $n = 1688$	Epidemiology and management of intentional self-poisonings in children	Most intentional self-poisoning presentations are related to intentional ingestions of therapeutic drugs at home by females. Regional variation in management
Professional skills/knowledge development					
Alisic *et al.*, 2016[23]	Online survey	PERN-wide	Jul 2013–Feb 2014; $n = 2648$ survey responses	ED professionals' knowledge of psychosocial care for injured children	More education is needed and wanted (>90%)
Craig *et al.*, 2019[25]	Cross-sectional survey	6 regional networks, 96 PERN sites	2013–2014, $n = 1332$ survey responses	Practice frequency and modality for critical paediatric procedures by senior PEM clinicians	Annual practice in an alt-clinical setting for airway manoeuvres and simulation for other procedures
Craig *et al.*, 2020[26]	Cross-sectional survey	6 regional networks, 96 PERN sites	2013–2014, $n = 1503$ survey responses	Exposure and confidence levels in performing critical non-airway procedures reported by senior PEM clinicians	CPR and intraosseous needle insertion were the only procedures performed by >50% of respondents within the previous year. Confidence was higher for these and for needle and tube thoracostomy
Nagler *et al.*, 2021[24]	Cross-sectional survey	6 regional networks, 96 PERN sites	2013–2014, $n = 1602$ survey responses	Exposure and confidence levels in performing critical airway procedures reported by senior PEM clinicians	Confidence varied by procedure and by patient age. Supervision of an airway procedure was the strongest predictor of procedural confidence

(*Continues*)

TABLE 2. *Continued*

Reference	Study design	Number of sites/ countries	Date of data collection, *n*	Topic of study	Major finding
Asthma					
Craig *et al.*, 2020[27]	Core outcome set	PERN-wide	In process	Acute severe paediatric asthma	Protocol for the development of a core outcome set for RCT design
Sepsis					
Balamuth *et al.*, 2019[4]	RCT (open-label pragmatic) 'PRoMPT BOLUS'	44 EDs, 4 countries	$n = 8800$ (>6 months, <18 years)	Comparative effectiveness and relative safety of balanced fluid resuscitation *versus* normal saline in children with septic shock	RCT of saline *versus* balanced fluids for paediatric septic shock
Pneumonia					
Florin *et al.*, 2020[28]	Prospective observational cohort	~80 sites	$n = \sim 2600$	CAP	Clinical prediction model to stratify risk for mild, moderate, severe CAP
COVID-19					
Funk *et al.*, 2021[6]	Prospective observational cohort	47 EDs, 12 countries	$n = 12\,500$	Characterisation of paediatric COVID-19	Large global dataset of children positive and negative for SARS-CoV-2 with details on exposures, symptoms, investigations, treatments and outcomes
Intussusception					
Shavit, 2020 (n/a)	Retrospective cohort 'PAINT'	85 EDs	Jan 2020–Mar 2021, $n = 3160$	Analgesia and sedation in intussusception	Largest global dataset of children presenting to EDs with intussusception

BIPED, Bronchiolitis in Infants Placebo versus Epinephrine and Dexamethasone; CAP, community-acquired pneumonia; CPR, cardiopulmonary resuscitation; GID, gastrointestinal decontamination; n/a, not available; PAINT, PAin management and sedation in paediatric Ileocolic INTussusception; PEM, paediatric emergency medicine; PERN, Paediatric Emergency Research Network; PRoMPT BOLUS, PRagMatic Paediatric Trial of Balanced versus nOrmal saline fLUid in Sepsis; RCT, randomised controlled trial.

from years to months: for example, in the mobilisation in Canada of the results of a US clinical trial of fluid infusion rates for in the treatment of paediatric diabetic ketoacidosis[36] or the rapid adoption of results of studies into new anti-epileptic medications individually from three of the PERN networks into treatment algorithms globally for the management of paediatric status epilepticus.[37–39] PERN has begun to disseminate its study findings globally in multiple languages through its website and associated digital media. This infrastructure to enhance rapid adoption of definitive evidence may be seen as the seed of international knowledge mobilisation efforts that will grow within PERN.

The field of implementation science (IS) has emerged as a means of rigorously designing and evaluating KT interventions (e.g. educational tools, organisational change management strategies) by comparing the effectiveness of intervention strategies across a series of hospitals, clinics, institutions, and so on. The opportunities for IS in paediatrics have been discussed and explored,[40] and should be rapidly adopted in paediatric emergency care. Effective implementation strategies are built on the behavioural sciences. Even with a clear path forward in the treatment of conditions such as sepsis or bronchiolitis, it is not appropriate to assume that a policy decision or practice guideline is equivalent to a change in behaviour. The psychological and contextual reasons for this have been studied extensively and compiled into frameworks to help researchers understand and address them.[41] Identification of the barriers and facilitators of practice change are further facilitated by the engagement of not only health care providers but also patients and families. The realisation of PERN's vision for the future will require expanding the model of collaboration beyond the geographical dimension into the disciplinary dimension, adding to the network experts in such disciplines as IS, behavioural science, health economics and patient and public engagement.

A well-designed implementation strategy could be evaluated with rigorous methods, for example in a cluster RCT, currently considered the strongest design to test implementation interventions.[42] PERN researchers have a rich depth of experience and expertise in conducting such RCTs with children, including a study in Australia and New Zealand to develop and test implementation interventions in treating bronchiolitis in infants[43–45] and a cluster RCT of parent-shared decision making to test the implementation of a decision rule for computed tomography in children with minor blunt head trauma.[46] Based on the evolution of the PERN research to date, the global cluster RCT in paediatric emergency care is within reach.

However, for any implementation strategy to be truly effective, it must take into consideration the principles of equity, diversity and inclusion. It is increasingly clear that racial and ethnic disparities exist in paediatric emergency care, both within regions and globally (e.g. imaging differences after minor head trauma and abdominal trauma, opiates for appendicitis etc.).[47–49] These disparities exist not only between countries but also between regions, even in high-income countries with well-developed health systems. For example, despite Canada's universal healthcare system, access to high-quality healthcare is not universal and is instead fraught with systemic racial bias.[50] This is reflected in poorer health outcomes for children and youth of Indigenous and racialised minorities.[51] Racial disparities in health are salient in the United States[52] and New Zealand[53,54] and are receiving increasing attention in Latin America as socioeconomic considerations are taken into account.[55–57] To truly fulfil PERN's agenda for the next decade will require not only addressing implementation broadly but also working toward actively promoting health and healthcare equity.

A model for international research in paediatric emergency care

International collaborative research has been established for some decades in the sub-specialties of neonatology and paediatric oncology, where global research is more feasible owing to relatively low patient volume, long-term hospital care for their patients and a higher incidence of serious outcomes. By comparison, most emergency conditions are acute and resolve after a single visit to the ED. Even with PERN's success at laying the foundation for global multicentre trials, including those in which multiple networks participate, inefficiencies remain and the network must face the important challenge of implementing science into everyday clinical practice. Effecting the desired changes will require progress in four areas: (i) expanding the capacity for global RCTs; (ii) deepening the focus on implementation science; (iii) increasing attention to healthcare disparities and their origins, with growing momentum toward equity; and (iv) expanding PERN's global reach to add sites and networks from resource-restricted regions. Continued international collaboration, with iterative gains in cooperation, knowledge generation and implementation, as demonstrated by PERN over the last decade, has the ability to more rapidly 'move the dial' and improve health and outcomes for acutely ill and injured children globally.

Competing interests

SRD and FEB are section editors for *Emergency Medicine Australasia*.

Data availability statement

No further data available.

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